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Environmental Noise and Vibration Impact Assessment

Mashala Resources
De Wittekrans Coal Project

Mpumulanga Province

Project No: 074/2010
Compiled by: B v/d Merwe
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Executive Summary

The noise and vibration impact assessment was done to quantify and assess the prevailing ambient noise and vibration levels in and around the proposed de Wittekrans mining area.

The purpose of the assessments was to:

- Identify and evaluate noise related problems i.t.o. SANS 10103 of 2008 – The measurement and rating of environmental noise with respect to annoyance and to speech communication and the International IFC - International Finance Corporation, Environmental, Health and Safety Guidelines.

- Determine the prevailing ambient noise level during the daytime period and the nighttime period.

- Determine if the noise generated by the proposed mining activities may cause a noise problem and/or increase the prevailing ambient noise levels.

- Determine the prevailing vibration levels within the boundaries of the mining area.

The following procedures were followed:

- An initial survey identified potential noise and vibration measuring sites.

- Noise and vibration measurements were done at the different measuring points in and around the proposed mining area.

The information obtained from the noise and vibration survey was used to calculate and predict what the impact of the proposed mining activities may have on the environment and abutting residential area.

The proposed mining area is situated in a rural type district and the N11 Road runs through the northern side of the proposed mine.

The following are potential noise sources in the vicinity of the proposed mining area:

- Distant traffic noise;
- Traffic noise;
- Domestic type noise;
- Farming activity noise;
- Wind noise;
- Aircraft noise;
- Insect and animal noises.

Discussion of the results

The World Health Organisation has published a series of recommended maximum sound pressure Levels, applicable to various situations:

Descriptor	Limit	Situation or effect
LAeq, 24	70 dBA	Negligible risk of hearing impairment
LAeq, 8	75 dBA	Negligible
LAeq	30 dBA	Excellent speech intelligibility
LAeq	55 dBA	Fairly good speech intelligibility
LAeq	30 dBA	No sleep disturbance in a bedroom
LAmax	45 dBA	No sleep disturbance – peak inside bedroom
LAeq	55 dBA	Residential areas, outdoors, daytime
LAeq	45 dBA	Residential areas, outdoors, night time

The activities to be introduced into this area will result that there will be a temporary shift and in some of the areas a permanent shift in the prevailing ambient noise level.

The proposed mine activities will however take place at some distance from the noise sensitive residential areas which will result in the reduction of the noise levels as experienced by the receptor. The sound pressure level will decrease by 6.0dB and for point sources and 3.0dB for line sources per doubling of the distance from the source. (Inverse Square Law Principle).

Summary of the rating of the project after the implementation of noise mitigatory measures:

Activity	Rating	Significance
Construction phase		
Upgrade of existing gravel road to a asphalt type surface;	18	Low
Grading and building of new internal roads and haul roads;	18	Low
Preparation of the footprint area, earthworks & construction;	18	Low
Provision of services such as water, sewerage and electricity;	18	Low
Construction of conveyor;	18	Low
Construction of earthberm on eastern side of pit 3;	18	Low
Construction of the ventilation shafts for under-ground mining	18	Low
Operational phase		
Drilling;	33	Medium
Overburden blasting;	52	Medium
Coal blasting;	52	Medium
Removal of coal	33	Medium
Crusher;	33	Medium
Conveying of coal by means of conveyor;	33	Medium
Transportation of coal by road;	52	Medium
Plant activities;	33	Medium
Decommissioning phase		
Rehabilitation of mined area	18	Low

The noise impact on the environment and the people residing in the vicinity of the coal mine will be low during the construction phase and medium during the operational phase.

The vibration levels are insignificant as there were no vibration generating sources within the vicinity of the study area.

Recommendations

The following three primary variables should be considered when designing acoustic screening measures for the control of noise:

- The source
- The transmission path
- The receiver

Essentially it requires and it is important to understand the problem, to identify which part of the proposal itself could produce noise and where are the key receptors.

The baseline noise information on the different noise sources, the location, type of equipment and the atmospheric conditions for a specific area will play an important role in the design of the acoustic screening measures.

The following acoustic measures must be implemented as a management control system:

- A bund wall to be erected on the side of the interface of the activity to face any noise sensitive areas within a distance of 800m from the open cast pit.
- Carry out an ongoing noise monitoring programme which is in line with the World Bank's IFC – International Finance Corporation, Environmental, Health and Safety Guidelines.

Blasting:

The air over pressure level and vibration, (audible and the inaudible – concussion - noise), to be monitored and controlled during the blasting operation. The standards implemented by the USA Bureau of Mine Standards, RU 8507, are used as a guideline to monitor and control blasting operations in South Africa.

- The limit for ground vibration should not exceed 10mm/s in the vicinity of clay huts and/or poorly constructed buildings.
- An over pressure limit of 134 dB should not be exceeded. Near schools and churches not to exceed 128 dB.
- No blasting to take place when there are windy conditions.

The Regulations under the Mines Health and Safety Act requires the owner of the operation to ensure that the health and safety of employees and people will not be affected during blasting.

Blasts must be designed in such a manner that ground vibration and over pressure levels are adhered to. In order to comply with the above, the following measures should be implemented:

- A scheme of vibration and air over pressure monitoring to be implemented;

- A scheme by which air over pressure is controlled;

- Days and times of blasting operations to be established;

- Ensure that the correct design relationship exists between burden, spacing and hole diameter;

- Ensure the maximum amount of explosive on any one day delay interval, the maximum instantaneous charge, is optimized by considering: -

    - Reduce the number of holes per detonator delay interval;
    - Reduce the instantaneous charge by in-hole delay techniques;
    - Reduce the bench height or hole depth;
    - Reduce the borehole diameter.

- Always attempt to minimize the resulting environmental effects of blasting operations and to recognize the fact that the perception of blasting events occurs at levels of vibration well below those necessary for the possible onset of the most cosmetic of damage; but nevertheless at levels that can concern occupants abutting the mining area;

- Be aware that relatively small changes in blast design can produce noticeable differences in environmental emissions and that it is very often in response to changes in these emissions rather than their absolute value that complaints may be made.

Scheme of vibration monitoring may include the following:

- The location and number of monitoring points;
- The type of equipment to be used and the parameters to be measured;
- The frequency of monitoring;
- The method by which such data are made available to management;
- The method by which such data are used in order to ensure that the site vibration limit is not exceeded and to mitigate any environmental effects of blasting.

Open cast mining area:

There are different activities taking place at the interface of the mining area i.e. drilling, excavation, loading etc. and this area will have to be monitored in order to determine if a noise nuisance/disturbance is created.

Additional mitigation measures i.e. earth berm, must be provided (if practical) during the construction and design phase before construction activities will commence.

The following measures must be considered prior to the acquisition of earthmoving equipment:

- Enclosure of engine bays;
- Modification of radiator fan design and materials;
- Installation of louvers on radiator and hydraulic cooling fans;
- Re-engineering of exhaust systems

Noise attenuation measures:

- Scheduling of equipment within the pit must take into consideration the noise emissions from the equipment in order to spread them out over the interface area.

General

Maintain the internal and roads leading to the mine in a good order at all times. Monitor the speed of the trucks and speed limits to be enforced according to the capacity and the condition of the roads.

The following are the Environmental, Health and Safety Guidelines of the International Finance Corporation of the World Bank, which should be considered at all times:

- Selecting equipment with lower sound power levels
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment causing radiating noise;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific equipment and mobile sources with high sound power outputs;
- Re-locate noise sources to areas which are less noise sensitive, to take advantage of distance and natural shielding;
- Taking advantage during the design stage of natural topography as a noise buffer;

- Develop a mechanism to record and respond to complaints.

- An ongoing noise monitoring programme to be initiated for the construction and operational phases of the project.

Conclusion and summary

- The prevailing ambient noise levels in the vicinity of the proposed mining area (Open cast pit) are higher due to the N11 Road which runs through this section of the proposed mining area.

- The prevailing noise levels are largely created by emissions from a combination of noise sources i.e. farming activities, heavy-duty vehicles, insects and animals.

There will be an upwards shift in the prevailing ambient noise levels at the near field and to a certain extent in the far field. In the immediate mining area, which is some distance from the residential areas the shift will be more of a permanent nature depending on the duration of such an activity.

An ongoing noise and vibration monitoring program to be implemented in order to ensure compliance to the Noise Control Regulations and/or SANS 10103 of 2008 - The measurement and rating of environmental noise with respect to annoyance and to speech communication.

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1. Purpose of the study

- The noise and vibration survey was carried out in order to determine the prevailing ambient noise and vibration levels at the boundaries of the proposed mining area.
- Quantify the alleged impact of noise on the prevailing ambient noise levels and the outdoor environment.
- Make recommendations on engineering control mitigatory measures.

2. Introduction

The proposed de Wittekrans mining area will be situated on Portion 11 an extent of Portion 10 of the Farm de Wittekrans 218 IS, Portion 5 and Portion 7 of the Farm de Wittekrans 218 IS, the Farm Tweefontein 203 IS, Remainder of extent of Groblershoek 191 IS, Remainder of an extent of the Farm Israel 207 IS, Farm Groblershoop 192 IS and a Remainder extent of Portion 1 and 2 of the Farm de Wittekrans 218 IS.

This proposed mining area is south-east of the Town of Hendrina some 6km from the town along the N11 Road. The mining activities will consist out of partially open-cast mining with the bulk of the mining activities which will be under - ground mining operations. The proposed open cast mining will take place in the region of the N11 Road and in the north-western section of the mining area.

Coal will be transported from the open cast mining area via conveyor to the plant which is located in the middle of the proposed mining area. The coal will then be transported via road to the nearby railway siding. The information relevant to this study can be seen in Figure 1.

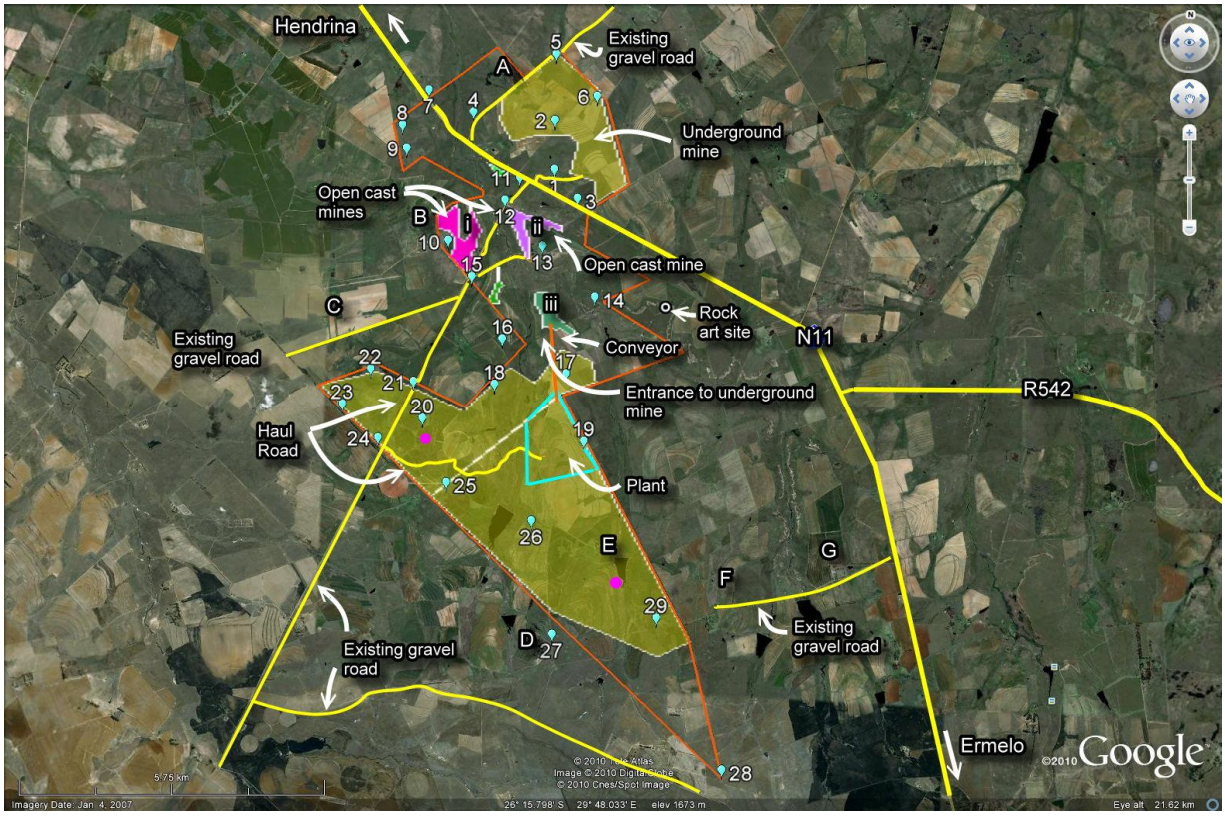

Figure 1: de Wittekrans mine area and other information

The prevailing ambient noise level is proportional to the type of activity i.e. traffic, farming and farm animal noises.

3. Background to noise and vibration

Noise

Sound is a wave motion, which occurs when a sound source sets the nearest particles of air in motion. The movement gradually spreads to air particles further away from the source. Sound propagates in air with a speed of approximately 340 m/s.

The sound pressure level in free field conditions is inversely proportional to the square of the distance from the sound source – inverse square law. Expressed logarithmically as decibels, this means the sound level decrease 6 dB with the doubling of distance. This applies to a point source only. If the sound is uniform and linear then the decrease is only 3 dB per doubling of distance.

The decibel scale is logarithmic therefore decibel levels cannot be added together in the normal arithmetic way, for example, two sound sources of 50 dB each do not produce 100 dB but 53 dB, nor does 50 dB and 30 dB equal 80 dB, but remains 50 dB.

Air absorption is important over large distances at high frequencies and it depends on the humidity but is typically about 40 dB/km @ 4000 Hz. Traffic noise frequencies are mainly mid/low and will be unaffected below 200m.

When measuring the intensity of a sound, an instrument, which duplicates the ear variable sensitivity to sound of different frequency, is usually used. This is achieved by building a filter into the instrument with a similar frequency response to that of the ear. This is called an A-weighting filter because it conforms to the internationally standardized A-weighting curves. Measurements of sound level made with this filter are called A-weighted sound level measurements, and the unit is dB.

Sound propagation is affected by wind gradient rather than the wind itself. The profile of the ground causes such a gradient. The sound may be propagated during upwind conditions upwards to create a sound shadow. A downwind refracts the sound towards the ground producing a slight increase in sound level over calm isothermal conditions.

The velocity of sound is inversely proportional to the temperature therefore a temperature gradient produces a velocity gradient and a refraction of the sound. Temperature decreases with height and the sound is refracted upwards.

For a source and receiver close to the ground quite large attenuation can be obtained at certain frequencies over absorbing surfaces, noticeably grassland. This attenuation is caused by a change in phase when the reflected wave strikes the absorbing ground and the destructive interference of that wave with the direct wave. The reduction in sound tends to be concentrated between 250 Hz and 600 Hz.

Noise screening can be effective when there is a barrier between the receiver and the source i.e. walls, earth mounds, cuttings and buildings. The performance of barriers is frequency dependent. To avoid sound transmission through a barrier the superficial mass should be greater than 10 Kg/m^2.

There is a complex relation between subjective loudness and the sound pressure level and again between annoyance due to noise and the sound pressure level. In general the ear is less sensitive at low frequencies and the ear will only detect a difference in the sound pressure level when the ambient noise level is exceeded by 3-5 dBA.

There are certain effects produced by sound which, if it is not controlled by approved acoustic mitigatory measures, seem to be construed as undesirable by most people and they are:

- Long exposure to high levels of sound, which may damage the hearing or create a temporary threshold shift – in industry or at areas where music is played louder than 95 dBA. This will seldom happen in far-field conditions;
- Interference with speech where important information by the receiver cannot be analyzed due to loud noises;
- Excessive loudness;
- Annoyance.

A number of factors, for example clarity of speech, age of listener and the presence of noise induced threshold displacement, will influence the comprehensibility of speech communication.

The effect of noise (with the exception of long duration, high level noise) on humans is limited to disturbance and/or annoyance and the accompanying emotional reaction. This reaction is very difficult to predict and is influenced by the emotional state of the complainant, his attitude towards the noisemaker, the time of day or night and the day of the week.

Types of noise exposure:

Continuous exposure to noise – The level is constant and does not vary with time e.g. traffic on freeway and an extractor fan;
Intermittent exposure to noise – The noise level is not constant and occurs at times e.g. car alarms and sirens;
Exposure to impact noise – A sharp burst of sound at intermittent intervals e.g. explosions and low frequency sound.

Depending upon the intensity of the sound, the length of time of exposure and how often over time the ear is exposed to it, noise affects humans differently. Urban dwellers are besieged by noise, not only in the city streets but also in the busy workplaces and household noises. The recommended noise levels for specific areas can be seen in Table 1.

Table 1: Recommended sound pressure levels for specific areas.

Descriptor	Limit	Situation or effect
LAeq, 24	70 dBA	Negligible risk of hearing impairment
LAeq, 8	75 dBA	Negligible
LAeq	30 dBA	Excellent speech intelligibility
LAeq	55 dBA	Fairly good speech intelligibility
LAeq	30 dBA	No sleep disturbance in a bedroom
LAmax	45 dBA	No sleep disturbance – peak inside bedroom
LAeq	55 dBA	Residential areas, outdoors, daytime
LAeq	45 dBA	Residential areas, outdoors, night time

This time-varying characteristics of environmental noise are described using statistical noise descriptors:

Leq: The Leq is the constant sound level that would contain the same acoustic energy as the varying sound level, during the same period of time.

L_{Max}: The instantaneous maximum noise level for a specified period of time.

L_{Min}: The instantaneous minimum noise level for a specified period of time.

The following relationships occur for increases in A-weighted noise levels:

- The trained healthy human ear is able to discern changes in sound levels of 1 dBA under controlled conditions in an acoustic laboratory;
- It is widely accepted that the average healthy ear can barely perceive noise level changes of 3 dBA;
- A change in sound level of 5 dBA is a readily perceptible increase in noise level;
- A 10-dBA change in the sound level is perceived as twice as loud as the original source.

The World Bank in the Environmental Health and Safety Regulations has laid down the following noise level guidelines:

- Residential area – 55 dBA for the daytime and 45 dBA for the nighttime period;
- Industrial area – 70 dBA for the day- and nighttime periods.

The difference between the actual noise and the ambient noise level and the time of the day and the duration of the activity, will determine how people will respond to sound and what the noise impact will be. In order to evaluate such, there must be uniform guidelines to evaluate each scenario. The SANS 10103 of 2008 has laid down sound pressure levels for specific districts and these noise levels can be seen in Table 2.

Table 2: Recommended noise levels for different districts.

1	2	3	4	5	6	7
	Equivalent continuous rating level $L_{Req,T}$ for ambient noise dBA					
	Outdoors			**Indoors, with open windows**		
Type of district	**Day-night** L_{Rdn} [2)]	**Daytime** L_{Rd} [1)]	**Night-time** L_{Rn} [1)]	**Day-night** L_{Rdn} [2)]	**Daytime** L_{Rn} [1)]	**Night-time** L_{Rn} [1)]
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with some workshops, with business premises and with main roads	60	60	50	50	50	40
e) Central business district	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

The reference time intervals can be specified to cover typical human activities and variations in the operation of noise sources and are for daytime between 6h00 to 22h00 and for nighttime between 22h00 and 6h00.

The response to noise can be classified as follows:

- An increase of 1dBA to 3dBA above ambient noise level will cause no response from the affected community. For a person with normal hearing an increase of 0dBA to 3 dBA will not be noticeable

- An increase between 1dBA – 10dBA will elicit little to sporadic response. When the difference is more than 5 dBA above the ambient noise level a person with normal hearing will start to hear the difference.
- An increase between 5dBA and 15 dBA will elicit medium response from the affected community.
- An increase between 10dBA and 20 dBA will elicit strong community reaction.

Because there is no clear-cut transition from one community response to another as well as several variables, categories of responses can overlap. This should be taken into consideration during the evaluation of a potential noise problem.

There is therefore a mixture of activities and higher noise levels as per the above recommended continuous rating levels within i.e. residential, industrial and feeder roads in close proximity of each other.

The ambient noise level will therefore differ throughout the study area, depending on the region and the measuring position in relation to areas with existing mining activities.

People exposed to an increase in the prevailing ambient noise level will react differently to the noise levels and the response is given in Table 3.

Table 3: Estimated community/group response when the ambient noise level is exceeded

1	2	3
Excess $)L_{Req,T}$[1]	**Estimated community/group response**	
dB	**Category**	**Description**
0	None	No observed reaction
0-10	Little	Sporadic complaints
5-15	Medium	Widespread complaints
10-20	Strong	Threats of community/group action
>15	Very strong	Vigorous community/group action

1) Calculate $)L_{Req,T}$ from the appropriate of the following:

a) $)L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation).

b) $)L_{Req,T}$ = $L_{req,T}$ of ambient noise under investigation MINUS the maximum rating level for the ambient noise given in Table 1.

c) $)L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from table 2.

The difference between the actual noise and the ambient noise level will determine how people will respond to sound.

Vibration

Human reaction to vibration will be in response to the resulting effects of both ground and airborne vibration and in particular the combined effects of such vibration. The blasting process is the biggest contributor to vibration.

Routine blasting operations regularly generate air over pressure levels at the closest properties at 15m of about 120 dB. A constant wind velocity of $5m/s^{-1}$ will generate the pressure equivalent of 120 dB at 15m from the blasting area. At 140 dB the wind velocity will increase to $8m/s^{-1}$.

Wavelength differences associated with this frequency range mean that any effects of topography are likely to be pronounced for the audible component of air over pressure levels rather than the concussive component. A topographic barrier i.e. an earthberm or rock face will play an important role in reducing the audible effect rather than the concussive effect. A series of quarry faces between the receptor and the source will be more effective to reduce the air over pressure levels.

The shock waves have a relatively high dominant frequency and the energy contained in the shock wave will reduce rapidly as the resultant energy will be subjected to geometric and natural attenuation. Rock formations absorb the vibrations and/or the distance from the source which will result in the shock wave to be attenuated by 6dB in the doubling of distance from the source.

The blast design chart suggested in Rock Slope Engineering by Wyllie and Mah, 2004 will be used to quantify damage potential to residential properties. It is generally accepted that residential buildings of sound construction can safely withstand peak particle velocity (PPV) in m/s of 50mm/s. Poorly constructed buildings should however not be subjected to PPV's of more than 10mm/s. Figure 2 depicts the typical vibration control diagram where the charge per delay is combined with the distance from the blast to indicate the safe and damage zones and when damage to structures can be expected.

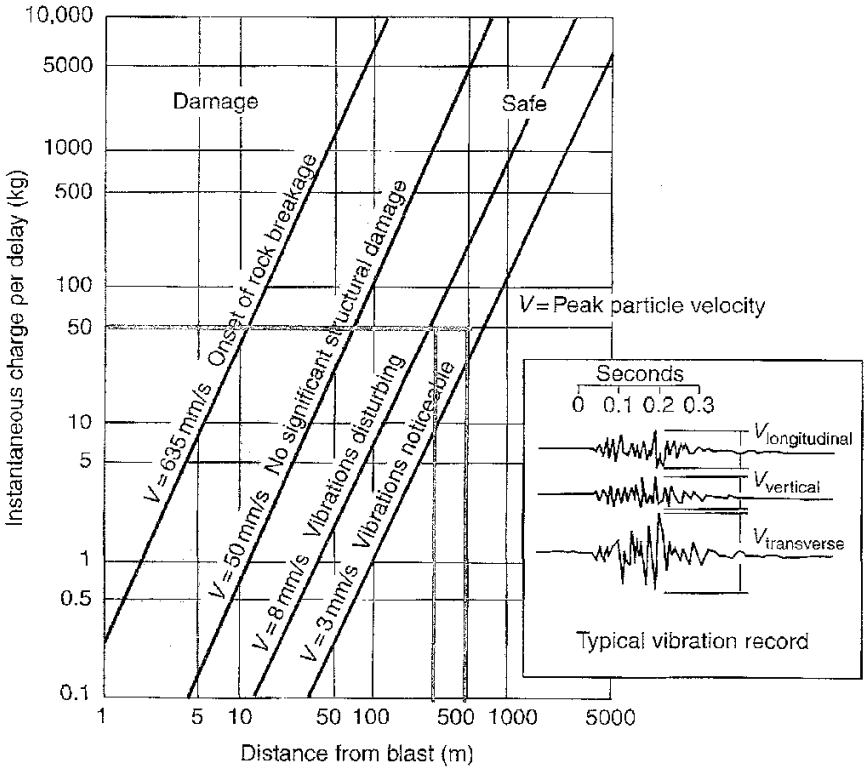

Figure 2 – Blast design chart

Meteorological conditions such as wind speed, direction, temperature, cloud cover and humidity will affect the intensity of the air over pressure levels perceived at a distance from the blasting area. A blast in a motionless atmosphere will reduce the air over pressure level by 6.0 dB as the distance from the source doubles.

The air over pressure levels at the source should be minimized in order for the energy to be within acceptable criteria at a distance. This could be achieved by proper blast design. In general, individual blasts should not exceed 50mm/s in the vicinity of properly constructed buildings and the average level should not exceed 10mms in the vicinity of poorly constructed buildings. These levels conform to the British Standards 6472 and the USA Bureau of Mine Standards, RU 8507.

4. Method of evaluation

The noise survey was conducted in terms of the provisions of the SANS 10103 of 2008 - The measurement and rating of environmental noise with respect to land use, health annoyance and to speech communication.

The instruments used in the noise survey:

Instrument 1

Larsen Davis Integrated Sound Level meter Type 1 – Serial no. S/N 0001072
Larsen Davis Pre-amplifier – Serial no. PRM831 0206
Larsen Davis ½" free field microphone – Serial no. 377 B02 SN 102184
Larsen Davis Calibrator 200 – Serial no.3073

Instrument 2

Larsen Davis Integrated Sound Level meter Type 1 – Serial no. S/N 824A3282
Larsen Davis Pre-amplifier – Serial no. PRM 902/3493
Larsen Davis ½" free field microphone – Serial no. 2541/7937
Larsen Davis Calibrator 200 – Serial no.3073

The instrument was calibrated before and after the measurements were done and coincided within 0, 5 dBA.

Batteries were fully charged and a windshield was in use at all times.

The equipment used in the vibration survey, was an 824 FFT shear Accelerometer with a sensitivity of 97.9mV/g.

5. Comments

The following is of relevance to the ambient noise measurements:

- The L_{Aeq} was measured over a 10minute period, which is a representative sampling period at each measuring point.
- The noise survey was carried out during the day and nighttime period being 6h00 to 22h00 for the day time and 22h00 to 6h00 for the night time period.

The World Bank has some Environmental, Health, and Safety (EHS) Guidelines for noise management. The preferred method for controlling noise from stationary sources is to implement noise control measures at the source.

Methods for prevention and control of sources of noise emissions depend on the source and proximity of receptors.

A point of reception or receptor may be defined as any point on the premises occupied by persons where extraneous noise and/or vibration are received.

The Environmental Health and Safety recommended noise level guidelines for a residential area are 45 dBA for the nighttime and 55 dBA for the daytime and for an industrial area it is 70 dBA for the day- and nighttime period.

The sections along the existing gravel roads and the N11 Freeway are already exposed to higher noise levels due to the traffic that make use of these roads.

6. Methodology of the study

6.1 Site visit – proposed mining area

6.2 Noise and Vibration measurements

6.3 Noise and vibration emissions from daytime activities at the proposed mining area

6.4 Noise and vibration emissions from night time activities at the proposed mining area

6.5 Assessment of noise and vibration impacts

6.1 Site visit – proposed mining area

A site visit was carried out at the proposed de Wittekrans mining area to:

- Identify the major contributors to the prevailing ambient noise level and vibration levels in the vicinity of the proposed de Wittekrans mining area.
- Identify the nearest sensitive noise areas being residential areas and to identify major feeder roads and other means of transport
- The site visit was furthermore done to identify potential measuring positions at the de Wittekrans mining area.

6.2 Noise and vibration measurements

Noise readings were carried out at pre-determined measuring positions along the boundary and at the noise sensitive areas, which are 29 noise readings in total for the day and nighttime periods. The distances between the measuring points and the proposed open cast mine activities and/or pits differs and will be dealt with later in this report. Vibration tests were carried out at some of the measuring positions where noise readings were done.

6.3 Noise and vibration emissions from daytime activities at the proposed mining area

The following are potential noise sources in the vicinity of the different farms at the proposed mining area:

- Distant traffic noise;
- Traffic noise;
- Domestic type noise;
- Farming activity noise;
- Wind noise;
- Aircraft noise;
- Insect and animal noises.

The noise is proportional to the type of activity and the distance of the receptor from such a noise source.

There are no potential vibration sources in the vicinity or inside the proposed mining area which could damage buildings or be harmful to people.

6.4 Noise and vibration emissions from night time activities at the proposed mining area

The noise level may be higher during the night time due to the insects and distant traffic noise of vehicles frequenting the abutting N11 Road. Inversion conditions and wind direction may also increase the prevailing ambient noise levels at times.

- Distant traffic noise;
- Traffic noise;
- Domestic type noise;
- Farming activity noise;
- Wind noise;
- Aircraft noise;
- Insect and animal noises.

There are no potential vibration sources in the vicinity or inside the proposed mining area which could damage buildings or be harmful to people.

6.5 Assessment of noise and vibration impacts

The assessment of the noise and vibration levels within the study area is necessary to determine intrusion levels and the subsequent recommended engineering mitigatory measures will ensure compliance to the relevant regulations and/or by-laws.

The difference between the actual noise and the ambient noise level will determine how people will respond to sound and what the noise impact will be.

7. Results of the Noise and Vibration Surveys

7.1 Description of the environment.
7.2 Noise and vibration measurements during day and nighttimes at the different measuring points.
7.3 Measured noise and vibration levels at the proposed mining area.

7.1 Description of the environment

The proposed open cast mine will be situated in the vicinity of the N11 road and in the northern section of the proposed mining area. The slope of the ground at the open cast section is from the east to west.

The area and the remainder of the mining area are hilly with a small valley. The ground is uneven and some is soft (agricultural land) and some hard (natural veldt). The prevailing ground conditions and vertical structures will absorb some of the proposed mining activity sound as it propagates in the direction of the noise sensitive areas. There are no formal residential development in the vicinity of the proposed mine only individual farm houses which is indicated in Figure 3.

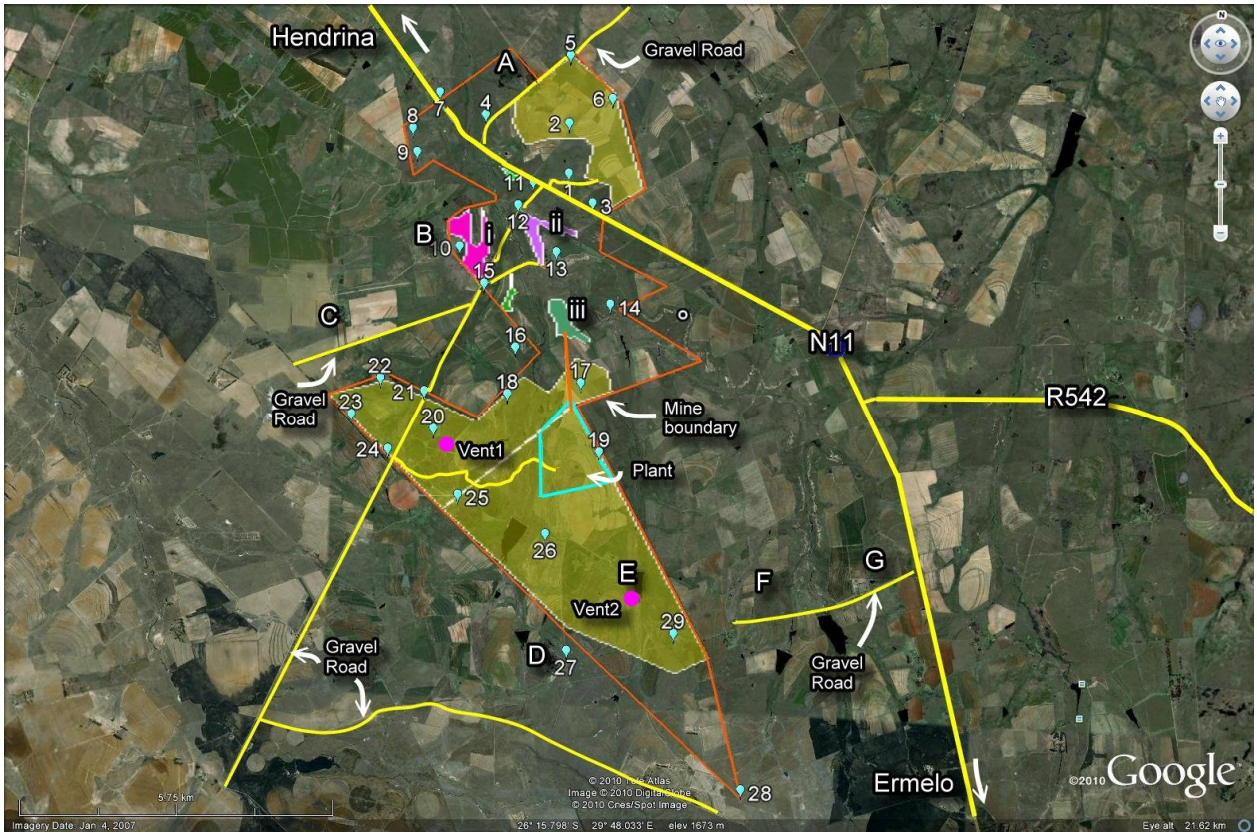

Figure 3: Noise sensitive farmhouses in the vicinity of the proposed mine

Distances between the noise sensitive areas (Farm houses A to G) and the proposed open cast pits, plant and Ventilation shafts are indicated in Table 4.

Table 4: Distances between mine activities and noise sensitive areas

Noise sensitive area	Open Cast Pit - i	Open Cast Pit - ii	Open Cast Pit - iii	Plant	Vent 1	Vent 2
A	2 350m from the northern side of the open cast pit	2 670m from the northern side of the open cast pit	4 430m from the northern side of the open cast pit	6 700m	6 800m	9 500m
B	420m from the western side of the open cast pit	1 500m from the western side of the open cast pit	2 720m from the western side of the open cast pit	4 700m	3 800m	7 300m
C	3 360m from the western side of the open cast pit	2 820m from the western side of the open cast pit	4 110m from the western side of the open cast pit	4 800m	3 100m	7 200m
D	8 260m from the southern side of the open cast pit	8 500m from the southern side of the open cast pit	6 450m from the southern side of the open cast pit	3 700m	4 600m	1 900m
E	7 760m from the southern side of the open cast pit	6 850m from the southern side of the open cast pit	4 460m from the southern side of the open cast pit	2 100m	3 400m	650m
F	8 100m from the eastern side of the open cast pit	9 110m from the eastern side of the open cast pit	6 420m from the eastern side of the open cast pit	4 300m	6 000m	2 100m
G	9 000m from the eastern side of the open cast pit	9 900m from the eastern side of the open cast pit	7 380m from the eastern side of the open cast pit	5 700m	7 800m	4 600m

7.2 Noise and vibration measurements during day and night times at the proposed mining area.

Noise and vibration readings were done at the measuring points as indicated in Figure 4 of which some of the readings were done on the boundary of the property and some within the boundary of the proposed mining area.

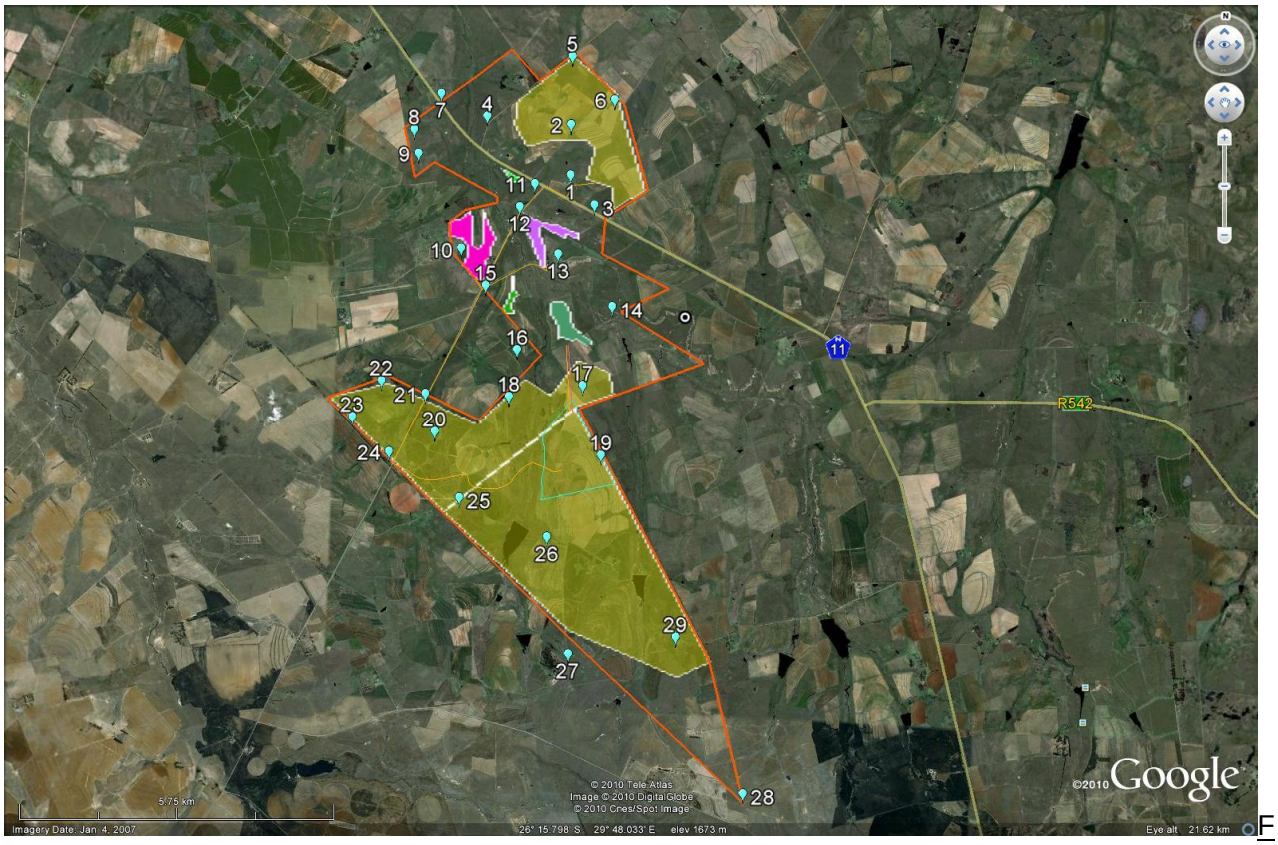

Figure 4: Measuring points at the de Wittekrans study area

The noise survey was done at the different measuring points and the measuring procedure was the same for the day – and nighttime readings. The atmospheric conditions were suitable for taking noise readings and there were no conditions, which could influence the noise readings.

The coal will be transported via a conveyor system to the plant and via haul road to and from the plant and the conveyor and the haul road can be seen in Figure 5. A section of the existing gravel road will be used as a haul road.

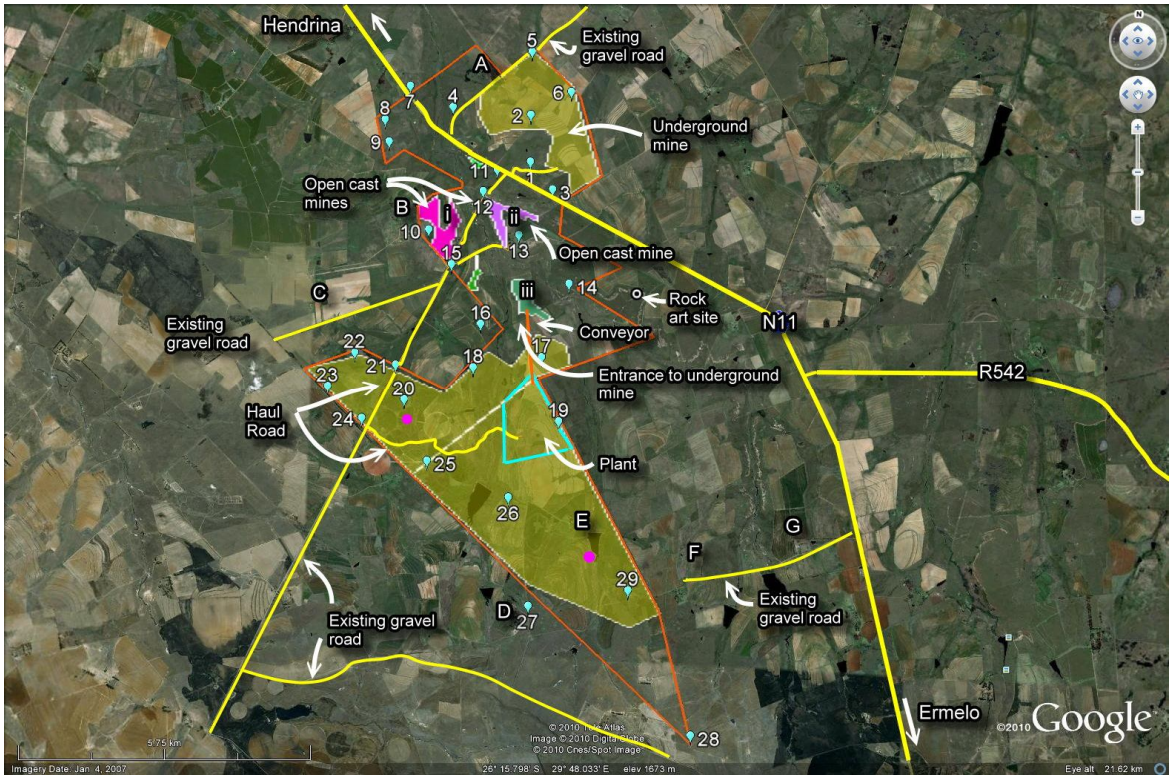

Figure 5: Conveyor section and haul roads

Information of measuring points, wind speed at the time of the noise survey and the wind direction is given in Table 5.

Table 5: Co-ordinates of the different measuring positions.

Position	Co-ordinates	Wind direction	Wind speed – daytime m/s	Wind speed – night time m/s
1	$26^0$13.503S and $029^0$47.246E	East	1.2	0,7
2	$26^0$13.006S and $029^0$47.228E	East	1.1	0.7
3	$26^0$13.741S and $029^0$47.602E	East	1.1	0.3
4	$26^0$12.952S and $029^0$46.299E	East	1.0	0.4
5	$26^0$12.332S and $029^0$47.211E	East	1.0	0.3
6	$26^0$12.745S and $029^0$47.697E	East	1.0	0.3
7	$26^0$12.747S and $029^0$45.781E	East	0.9	0.3
8	$26^0$13.857S and $029^0$46.869E	East	1.0	0.5
9	$26^0$13.352S and $029^0$45.580E	East	0.9	0.5
10	$26^0$14.270S and $029^0$46.075E	East	2.0	0.5
11	$26^0$13.547S and $029^0$46.856E	East	1.8	0.5
12	$26^0$13.835S and $029^0$46.700E	East	1.9	0
13	$26^0$14.289S and $029^0$47.146E	East	0.8	0
14	$26^0$14.784S and $029^0$47.767E	East	1.8	0
15	$26^0$14.628S and $029^0$47.361E	East	1.3	0
16	$26^0$15.251S and $029^0$46.738E	East	1.0	0
17	$26^0$15.578S and $029^0$47.480E	East	2.0	0
18	$26^0$15.718S and $029^0$46.674E	East	1.6	0
19	$26^0$16.267S and $029^0$47.715E	East	1.7	0
20	$26^0$16.098S and $029^0$45.875E	East	1.6	0

Position	Co-ordinates	Wind direction	Wind speed – daytime m/s	Wind speed – night time m/s
21	$25^0$15.725S and $029^0$45.754E	East	2.4	0
22	$26^0$15.613S and $029^0$45.265E	East	2.5	0.2
23	$26^0$15.821S and $029^0$45.013E	East	2.7	0.2
24	$26^0$16.317S and $029^0$45.382E	East	1.4	0.2
25	$26^0$16.739S and $029^0$46.177E	East	1.9	0.3
26	$26^0$17.091S and $029^0$47.159E	East	0.8	0.2
27	$26^0$18.228S and $029^0$47.451E	East	1.3	0.2
28	$26^0$19.217S and $029^0$48.404E	East	1.6	0.2
29	$26^0$18.019S and $029^0$48.623E	East	1.6	0.2

The following meteorological conditions were recorded:

20 May 2009 – Daytime

- Wind speed – 0.2 to 2.7 m/s
- Temperature – 19.5^{o}C
- Cloud cover – No cloud cover
- Wind direction – There was an Easterly wind.
- Humidity – None.

20 May 2009 - Nighttime

- Wind speed – less than 1.5 m/s
- Temperature – 8.5^{o}C
- Cloud cover – None
- Wind direction – The wind direction was from the East
- Humidity – None

21 May 2009 - Daytime

- Wind speed – less than 1.6 m/s
- Temperature – 19.0^{o}C – No strong temperature gradient occurred near the ground
- Cloud cover – No clouds
- Wind direction – The wind direction was from the East
- Humidity – No humidity

7.3 Measured noise levels in and around the proposed mining area

Results:

Daytime

Table 6: Results for the daytime period

	Daytime			**Remarks**
Position	Leq – dBA	L_{Max} - dBA	L_{Min} - dBA	
1	45.3	63.7	30.7	Wind and bird noise
2	38.0	64.3	23.9	Aircraft, traffic slightly audible
3	62.6	79.4	33.2	Next to Hendrina/Ermelo Road
4	48.0	64.0	29.5	Traffic noise
5	40.9	62.3	19.2	Distant traffic, birds, farm animals
6	37.1	52.9	32.0	Distant traffic, birds, farm animals
7	62.1	84.1	28.1	Next to Hendrina/Ermelo Road
8	45.2	51.8	31.8	Distant traffic, birds, farm animals
9	44.7	54.6	35.7	Distant traffic, birds, farm animals
10	38.1	59.5	25.7	Distant traffic, birds, farm animals
11	60.5	72.6	27.6	Intersection Davel and N11Roads
12	42.7	63.4	28.1	Distant traffic Hendrina Road
13	40.2	60.4	30.8	Distant traffic
14	33.9	52.1	27.6	Distant traffic
15	42.1	63.5	24.9	Distant traffic and farming activities
16	32.0	49.1	23.9	Distant traffic
17	37.3	48.5	33.8	Birds and wind noise
18	34.8	52.1	24.1	Birds and wind noise
19	35.9	55.0	26.7	Birds and wind noise
20	31.7	53.1	21.3	Birds and wind noise
21	37.6	47.0	28.6	Animals, birds and farming activities
22	38.2	52.6	33.6	Birds and animal noise
23	32.5	41.5	22.4	Birds and animal noise
24	36.6	57.2	28.0	Birds and farming activities
25	32.6	51.2	26.6	Distant farming activities, birds
26	30.9	49.8	21.3	Distant farming activities, birds
27	33.0	43.3	25.6	Distant farming activities, birds
28	34.7	50.9	27.3	Distant traffic
29	32.7	45.0	21.9	Distant traffic

The maximum sound pressure level of 84.1dBA was measured at measuring point 7 which is next to the N11 Road and the highest maximum sound pressure level in the agricultural district was 60.4dBA. Traffic noise was audible at some of the measuring points towards the south of the study area.

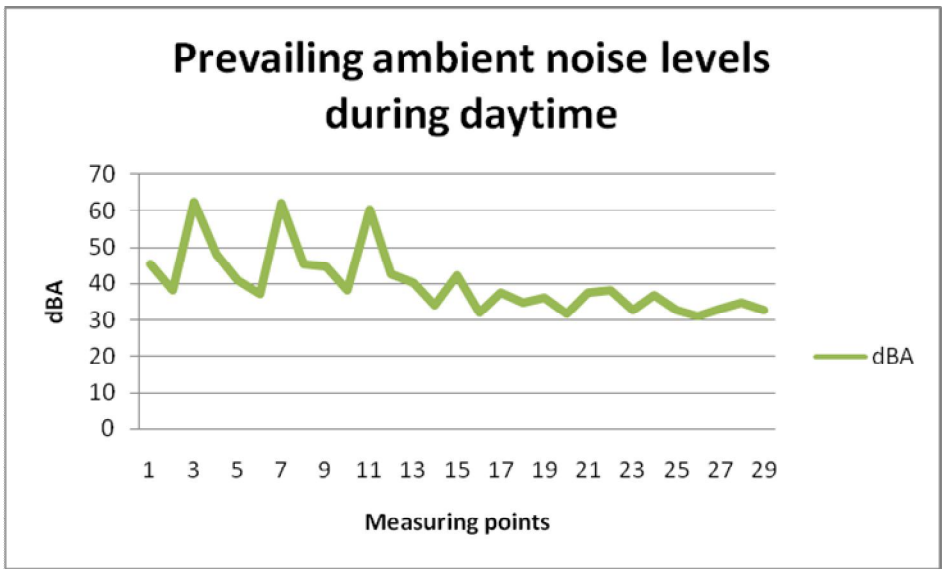

Figure 6: Prevailing ambient noise during daytime

The peak values are for the measuring points next to the N11 Road (measuring points 3, 7, 11) and the sections close to the N11 road. The prevailing ambient noise level for the sections/areas close to the road is between 40 and 50dBA whereas the remainder of the measuring positions some distance from the road is between 30 and 40dBA.

Night time

Table 7: Results for the night time period

	Night time			**Remarks**
Position	Leq – dBA	L_{Max} - dBA	L_{Min} - dBA	
3	61.8	78.7	26.8	Next to N11 Road
4	41.7	55.1	32.6	Insects
5	33.8	45.9	31.8	Distant insects
6	30.2	43.0	19.5	Distant insects
7	62.8	82.7	33.7	Next to N11 Road
9	35.9	46.8	33.6	Distant traffic
10	31.2	49.1	27.6	Distant insects
12	39.1	49.2	22.2	In line with house at De Langes Rust
15	35.2	49.3	33.2	Along gravel road to Davel Street
17	31.5	44.8	25.7	Distant insects
18	33.3	45.4	26.7	Distant insects
20	34.8	49.1	27.6	Insects
21	35.9	47.3	33.3	Insects
22	31.7	38.8	28.0	Insects
23	32.9	34.9	19.4	Insects
25	31.1	46.6	26.6	Insects
26	35.0	45.6	33.6	Insects
27	36.8	57.9	33.5	Insects and domestic noise
28	33.8	53.8	26.2	Insects and distant traffic

The peak noise level of 82.7dBA is at measuring point 7 which is close to the N11 Road. The noise level during the night time is between 30 and 40.0dBA, which is more or less the same as for the day time period. This is due to insect noise i.e. crickets that make more noise during the night time period.

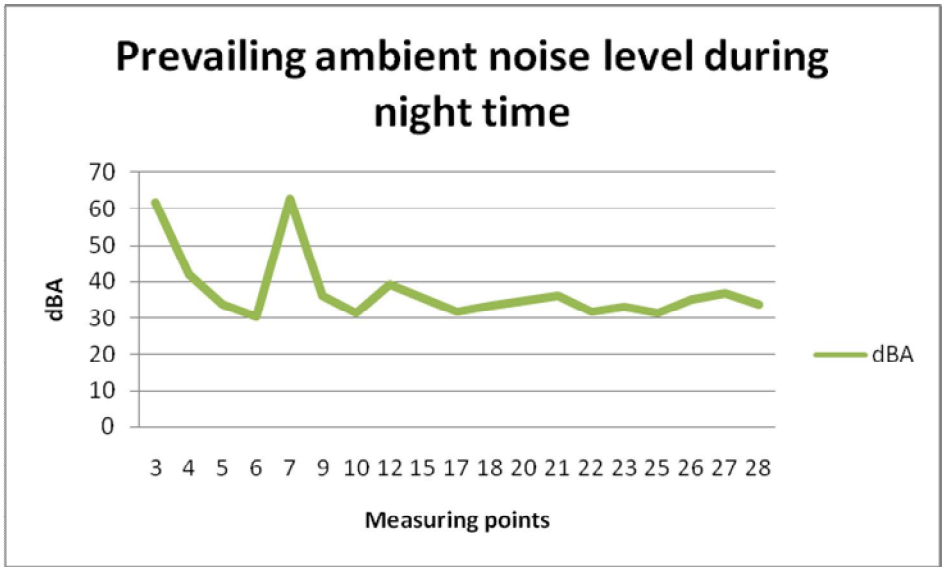

Figure 7: Prevailing noise levels during night time.

There is therefore not a big difference between the day and night time measuring points from measuring points 13 to 29.

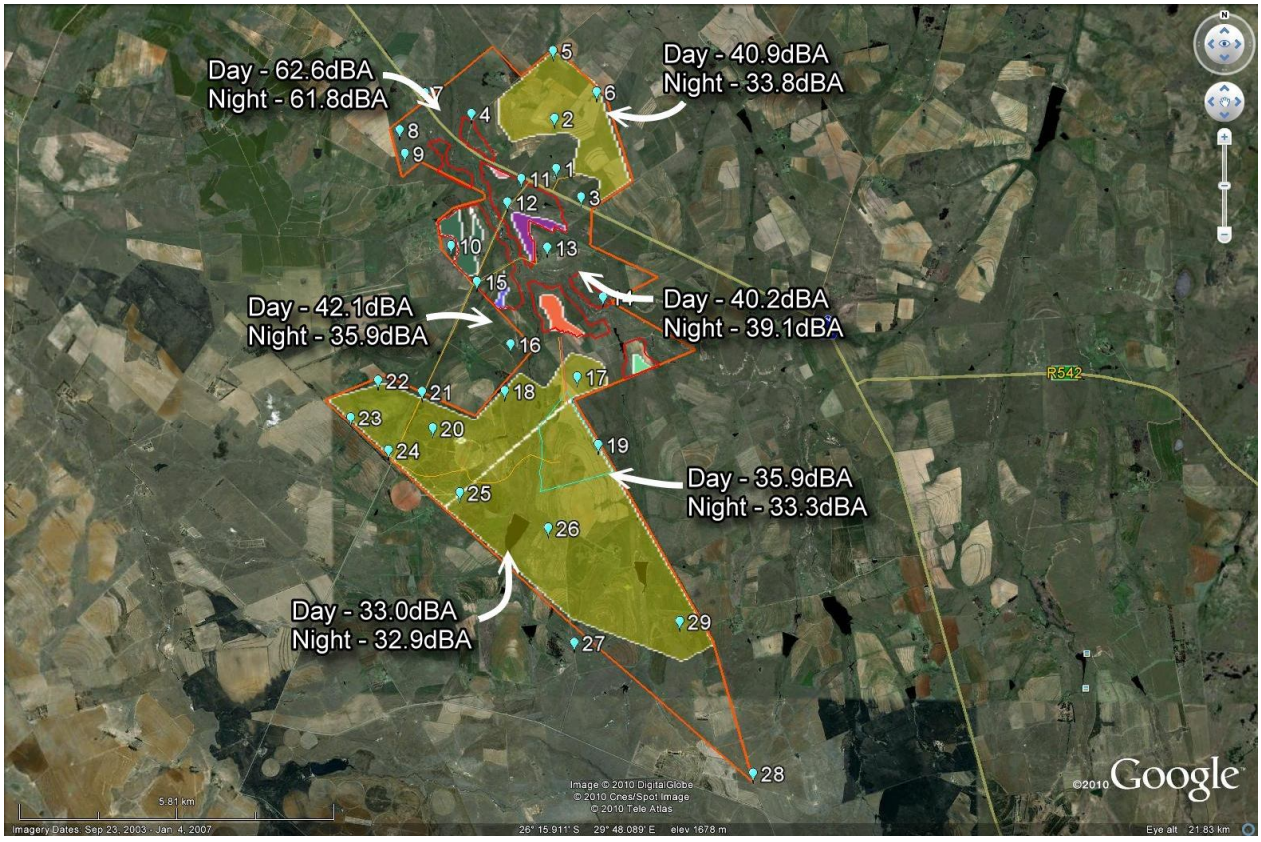

Figure 8: Prevailing ambient noise levels in the study area

The highest noise levels were recorded along the roads and these noise levels exclude farm activity noise as this is only a seasonal occurrence.

The following vibration levels in mm/s were recorded at the following measuring points:

- Position 5 – 0.56mm/s
- Position 6 – 0.54mm/s
- Position 10 – 0.30mm/s
- Position 12 – 0.43mm/s
- Position 13 – 0.52mm/s
- Position 14 – 0.59mm/s
- Position 15 – 0.34mm/s
- Position 16 – 0.65mm/s
- Position 17 – 0.74mm/s
- Position 18 – 0.56mm/s
- Position 20 – 0.60mm/s
- Position 27 – 0.68mm/s
- Position 28 – 0.72mm/s

These vibration levels are insignificant as there were no vibration generating sources within the vicinity of the study area.

7.4 Noise attenuation - Calculations

Mining activities

The following are noise levels at machinery which is used during construction and/or mining activities.

Table 8: Noise levels of machinery used during mine activities

Equipment	Direct Line-of-Sight Estimated Noise Level Attenuation - dBA						
	15m	30m	60m	120m	240m	480m	960m
Cumulative distance from source	15m	45m	105m	225m	465m	945m	1905m
Dump truck	91	85	79	73	63	53	43
Backhoe	85	79	73	67	57	47	37
Drilling Equipment	100	94	88	78	68	58	48
Flatbed truck	85	79	73	67	57	47	37
Pickup truck	70	64	58	52	42	32	22
Tractor trailer	85	79	73	67	57	47	37
Crane	85	79	73	67	57	47	37
Pumps	70	64	58	52	42	32	22
Welding Machine	72	66	60	50	40	30	20
Generator	90	84	78	72	62	52	42
Compressor	85	79	73	67	57	47	37
Pile driver	100	94	88	78	68	58	48
Jackhammer	90	84	78	72	62	52	42
Rock drills	100	94	88	78	68	58	48
Pneumatic tools	85	79	73	67	57	47	37

The above is equipment used at a mining site and they will not be stationary all the time and will not operate at a fixed position and time.

Distance from the opencast mine and the calculated increase in the prevailing ambient noise level at the noise sensitive areas is given in Table 9, 10, 11, and 12.

Table 9: Noise impact at noise sensitive areas from activities at Pit 1

Noise sensitive area	Open cast Pit - i	Calculated sound pressure level at the noise sensitive areas -dBA	Prevailing ambient noise level - dBA	Increase above the prevailing ambient noise level, which may at times be a temporary shift -dBA
A	2 350m from the northern side of the open cast pit	39.0	39.0	0
B	420m from the western side of the open cast pit	56.0	38.1	17.9
C	3 360m from the western side of the open cast pit	38.0	34.7	-3.3
D	8 260m from the southern side of the open cast pit	33.0	33.4	-0.4
E	7 760m from the southern side of the open cast pit	33.0	33.4	-0.4
F	8 100m from the eastern side of the open cast pit	33.0	33.7	-0.7
G	9 000m from the eastern side of the open cast pit	32.0	33.7	-1.7

Table 10: Noise impact at noise sensitive areas from activities at Pit 2

Noise sensitive area	Open cast Pit - ii	Calculated sound pressure level at the noise sensitive areas -dBA	Prevailing ambient noise level - dBA	Increase above the prevailing ambient noise level, which may at times be a temporary shift -dBA
A	2 670m from the northern side of the open cast pit	39.0	39.0	0
B	1 500m from the western side of the open cast pit	50.0	38.1	11.9
C	2 820m from the western side of the open cast pit	38.0	34.7	3.3
D	8 500m from the southern side of the open cast pit	33.0	33.4	-0.4
E	6 850m from the southern side of the open cast pit	35.0	33.4	0.6
F	9 110m from the eastern side of the open cast pit	32.0	33.7	-1.7
G	9 900m from the eastern side of the open cast pit	31.5	33.7	-2.2

Table 11: Noise impact at noise sensitive areas from activities at Pit 3

Noise sensitive area	Open cast Pit - iii	Calculated sound pressure level at the noise sensitive areas -dBA	Prevailing ambient noise level - dBA	Increase above the prevailing ambient noise level, which may at times be a temporary shift -dBA
A	4 430m from the northern side of the open cast pit	37.0	39.0	-2.0
B	2 720m from the western side of the open cast pit	39.0	38.1	0.9
C	4 110m from the western side of the open cast pit	37.0	34.7	2.3
D	6 450m from the southern side of the open cast pit	35.0	33.4	1.6
E	4 460m from the southern side of the open cast pit	36.0	33.4	2.6
F	6 420m from the eastern side of the open cast pit	35.0	33.7	1.3
G	7 380m from the eastern side of the open cast pit	34.0	33.7	0.3

The average sound pressure level at the plant, which can be classified as a point source is 73.3dBA during the daytime and 73.8dBA during the night time. There is no difference between the day- and night time sound pressure levels.

The calculated noise impact of the open cast mining activities is given in Figure 9 and may vary depending on the position of the mining activity within the pit. There will not be a cumulative noise from all the pits as the pits will be mined on an individual basis.

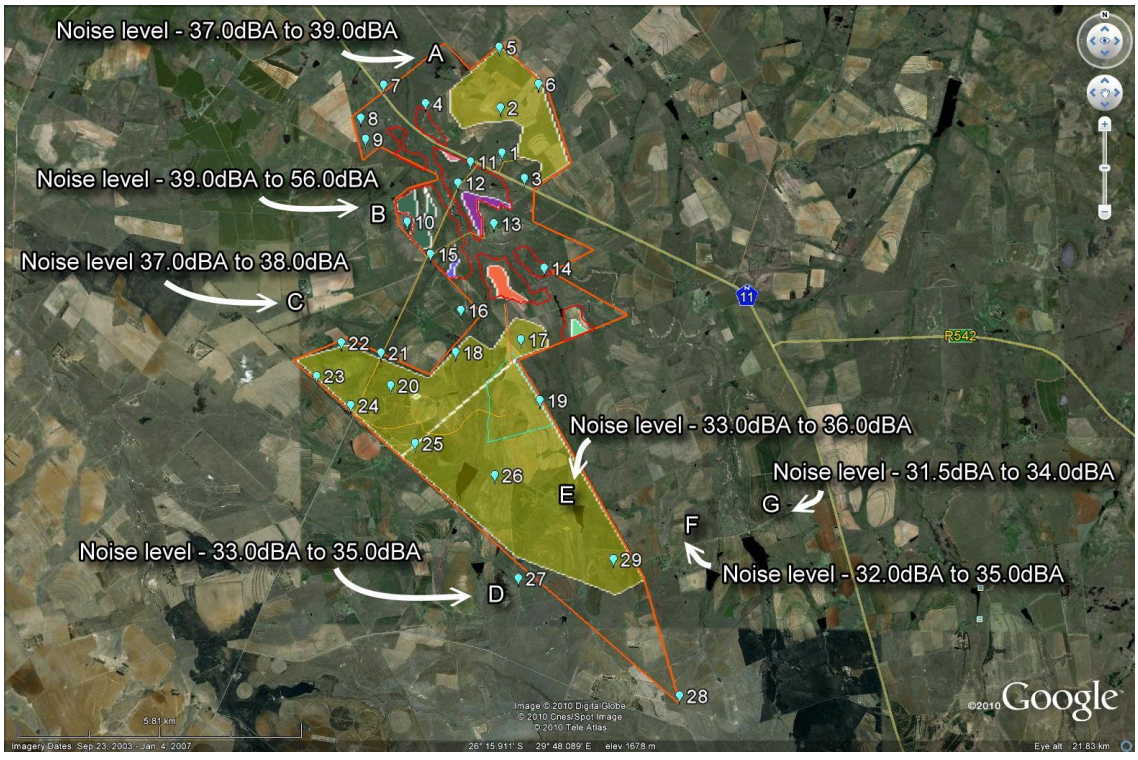

Figure 9: Calculated noise level at the noise sensitive abutting residential houses.

Table 12: Noise impact at noise sensitive areas from activities at Plant

Noise sensitive area	Plant	Calculated sound pressure level at the noise sensitive areas -dBA	Prevailing ambient noise level - dBA	Increase above the prevailing ambient noise level, which may at times be a temporary shift -dBA
A	6 700m	33.0	39.0	-6.0
B	4 700m	36.0	38.1	-2.1
C	4 800m	36.0	34.7	1.3
D	3 700m	37.0	33.4	3.6
E	2 100m	39.0	33.4	5.6
F	4 300m	36.0	33.7	2.3
G	5 700m	34.0	33.7	0.3

The measured and calculated reduction of the noise level of a periscope ventilation fan is given in Table 13.

Table 13: Noise reduction of the ventilation fan at different distances

Equipment	Line-of-Sight Estimated Noise Level Attenuation - dBA						
	15m	30m	60m	120m	240m	480m	960m
Cumulative distance from source	15m	45m	105m	225m	465m	945m	1905
Ventilation shaft – open end	74	66	54	49	43	37	31
Ventilation shaft – rear end	69	57	51	45	39	33	29

The possible noise impact at the different noise sensitive areas to be created by the two proposed ventilation fans are given in Table 14 and 15.

Table 14: Noise impact at noise sensitive areas from Ventilation Fan 1

Noise sensitive area	Vent 1	Calculated sound pressure level at the noise sensitive areas -dBA	Prevailing ambient noise level - dBA	Increase above the prevailing ambient noise level, which may at times be a temporary shift -dBA
A	6 800m	31.0	39.0	-8.0
B	3 800m	31.0	38.1	-7.1
C	3 100m	31.0	34.7	-3.7
D	4 600m	31.0	33.4	-2.4
E	3 400m	31.0	33.4	-2.4
F	6 000m	31.0	33.7	-2.7
G	7 800m	31.0	33.7	-2.7

Table 15: Noise impact at noise sensitive areas from Ventilation Fan 2

Noise sensitive area	Vent 2	Calculated sound pressure level at the noise sensitive areas -dBA	Prevailing ambient noise level - dBA	Increase above the prevailing ambient noise level, which may at times be a temporary shift -dBA
A	9 500m	31.0	39.0	-8.0
B	7 300m	31.0	38.1	-7.1
C	7 200m	31.0	34.7	-3.7
D	1 900m	31.0	33.4	-2.4
E	650m	43.0	33.4	9.6
F	2 100m	31.0	33.7	-2.7
G	4 600m	31.0	33.7	-2.7

Haul road

SANS 10210 of 2004, the national standard for the calculating and predicting of road traffic noise was used to calculate the noise level to be generated by the traffic along the proposed haul road in the study area.

The prevailing noise level along the N11 Freeway between Hendrina and Ermelo is 62.1dBA for the daytime and 61.8dBA for the night time period.

The prevailing ambient noise level in the vicinity of the existing gravel road which is to become the haul road is 37.0 dBA during daytime and 35.3dBA during night time.

Basic Model

$L_{Basic} = 38.3 + 10 \text{ Log } (Q_r)$ dBA,

Where L_{Basic} = basic noise level in dBA and Q_r is the mean traffic flow per hour.

The mean traffic flow for the transportation of the coal between the open cast areas, mine to the plant and to the siding will be for the first year 105 trucks per day, 621 trucks per day for year 2 to year 9, 516 trucks for year 10 to year 15, 347 trucks per day for year 16 to year 21. The truck movement will be during daytime only and will be based on a 12 hour shift.

- Year 1 – 8 trucks per hour
- Year 2 to 9 – 51 trucks per hour
- Year 10 to 15 – 43 trucks per hour
- Year 16 to 21 – 29 trucks per hour

Primary corrections to the basic model:

- Traffic flow Q – vehicles/hour
- Corrections for speed of traffic and percentage of heavy vehicles, $L_{P,v}$
- Correction for gradient, L_{gr}
- Correction for road surface texture, L_{t}

The calculated noise levels for the additional coal trucks to transport coal to the plant and to the siding are given in Table 16.

Table 16: Calculated noise levels at a speed of 50km/h

Period	10m from road - dBA	40m from the road - dBA	125m from the road - dBA
Year 1	56.8	51.3	46.3
Year 2 to 9	64.9	59.4	54.4
Year 10 to 15	64.1	58.6	53.6
Year 16 to 21	62.4	56.9	51.9

The noise impact along the N11 Road at 10m from the road will only be 2.8dBA during the period year 2 to 9, 2.0dBA during year 10 to 15 and 0.3dBA during year 16 to 21.

The noise impact along the existing gravel road which will have to be upgraded before it is used as a haul road will be at 10m from the road 19.8dBA during the 1st year, 27.9dBA during year 2 to 9, 27.1dBA during year 10 to 15, 25.1dBA during year 16 to 21. The impact at 125m will be 10.5dBA less than the above sound pressure levels and it will be for the first year be 9.8dBA, year 2 to 9 17.9dBA, year 10 to 15 17.1dBA and year 16 to 21 15.1dBA.

The nearest residential area is however 1 000m (C), 1 860m (D), 4 400m (E), 4300m (F) respectively and the noise impact on these noise sensitive areas will be negligible.

Conveyor

The conveyor as can be seen in Figure 5 will transfer the coal from the open cast and underground mine to the plant to the south of the open cast coal mining areas.

The conveyor will be well within the mine boundaries and some distance from any residential area. The measured noise levels from a similar conveyor which will be used at the mine are given in Table 17.

Table 17: Noise levels at a conveyor system

Position	7m from conveyor – dBA	21m from conveyor - dBA	49m from the conveyor - dBA
Open side of the conveyor	60.3	53.5	48.6
Closed side of the conveyor	57.6	51.5	46.5

This was for direct line of sight with no obstructions except the ground conditions that could reduce the noise level as it propagates from the source. It was furthermore found that at a distance of 400m from the conveyor the noise level was constant at 45.3dBA with the wind blowing towards the measuring site at a velocity of 1.0m/s. The nearest residential area to the proposed conveyor is in access of 1 500m from the conveyor.

Blasting

Free digging of mine body will take place and localized blasting of bigger rocks will take place. Should it be required that blasting will have to take place there will be an increase in the prevailing noise level for 5 – 10 seconds only. This will be a sudden impact after which the prevailing ambient noise level in the vicinity of the mining area will be maintained.

A noise and vibration survey was carried out during an overburden blast whereby 80 tons of explosives were used to uplift 180m^3 of soil. The measuring point was 700m from the blasting site. The change in the prevailing ambient noise level during a blast is indicated in Figure 10.

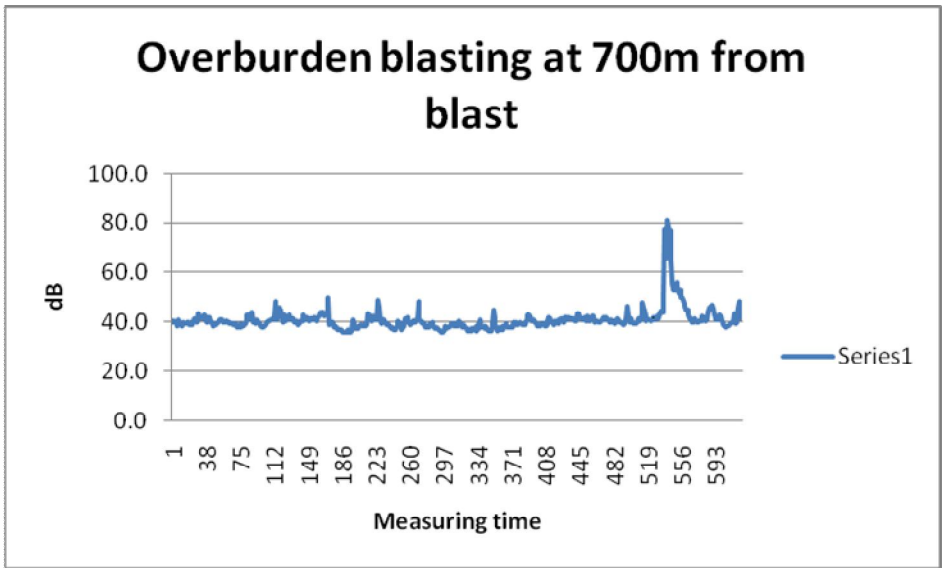

Figure 10: Overburden blast graph at 700m from blasting area

The vibration levels at 700m from the blasting area are given in Table 18.

Table 18: Vibration levels during overburden blasting

Position	**Magnitude**			**Peak Vector**
	Transverse – mm/s	Vertical – mm/s	Longitudinal - mm/s	Peak Vector Sum
During overburden blast at 700m from the blasting area	0.889	0.762	1.27	**1.42mm/s**

The vibration level of 1.42mm/s is well below the limit where structural damage can occur.

The peak sound pressure level of 86.9dB was for a second only. The increase during the blasting action over the prevailing noise level was for 9 seconds only after which the noise level returned to 45.0dBA.

Another noise and vibration survey was carried out when coal blasting took place whereby 2 700kg of explosives were used to uplift a 1m coal band. This was done at an open cast mine at 20m below ground level and the distance of the measuring site was 500m from the blasting area.

The change in the prevailing ambient noise level during a blast is indicated in Figure 11.

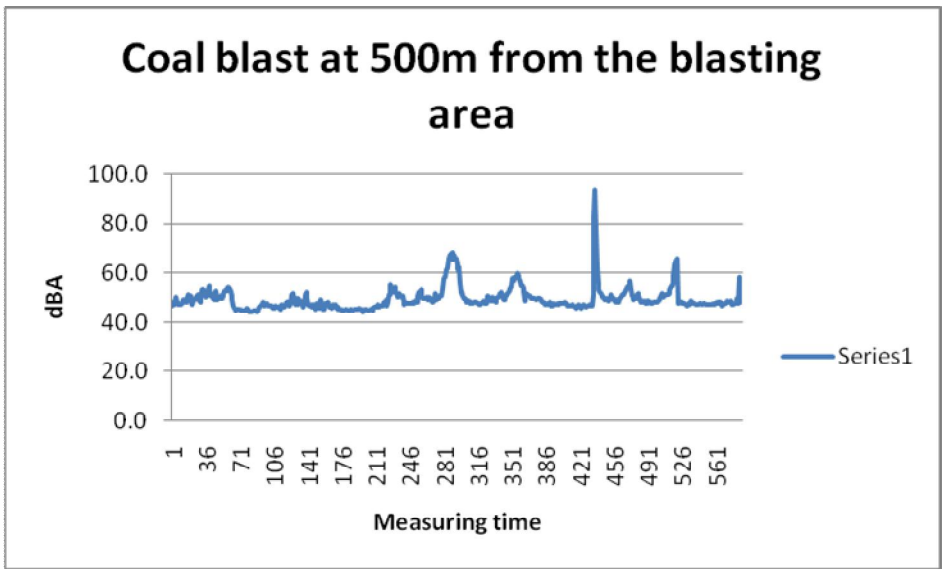

Figure 11: Coal blast graph at 500m from blasting area

The peak sound pressure level of 89.9dB was for a second only. The increase during the blasting action over the prevailing noise level was for 7 seconds whereby the noise level returned to the prevailing noise level.The other peak levels in the graph were from trucks passing the measuring position.

The vibration levels at 500m from the blasting area are given in Table 19.

Table 19: Vibration levels during coal blasting

Position	**Magnitude**			**Peak Vector**
	Transverse – mm/s	Vertical – mm/s	Longitudinal - mm/s	Peak Vector Sum
During coal blast at 500m from the blasting area at 20m below ground level.	0.635	0.254	0.508	**0.751mm/s**

The vibration level of 0.751mm/s is well below the limit where structural damage can occur.

The people in the vicinity of a blast will experience the over air pressure, which at times confused with structural vibration.

Human response to air blast and ground vibration from blasting can be seen in Table 20.

Table 20: Human response to blasting

Response	Ground Vibration Range (mm/s)	Air blast Range (dB)
Barely to distinctly perceptible	0.05- 2.54	50 – 70
Distinctly perceptible to strongly perceptible	2.54 – 12.7	70 – 90
Strongly perceptible to mildly unpleasant	12.7 – 25.0	90 - 120
Mildly unpleasant to distinctly unpleasant	25.0 – 50.0	120 – 140
Distinctly unpleasant to intolerable	50.0 – 200.0	140 - 170

* U.S Department of the Interior, Bureau of Reclamation – State Water Resources Control Board – Noise

In Table 21 is the estimated over-air pressure level that can be expected at the different distances from the source whereby the sound pressure level is 120dB and 140dB respectively.

Table 21: Typical estimated noise impacts from blasting operations

Activity	Direct Line-of- Sight Estimated Noise Level, dBA						
	15m	1000m	2000m	3000m	4000m	5000m	6000m
Blasting – 120 dBA	120	84	78	74	71	70	68
Blasting 140 dBA	140	104	98	94	91	90	88

The blasting period is for a few seconds only when there is a peak and the prevailing ambient noise level is maintained after the peak. This is typical of lightning during a thunderstorm.

The rock art, which is situated east of the proposed open mine pit no 3 is some 1 780m from the eastern side of the open cast mine. Vibration test carried out during an overburden and coal blasting at 700m and 500m respectively revealed that the vibration levels were 1.4mm/s and 0.75mm/s. The distance is more than double the measured distance and due to this distance the vibration level at the rock art will be less than .50mm/s which is the normal vibration levels that prevail in the vicinity of the mine study area, without any type of blasting or vibration sources.

Proper blast design at the open cast pit, control over the blasting process and compliance to the blast design chart – Figure 2 - will ensure that there can be no damaged at any of the concerned areas such as the rock art site.

As there are no vibration limits for geologically cliffs the limit for poorly constructed buildings and/or historical buildings of 10mm/s will be enforced in this area to protect the rock art site. Should 50kg of explosives be detonated per round at a distance of 1 700m the peak particle velocity (PPV) in mm/s will be well below 3mm/s.

The over air pressure which is associated with blasting will have no affect as the distance and the topography of the area will reduce the air pressure substantially at the rock art site in that the sound pressure level at the site will only be 75.4dB, which is similar to a truck noise passing measuring site at 30m from the road.

8. Environmental impact assessment

The development of the mine will take place in stages and it is envisaged that the following processes and/or activities will take place.

Construction phase

- Upgrade of existing gravel road to a asphalt type surface;
- Grading and building of new internal roads and haul roads;
- Preparation of the footprint area, earthworks & construction;
- Provision of services such as water, sewerage and electricity;
- Construction of conveyor;
- Construction of earthberm on eastern side of pit 3;
- Construction of the ventilation shafts for the underground mining.

Operational phase

- Drilling;
- Overburden blasting;
- Coal blasting;
- Removal of coal
- Crusher;
- Conveying of coal by means of conveyor;
- Transportation of coal by road;
- Plant activities;
- Ventilation shaft.

Decommissioning phase

- Rehabilitation of mined area.

8.1 Construction Phase

The noise assessment of the different activities and the Environmental Management Plan (EMP) during the construction phase is given in Table 18 and the assessment methodology is attached as Appendix A.

Table 22: Noise impact assessment and EMP during the construction phase

Aspect	Impact	Significance Rating	Mitigation	Result after mitigation measures	Responsible person	Monitoring
Upgrade of existing gravel road to an asphalt type surface	Noise	Medium	All construction equipment to comply with the standards as for construction vehicles as explained in IFC's Environmental Health & Safety Regulations.	Low	Mine manager	Environmental audits during the construction phase
Grading and building of new internal roads and haul roads;	Noise	Medium	All construction equipment to comply with the standards as for construction vehicles as explained in IFC's Environmental Health & Safety Regulations.	Low	Mine manager	Environmental audits during the construction phase
Preparation of the footprint area, earthworks &	Noise	Medium	All construction equipment to comply with the standards as for construction vehicles as explained in IFC's Environmental Health &	Low	Mine manager	Environmental audits during the construction

construction;			Safety Regulations. The work to be undertaken during normal working hours only.			phase
Provision of services such as water, sewerage and electricity;	Noise	Medium	Any power generation plant to be acoustically screened off and compliance certificate to be provided; All construction work to take place during normal working hours; All construction equipment to comply with the standards as for construction vehicles as explained in IFC's Environmental Health & Safety Regulations.	Low	Mine manager	Environmental audits during the construction phase
Construction of conveyor	Noise and vibration	Medium	Any construction and/or blasting work to take place during normal working hours; Blasting operations to be monitored and to comply to the Blasting Design Chart; Blasting to comply with the general blasting standards as explained in Item 10, page 40 &41	Low	Mine manager	Environmental audits during the construction phase
Construction of earth berm on eastern side opposite pit 3	Noise		All construction equipment to comply with the standards as for construction vehicles as explained in IFC's Environmental Health & Safety Regulations.	Low	Mine manager	Environmental audits during the construction phase
Construction of the ventilation shaft for the underground mining	Noise		All construction equipment to comply with the standards as for construction vehicles as explained in IFC's Environmental Health & Safety Regulations.	Low	Mine manager	Environmental audits during the construction phase

8.2 Operational

The noise and vibration assessment of the different activities during the operational phase and the EMP is given in Table 19 and the assessment methodology is attached as Appendix A.

Table 23: Noise and vibration impact assessment during the operational phase

Aspect	**Impact**	**Significance rating**	**Mitigation**	**Result after mitigation measures**	**Responsible person**	**Monitoring**
Drilling	Noise	Medium	Acoustic screening measures as recommended by the IFC as explained in Item 10, page 39, 40 &41.	Medium	Mine manager	Noise monitoring to be done
Overburden blasting	Noise &Vibration	High	Acoustic screening measures as recommended by the IFC as explained in Item 10, page 39 &40.	Medium	Mine manager and contractor	Noise and vibration monitoring at specific locations
Coal blasting	Noise and	High	Acoustic screening	Medium	Mine manager	Noise and

	vibration		measures as recommended by the IFC as explained in Item 10, page 39 &40.		and contractor	vibration monitoring at specific locations
Removal of coal	Noise	Medium	Acoustic screening measures as recommended by the IFC as explained in Item 10, page 39 & 40;	Medium	Mine manager	Noise monitoring
Plant activities	Noise n	Medium	Acoustic screening measures as recommended by the IFC as explained in Item 10, page 39 &40.	Medium	Mine manager	Noise monitoring
Conveying of coal by means of conveyor	Noise	Medium	Conveyor to be serviced and noisy rollers replaced immediately.	Medium	Mine manager	Noise monitoring
Transportation of coal by road	Noise	High	Speed control measures to be implemented and enforced; Acoustic screening measures as recommended by the IFC as explained in Item 10, page 39 &40.	Medium	Mine manager	Noise monitoring

8.3 Decommissioning phase

The assessment of the different activities during the decommissioning phase is given in Table 20 and the assessment methodology is attached as Appendix A.

Table 24: Noise and vibration impact assessment during the decommissioning phase

Aspect	**Impact**	**Significance rating**	**Mitigation**	**Result after mitigation measures**	**Responsible person**	**Monitoring**
Rehabilitation of mined area	Noise	Medium	All relevant Environmental Health and Safety Guidelines of the IFC to be complied with during this phase.	Low	Mine manager	Noise monitoring

The noise impact on the environment and the people residing in the vicinity of the proposed mine will have to be pro actively managed during the construction and operational phases. The residents will have to be informed of the anticipated shift in the prevailing ambient noise levels which will be temporary during the construction phase and more permanent during the operational phase.

The vibration issue will have to be communicated to the residents whereby they are briefed on the different kinds of vibration and at which level damage to structures may occur.

The noise impact on the environment and the people residing in the vicinity of the coal mine will be low to moderate during the construction phase and moderate during the operational phase.

9. Discussion of the results

Noise or sound is part of our daily exposure to different sources which is part of daily living and some of the sounds which are intrusive such as traffic noise forms part of the ambient noise which people get accustomed to without noticing the higher sound levels.

Any person in the workplace and at home is exposed to the following noise levels as indicated in Table 25.

Table 25: Different noise levels in and around the house that a person is exposed to on a daily basis

	Activity	**dBA**
Communication	Whisper	30
Communication	Normal Conversation	55-65
Communication	Shouted Conversation	90
Communication	Baby Crying	110
Communication	Computer	37-45
Home/Office	Refrigerator	40-43
Home/Office	Radio Playing in Background	45-50
Home/Office	Background Music	50
Home/Office	Washing Machine	50-75
Home/Office	Microwave	55-59
Home/Office	Clothes Dryer	56-58
Home/Office	Alarm Clock	60-80
Home/Office	Vacuum Cleaner	70
Home/Office	TV Audio	70
Home/Office	Flush Toilet	75-85
Home/Office	Ringing Telephone	80
Home/Office	Hairdryer	80-95
Home/Office	Maximum Output of Stereo	100-110

Two aspects are important when considering potential noise impacts of a project and it is:

- The increase in the noise level, and;
- The overall noise level produced

The sections along the existing N11 Road and existing gravel roads have higher noise levels than some of the areas to the south of the proposed mining area. There is a constant flow of traffic along the N11 Road and the residents in the vicinity of the road is already exposed to higher noise levels up to the early hours of the morning as coal trucks make use of this road between Hendrina and Ermelo.

The activities to be introduced into this area will result that there will be a temporary shift and in some of the areas a permanent shift in the prevailing ambient noise level. The proposed activity will however take place at some distance from the noise sensitive residential areas which will result in the reduction of the noise levels as experienced at the source of such an activity. The sound pressure level will decrease by 6.0dB and for point sources and 3.0dB

for line sources per doubling of the distance from the source. (Inverse Square Law Principle).

A recent study done at an open cast pit revealed that the reverse signal of construction vehicles at 1 000m is not intrusive to create a noise nuisance.

The indoor noise levels inside a house will mask the distant noise from these reverse signals. The only noise sensitive areas below 2 000m from the open cast activities will be a small village at 420m to the west of Pit 1 and 1 500m from the western side of opencast pit 2. The remainder of the noise sensitive areas is in excess of 2 000m from the open cast mining activities.

The nearest residential area to the proposed plant will be 2 100m to the east of the plant, which will ensure that the sound will be reduced to a sound pressure level where it is acceptable for residential purposes. The calculated noise level at noise sensitive area E will be 39.0dBA when the plant is fully operational. Engineering control measures will be implemented at the sifters, crushers and fans.

The proposed ventilation fans at the mine shafts will be positioned in such a manner that the open end of the ventilation duct will face away from any noise sensitive areas.

The prevailing noise level along the N11 Road is between 60.0dBA to 65.0dBA and 30.0dBA to 40dBA for the sections of the study area at some distance from the existing noise sources. These noise levels exclude the farming activities that could increase the prevailing noise levels accordingly. The activities such as power generators, ploughing and sowing activities and the odd vehicle travelling on the gravel roads are excluded from the results of this noise study as these noise levels are seasonal and site specific.

There will be an increase along the section of the existing gravel road, which will have to be upgraded to an asphalt type road, but the increase at 125m from the road will be for the first year be 9.8dBA, year 2 to 9 17.9dBA, year 10 to 15 17.1dBA and year 16 to 21 15.1dBA.

The nearest noise sensitive areas to the road is however 1 000m (C), 1 860m (D), 4 400m (E), 4300m (F) respectively and the noise impact on these noise sensitive areas will be negligible or the same as the N11 Road.

The mine construction vehicles will travel at lower speeds and at times it will only be mechanical noise that will be audible in the near field. This will be finite type of noise as the vehicles will be site specific and will not be located at one specific site only to make it a point noise source. The sides of the pit as soon as they operate lower than ground level will furthermore screen off the mechanical type noise associated with mine activities.

The conveyor is situated in the middle of the proposed mine area and the distant from the conveyor to the noise sensitive areas will ensure that the conveyor noise at 1 000m from the conveyor will be below 40.0dBA.

The distance between the rock art site and the side of pit 3 is in excess of 1 780m and the vibration level at this distance will be below 3.0mm/s which will not create destruction of the existing rock art. The recommended vibration level for poorly constructed historical sites and/or clay buildings is 10mm/s before any damage to the building may occur. Due to the lack of recommended vibration levels for such rock art sites the recommended vibration level of 10mm/s will be used as a baseline figure. The design of the blast will be done according to the blast design chart to ensure minimum impact on the sensitive sites.

Noise contours for the open cast mining operation during a blast are given in Figures 12, 13 and 14.

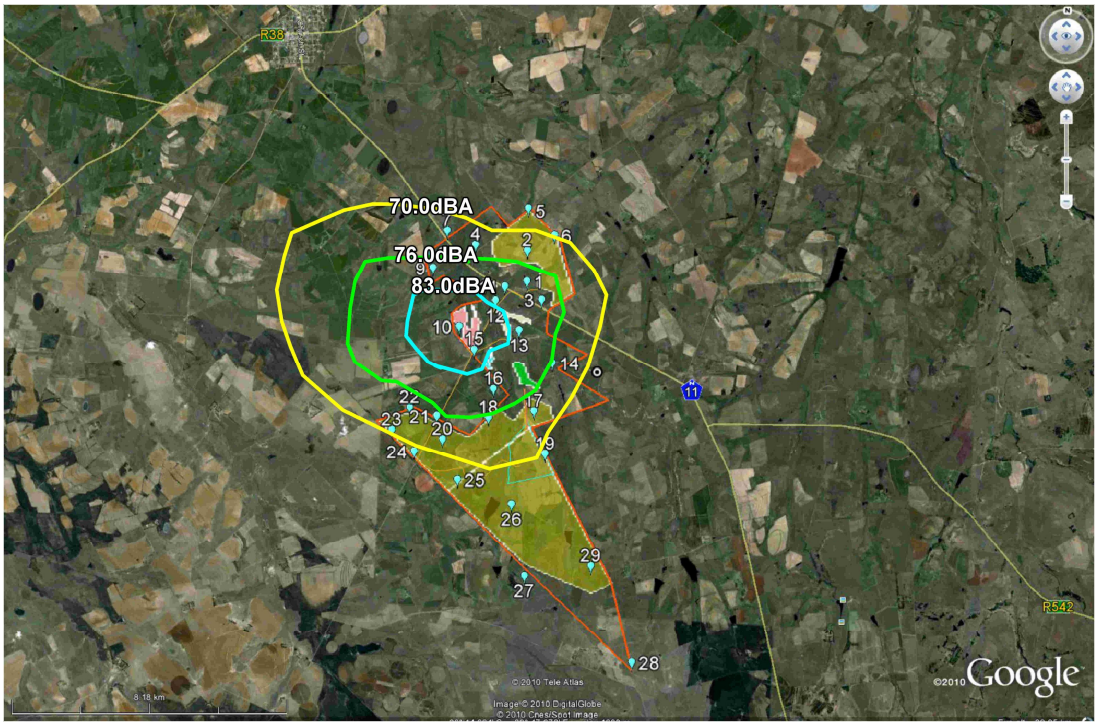

Figure 12 : Blasting contours at Pit 1

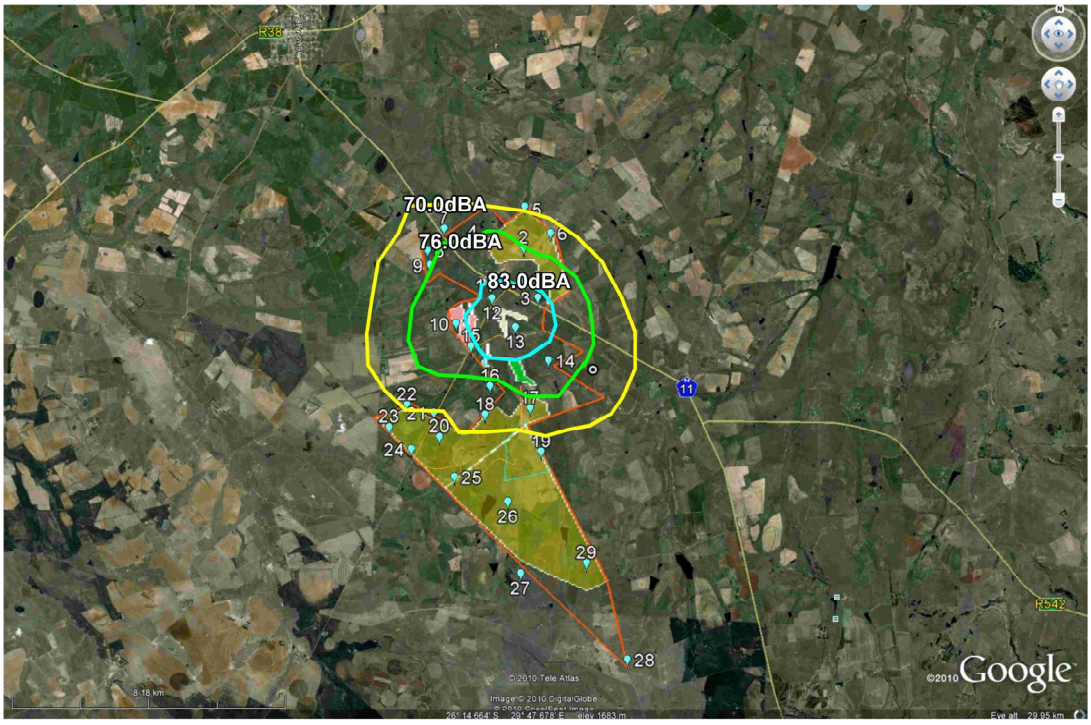

Figure 13 : Blasting contours at Pit 2

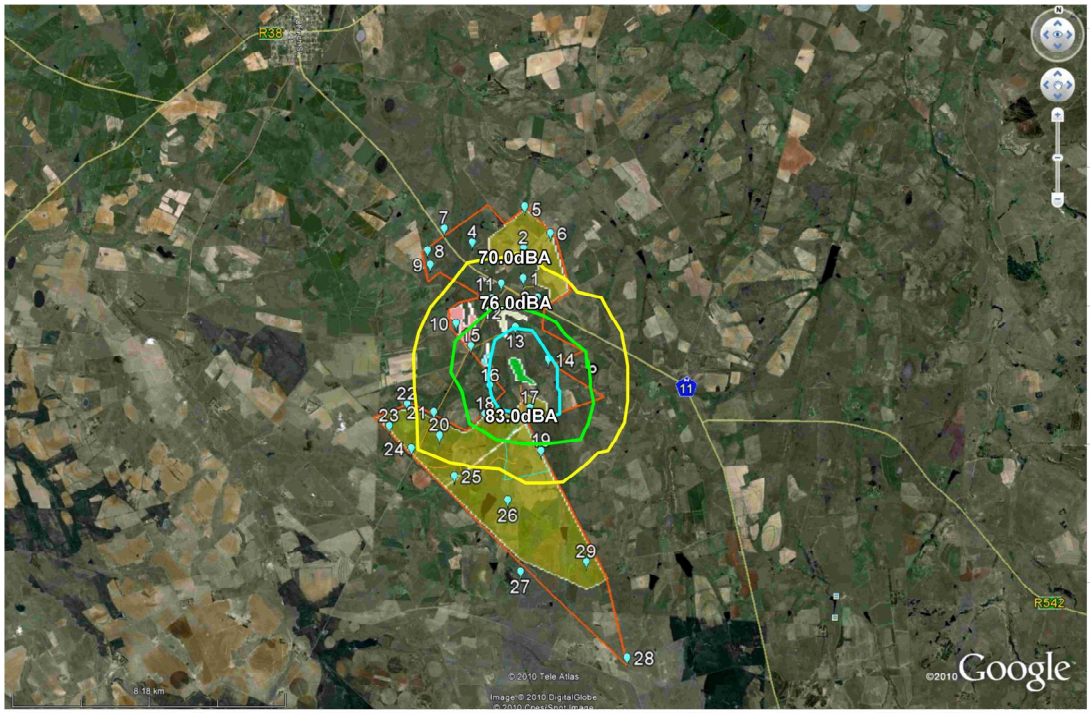

Figure 14 : Blasting contours at Pit 3

The distances between the open cast mines and the rock art site east of the mining area is:

- 3 760m from open cast pit 1
- 2 690m from open cast pit 2
- 1 725m from open cast pit 3

These contours are for the maximum peak sound pressure that will be registered for a blasting and will be for a maximum of 2 seconds per blast.

At 120dB at 15m from the blasting area the projected noise level without any acoustic screens and/or noise barriers will be 84dB @ 1000m, 78dB @ 2 000m, 71dB @ 4 000m and 67dB @ 7 000m.

At 140dB at 15m from the blasting area the projected noise level without any acoustic screens and/or noise barriers will be 104dB @ 1000m, 98dB @ 2 000m, 91dB @ 4 000m and 87dB @ 7 000m.

The vibration levels in excess of 1 000m are insignificant and should be monitored during blasting in order to determine the vibration levels and the subsequent impact it may have on the environment, residential properties and human beings.

There will be an upwards shift in the prevailing ambient noise level at areas some distance from the N11 and gravel road to Davel. This will be a temporary occurrence whereas for the plant and the conveyor activities it will be a permanent increase in the prevailing noise level.

10. Recommendations

The following three primary variables should be considered when designing acoustic screening measures for the control of noise:

- The source
- The transmission path

- The receiver

Essentially it requires and it is important to understand the problem, to identify which part of the proposal itself could produce noise and where are the key receptors.

The baseline noise information on the different noise sources, the location, type of equipment and the atmospheric conditions for a specific area will play an important role in the design of the acoustic screening measures.

The following acoustic measures must be implemented as a management control system:

- An earth berm with overburden material to be erected on the eastern and western sides of the open cast mining area.
- Carry out an ongoing noise monitoring programme which is in line with the World Bank's IFC – International Finance Corporation, Environmental, Health and Safety Guidelines.

Blasting:

The air over pressure level and vibration, (audible and the inaudible – concussion - noise), to be monitored and controlled during the blasting operation. The standards implemented by the USA Bureau of Mine Standards, RU 8507, are used as a guideline to monitor and control blasting operations in South Africa.

- The limit for ground vibration should not exceed 10mm/s at or near clay buildings, poorly constructed buildings.
- An over pressure limit of 134 dB should not be exceeded. Near schools and churches not to exceed 128 dB.
- No blasting to take place when there are windy conditions.

The Regulations under the Mines Health and Safety Act requires the owner of the operation to ensure that the health and safety of employees and people will not be affected during blasting.

Blasts must be designed in such a manner that ground vibration and over pressure levels are adhered to. In order to comply with the above, the following measures should be implemented:

- A scheme of vibration and air over pressure monitoring to be implemented;

- A scheme by which air over pressure is controlled;

- Days and times of blasting operations to be established;

- Ensure that the correct design relationship exists between burden, spacing and hole diameter;

- Ensure the maximum amount of explosive on any one day delay interval, the maximum instantaneous charge, is optimized by considering: -

    - Reduce the number of holes per detonator delay interval;
    - Reduce the instantaneous charge by in-hole delay techniques;
    - Reduce the bench height or hole depth;
    - Reduce the borehole diameter.

Always attempt to minimize the resulting environmental effects of blasting operations and to recognize the fact that the perception of blasting events occurs at levels of vibration well

below those necessary for the possible onset of the most cosmetic of damage; but nevertheless at levels that can concern occupants abutting the mining area;

Be aware that relatively small changes in blast design can produce noticeable differences in environmental emissions and that it is very often in response to changes in these emissions rather than their absolute value that complaints may be made.

Scheme of vibration monitoring may include the following:

- The location and number of monitoring points;
- The type of equipment to be used and the parameters to be measured;
- The frequency of monitoring;
- The method by which such data are made available to management;
- The method by which such data are used in order to ensure that the site vibration limit is not exceeded and to mitigate any environmental effects of blasting.

Open cast mining area:

There are different activities taking place at the interface of the mining area i.e. drilling, excavation, loading etc. and this area will have to be monitored in order to determine if a noise nuisance/disturbance is created.

Additional mitigation measures i.e. earth berm, must be provided (if practical) during the construction and design phase before construction activities will commence.

The following measures must be considered prior to the acquisition of earthmoving equipment:

- Enclosure of engine bays;
- Modification of radiator fan design and materials;
- Installation of louvers on radiator and hydraulic cooling fans;
- Re-engineering of exhaust systems

Noise attenuation measures:

- Scheduling of equipment within the pit must take into consideration the noise emissions from the equipment in order to spread them out over the interface area.

General

Maintain the internal and roads leading to the mine in a good order at all times. Monitor the speed of the trucks and speed limits to be enforced according to the capacity and the condition of the roads.

The following are the Environmental, Health and Safety Guidelines of the International Finance Corporation of the World Bank, which should be considered at all times:

- Selecting equipment with lower sound power levels

- Installing silencers for fans;

- Installing suitable mufflers on engine exhausts and compressor components;

- Installing acoustic enclosures for equipment causing radiating noise;

- Installing vibration isolation for mechanical equipment;

- Limiting the hours of operation for specific equipment and mobile sources with high sound power outputs;

- Re-locate noise sources to areas which are less noise sensitive, to take advantage of distance and natural shielding;

- Taking advantage during the design stage of natural topography as a noise buffer;

- Develop a mechanism to record and respond to complaints.

- An ongoing noise monitoring programme to be initiated for the construction and operational phases of the project.

11. **Conclusion and summary**

- The prevailing ambient noise levels in the vicinity of the proposed mining area (Open cast pit) are higher due to the N11 Road which runs through the northern section of the proposed mining area.

- The prevailing noise levels are largely created by emissions from a combination of noise sources i.e. farming activities, heavy-duty vehicles, insects and animals.

There will be an upwards shift in the prevailing ambient noise levels at the near field and to a certain extent in the far field. In the immediate mining area, which is some distance from the residential areas the shift will be more of a permanent nature depending on the duration of such an activity.

An ongoing noise monitoring and vibration program to be implemented during the construction and operational phases of the project. This is to ensure compliance to the Noise Control Regulations and/or SANS 10103 of 2008 - The measurement and rating of environmental noise with respect to annoyance and to speech communication.

Barend van der Merwe
Environmental Acoustic Consultant

References:

Environmental, Health and Safety Guidelines for Community Noise and Mining, World Health Organisation, Geneva, 1999;

Environmental, Health and Safety (EHS) Guidelines, World Health Organisation, Geneva, 1999;

Google Earth – Aerial photos;

Noise Control Regulations;

Rock Slope Engineering, Wyllie and Mah, 2004;

SANS 10103 of 2008 – The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication;

The Scottish Government – Controlling the Environmental Effects of Surface Mineral Workings;

USA Bureau of Mine Standards, RU 8507;

Woods Practical Guide to Noise Control, Sharland Ian, 1972

Definitions/Noise:

Ambient noise
The totally encompassing sound in a given situation at a given time and usually composed of sound from many sources, both near and far

A-weighted sound pressure level (sound level) (L_{pA}), in decibels
The A-weighted sound pressure level is given by the equation:

$L_{pA} = 10 \log (p_A/p_o)^2$

Where

p_A is the root-mean-square sound pressure, using the frequency weighting network A in pascals; and

p_o is the reference sound pressure (p_o = 20 µPa).

NOTE The internationally accepted symbol for sound level is dBA.

Distant source
A sound source that is situated more than 500 m from the point of observation

Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$), in decibels
The value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval *T*, has the same mean-square sound pressure as a sound under consideration whose level varies with time. It is given by the equation

Where

$L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level, in decibels, determined over a time interval *T* that starts at t_1 and ends at t_2;

p_o is the reference sound pressure (p_o = 20 µPa); and

$p_A(t)$ is the instantaneous A-weighted sound pressure of the sound signal, in Pascals.

Impulsive sound
Sound characterised by brief excursions of sound pressure (acoustic impulses) that significantly exceed the residual noise

Initial noise
The component of the ambient noise present in an initial situation before any change to the existing situation occurs

Intelligible speech
Speech that can be understood without undue effort

Low frequency noise
Sound, which predominantly contains frequencies below 100 Hz

Nearby source
A sound source that is situated at a distance of 500 m or less from the point of observation

Residual noise
The ambient noise that remains at a given position in a given situation when one or more specific noises are suppressed

Specific noise
A component of the ambient noise which can be specifically identified by acoustical means and which may be associated with a specific source

NOTE Complaints about noise usually arise as a result of one or more specific noises.

Ambient sound level
Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation.

Disturbing noise
Means a noise that cause the ambient noise level to rise above 7dBA above the designated zone level, or if no zone level has been designated, the typical rating levels for ambient noise in districts, indicated in table 2 of SANS 10103.

Noise nuisance
Means any sound which disturbs or impairs the convenience or peace of any person

Appendix A
Calibration certificates of noise monitoring equipment

SANAS
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148 1302

De Beer Calibration Services
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CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2009-020
ORGANISATION	dB ACOUSTICS
ORGANISATION ADDRESS	P.O. BOX 1219, ALLENSNEK, 1737
CALIBRATION OF	INTEGRATING SOUND LEVEL METER with built-in ⅓-OCTAVE/OCTAVE FILTER and ½" MICROPHONE
CALIBRATED BY	M.W. DE BEER
MANUFACTURER	LARSON.DAVIS
MODEL NUMBERS	824 and 2541
SERIAL NUMBERS	824A3282 and 7937
DATE OF CALIBRATION	6 JANUARY 2009
RECOMMENDED DUE DATE	JANUARY 2010
PAGE NUMBER	PAGE 1 OF 4

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The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

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M.W. DE BEER (SANAS AUTHORIZED SIGNATORY)

8 January 2009
DATE OF ISSUE

Director: M.W. de Beer

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CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	*2009-019*
ORGANISATION	*dB ACOUSTICS*
ORGANISATION ADDRESS	*P.O. BOX 1219, ALLENSNEK, 1737*
CALIBRATION OF	*INTEGRATING SOUND LEVEL METER with built-in ⅓-OCTAVE/OCTAVE FILTER and ½" MICROPHONE*
CALIBRATED BY	*M.W. DE BEER*
MANUFACTURERS	*LARSON.DAVIS and PCB*
MODEL NUMBERS	*831 and 377 B 02*
SERIAL NUMBERS	*0001072 and 102184*
DATE OF CALIBRATION	*6 JANUARY 2009*
RECOMMENDED DUE DATE	*JANUARY 2010*
PAGE NUMBER	*PAGE 1 OF 4*

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8 January 2009
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CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	*2009-021*
ORGANISATION	*dB ACOUSTICS*
ORGANISATION ADDRESS	*P.O. BOX 1219, ALLENSNEK, 1737*
CALIBRATION OF	*ACOUSTIC CALIBRATOR*
CALIBRATED BY	*M.W. DE BEER*
MANUFACTURER	*LARSON.DAVIS*
MODEL NUMBER	*CAL 200*
SERIAL NUMBER	*3073*
DATE OF CALIBRATION	*6 JANUARY 2009*
RECOMMENDED DUE DATE	*JANUARY 2010*
PAGE NUMBER	*PAGE 1 OF 3*

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The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

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M.W. DE BEER (SANAS AUTHORIZED SIGNATORY)

8 January 2009
DATE OF ISSUE

Assessment of impacts identified

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
		M	D	S	P	TOTAL	SP		M	D	S	P	TOTAL	SP
ISSUES RELATED TO NOISE AND VIBRATION														
Construction phase														
Upgrade of existing gravel road to a asphalt type surface	Noise	8	2	1	3	33	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L
Grading and building of new internal roads and haul roads	Noise	8	2	1	3	33	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L
Preparation of the footprint area, earthworks & construction	Noise	8	2	1	3	33	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L
Provision of services such as water, sewerage and electricity	Noise	8	2	1	3	33	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L
Construction of conveyor	Noise	8	2	1	3	33	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L
Construction of earthberm on eastern side of pit 3	Noise	8	2	1	3	33	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L
Construction of the ventilation shafts for the underground mining	Noise	8	2	1	3	33	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L
						0							0	
Operational phase						0							0	
Drilling	Noise	8	4	1	3	39	M	Apply the IFC's Environmental Health and Hygiene Regulations.	6	4	1	3	33	M
Overburden blasting	Noise & vibration	10	4	1	4	60	H	Blasting to be designed aacording to the IFC's Environmental Health and Hygiene Regulations and the Blast design chart.	8	4	1	4	52	M
Coal blasting	Noise & vibration	10	4	1	4	60	H	Blasting to be designed aacording to the IFC's Environmental Health and Hygiene Regulations and the Blast design chart.	8	4	1	4	52	M
Removal of coal	Noise	8	4	1	3	39	M	Apply the IFC's Environmental Health and Hygiene Regulations & mitigatory measures. Mitigatory measures at plant.	6	4	1	3	33	M
Crusher	Noise	8	4	1	3	39	M	Apply the IFC's Environmental Health and Hygiene Regulations & mitigatory measures. Mitigatory measures at plant.	6	4	1	3	33	M
Conveying of coal by means of conveyor	Noise	8	4	1	3	39	M	Apply the IFC's Environmental Health and Hygiene Regulations & mitigatory measures. Mitigatory measures at plant.	6	4	1	3	33	M
Transportation of coal by road	Noise	8	4	3	4	60	H	Upgrade the existing gravel road and to apply strict speed control measures.	8	4	1	4	52	M
Plant activities	Noise	8	4	1	3	39	M	Apply the IFC's Environmental Health and Hygiene Regulations & mitigatory measures	8	4	1	3	39	M
Ventilation shaft.	Noise	8	4	1	3	39	M	Apply the IFC's Environmental Health and Hygiene Regulations & mitigatory measures direction of the duct opening to face away from noise sensitive areas.	8	4	1	3	39	M
Decommissioning phase														
Rehabilitation of mined area	Noise	8	3	1	3	36	M	Apply the IFC's Environmental Health and Hygiene Regulations	6	2	1	2	18	L

Annexure C

Action Plan	Time Frame	Responsible Person	Capital Required (capex)	Operational Cost (opex)
Noise and vibration monitoring				
Noise and vibration monitoring to be done at the existing measuring points during the construction phase.	Construction phase – Every three months	Environmental Manager	Consultant fees	Approximately R60 000 per annum for monitoring an analyses
Noise and vibration monitoring to be done at the existing measuring points during the operational phase.	Operational phase – Monthly and when blasting take place for the first six months thereafter own monitoring to take place.	Environmental Manager	Consultant fees	Approximately R90 000-00 for consulting and R150 000-00 for purchasing of Sound level meter and Vibration meter.