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Environmental Noise Report

Exxaro Belfast Project

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EXECUTIVE SUMMARY

An opencast coal mine and crusher plant is proposed at a rural site in an area with extensive existing coal mining activity, stretching 12km or so south of the N4 highway, between the R33 and Wonderfontein-Carolina roads, approximately 10 km west of Belfast, in a farming area with the generally low ambient noise levels typical of rural environments. The investigation's purpose was to estimate the potential noise impact of the proposed opencast mine and fixed infrastructure on the existing ambient noise climate in the surrounding areas which are primarily mixed farming. This was achieved by measuring the existing ambient noise levels at the site and determining the noise of operations at a functioning opencast mine and crusher plant, currently operated in a similar manner and with similar equipment and procedures, and therefore can be considered representative of the situation to be expected at the proposed mine. Measurements of the existing noise climate at the site were made at 4 defined positions around the proposed site as described in section 3, three of them close to the boundaries of the site in the rural areas and one adjacent to the main noise source in the area, the N4 Highway, which crosses the northern part of the mine.

All measurements and comparisons were carried out with the recommended zone levels in accordance with the relevant SANS 10103:2008 Code of Practice, and as required by the DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM. It is assumed that operations will take place during periods defined as daytime (06:00 to 22:00) and at least partially in the night-time period (22:00 to 06:00) in these publications.

The expected response from the local community to the noise impact, i.e. any increase of predicted operational noise over the original ambient or recommended zone noise levels, is primarily based on the relevant document, SANS 10103:2008, and expressed in terms of the effects of impact, on a scale of 'NONE' to 'VERY HIGH'.

This report is an overall assessment designed to predict the collective response of a noise-exposed population and therefore the impact the operation is likely to have on them, and is based on measured and predicted equivalent continuous noise levels according to the relevant SANS code of practice.

The noise impact is generally rated as NONE or VERY LOW at the nearest surrounding dwellings. In the worst case of the noisiest operations of the opencast phase being at their closest to those dwellings during a short duration for part of the lifetime of the opencast mine, the impact is rated as LOW reducing to NONE, as these operations move further away, and as the activities move under ground level, whereby the noisy opencast activities are reduced by the barrier effect of the pit walls. Complaints of noise intrusion are therefore not expected from the nearest residences to the proposed mine. The noise impact on the community for blasting operations, because of their unpredictable occurrence and effects, should be considered MODERATE.

Methods of mitigation to reduce any potential noise impact, including placement of dam earthworks, berms, barriers, and operational and administrative procedures, plant maintenance, and on-site monitoring to ensure that any agreements entered into regarding operating times are adhered to, are discussed. It is especially effective to group noisy activities such as crushing and loading at the same location and to surround those activities with the stockpiles if feasible, as these are the noisiest surface activities and the most likely to be propagated to sensitive receivers.

The predicted noise levels generated by truck activity alone meets the daytime criterion of 45 dB(A) at 55m from the proposed road extension to the R33. It is not expected that dwellings will be within that corridor, and night-time transportation is not expected.

1. PURPOSE OF THE INVESTIGATION AND TERMS OF REFERENCE

An opencast coal mine and crusher plant is proposed at a rural site in an area with extensive existing coal mining to the south of the N4 highway, between the R33 and Wonderfontein-Carolina roads, approximately 10 km west of Belfast, in a farming area with the generally low ambient noise levels typical of rural environments. The investigation's purpose was to estimate the potential noise impact of the proposed mine on the existing ambient noise climate in the surrounding areas which are primarily mixed farming. This was achieved by measuring the existing ambient noise levels at the site and determining the noise of operations at a functioning and opencast mine and crusher plant which are currently operated in a similar manner and with similar equipment and procedures, and therefore can be considered representative of the situation to be expected at the proposed mine. Measurements of the existing noise climate at the site were made at 4 defined positions in and around the proposed site as described in section 3.

Construction phase

Construction activities associated with the new infrastructure are unlikely to increase the noise level by more than that experienced for the operational phase. This is in any case likely to span a relatively short time period.

Operational phase

This is the primary purpose of this report. The opencast mine and the crusher plant are considered. Formal complaints regarding noise disturbance should be responded to using an agreed protocol.

Decommissioning and closure phase

No significant noise impacts are expected during the decommissioning phase of the site. This impact is in any case likely to be of a short duration.

Possible residual and latent impacts

No residual or latent impacts are expected.

2. INVESTIGATIVE METHODOLOGY

2.1 Introduction

The proposed mine is to be situated in a rural environment, with typically low levels of noise, dominated by the natural sounds of rustling vegetation, wildlife (primarily birdsong and insects), and man-influenced sounds such as livestock, farming activities, and very occasional remote road and air traffic. Therefore it is to be expected that the noise from the suggested operation, using high-powered machinery and blasting, could potentially have an impact on the surrounding area. In order to be able to assess both the quantitative and geographical extent of the potential impact, it is necessary to predict the noise levels generated by the operation of the mine and compare these with the zone noise level for the type of district backed up by confirmatory ambient noise measurements on site. The extent of community response can then be assessed according to national and international standards which take into account sociological factors as well as the estimated change in noise climate.

2.2 Ambient Noise Measurements at the Belfast Block Mines

Confirmatory site noise measurements were carried out on Monday 23 and Tuesday 24 November 2009. These are reported and discussed in section 3.5. below.

2.3. Measurement of Noise Emitted by Similar Operations at an Existing Mine

The approach used in this assessment is to identify all the characteristic noise-generating operations involving a number of machines working together at a specific location, and make measurements of each operation over a representative time period. This approach has the advantage that realistic noise values representing actual equipment maintenance condition and actual operating conditions and durations are used in the later predictions.

2.4. Prediction of Noise Levels at the Proposed Belfast Block Mines

The values measured at the operating sites then formed the basis of calculations to predict the noise levels at specific locations of interest at the boundaries of the proposed mine. Using the point source and attenuation-by-distance model, the following assumptions were made:

1. Acoustically hard ground conditions. This assumes that no attenuation due to absorption at the ground surface takes place. The effects of frequency-dependent

atmospheric absorption were also ignored. Both assumptions represent a pessimistic evaluation of the potential noise impact.

2. Meteorological conditions. Neutral weather conditions, i.e. windless and inversionless, and standard conditions of temperature and humidity (20°C and 50%RH) were assumed, representing a neutral evaluation of the noise impact.
3. Noise measurements were representative of normal operation. Equivalent continuous A-weighted noise levels, $L_{Aeq,I}$, measured for each type of operation correctly represent the noise from that operation. Impossible-to-predict (random) single noise events louder than the continuous noise level are not taken into account, although short events which are part of the process, such as the impact noise from material transport, and beepers indicating reversing vehicles, for example, are fully represented in the measurements, representing a neutral evaluation of the noise impact.
4. Ambient noise levels. Measured levels are assumed typical of the environment, representing a neutral evaluation of the noise impact.
5. Barrier effect of temporary stockpiles and levees. Because of the highly mobile nature of all operations on the proposed site, at least in the initial opencast phase, the effect of these temporary structures on the noise climate has been ignored, representing a pessimistic evaluation of the potential noise impact.
6. Current noise control technology is assumed. No allowance is made in the noise level predictions for improvements in noise control techniques or mitigation measures which may be incorporated into the proposed project, representing a pessimistic evaluation of the potential noise impact.
7. Worst case operational noise level assumption. The highest noise level of plant as measured at the operating site was used as the criterion value for the noise predictions at the proposed project, representing a pessimistic evaluation of the potential noise impact.

2.5. Quantifying the Noise Impact

The noise impact is quantified as the predicted increase in ambient noise level, in decibels (dB), which can be attributed to the operation of the proposed mine appropriate to the

proposed operating times. The mine and its processing plant are assumed to be operating continuously, at any time of the day, or day of the week.

Existing noise sources include:

1. Natural sounds of the bush.
2. Livestock and agricultural activity on surrounding land.
3. Local community and domestic noise.
4. Remote vehicles and other transport serving the local community.

Table 1: Typical noise level and human perception of common noise sources.

Noise level (dBA)	Source	Subjective description
160-170	Turbo-jet engine	Unbearable
130	Pneumatic chipping and riveting (operator's position)	Unbearable
120	Large diesel power generator	Unbearable
110	Circular saw Blaring radio	Very noisy
90 - 100	Vehicle on highway	Very noisy
80 - 90	Corner of a busy street Voice - shouting	Noisy
70	Voice - conversational level	Quiet
40 - 50	Average home - suburban areas	Quiet
30	Average home - rural areas Voice - soft whisper	Quiet
0	Threshold of normal hearing	Very quiet

Table 2 Acceptable rating levels for noise in districts (Ref.1)

Type of district	Equivalent continuous rating level ($L_{Req.T}$) for noise dB(A)					
	Outdoors			Indoors, with open windows		
	Day-night $L_{R,dn}$ [1)]	Day-time $L_{Req,d}$ [2)]	Night-time $L_{Req,n}$ [2)]	Day-night $L_{R,dn}$ [1)]	Day-time $L_{Req,d}$ [2)]	Night-time $L_{Req,n}$ [2)]
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 one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

NB: Day-time: 06:00 to 22:00, Night-time: 22:00 to 06:00

The worst case criterion appropriate for this assessment is for rural districts as shown in bold script in the above table.

2.6. Assessing the Noise Impact

The expected response from the local community to the noise impact, i.e. the increase of noise over the original ambient, is primarily based on Table 5 of SANS 10103 (ref. 1), but expressed in terms of the effects of impact, on a scale of ‘none’ to ‘very high’.

Table 3: Response intensity & noise impact for various increases over the ambient noise

INCREASE dB	RESPONSE INTENSITY	REMARKS	NOISE IMPACT
0	None	Change not discernible to a person	None
3	None to little	Change just discernible	Very low
3 ≤ 5	Little	Change easily discernible	Low
5 ≤ 7	Little	Sporadic complaints	Moderate
7	Little	Defined by National Noise Regulations as being 'disturbing'	Moderate
7 ≤ 10	Little to medium	Sporadic complaints	High
10 ≤ 15	Medium	Change of 10dB perceived as 'twice as loud' leading to widespread complaints	Very high
15 ≤ 20	Strong	Threats of community/group action	Very high

2.7. Response of Communities to Blast Noise

The characteristics of blast noise, which is transient, its manner of propagation, and the assessment of the response of a community to it, is completely different from the assessment of the mine equipment noise, which is continuous, or at least takes place over extended periods. In addition, there are no straightforward methods of assessment of community response to blast noise which are not based on actual blast event measurements. An International Standards Organisation committee, (see ref. 9) is considering a method of modeling the propagation of blast and other impulsive noise, but there is no reliable scientific method of predicting community response to it at present. Some good practices and mitigation methods to reduce the possible reaction to blasting are discussed in the relevant section.

3. AMBIENT NOISE MEASUREMENTS AT THE SITE

3.1 Introduction

Ambient noise measurements were carried out according to SANS Code of Practice 10103:2008 (Ref. 1) at four points on or near the property boundary on Monday 23 and

Tuesday 24 November 2009. These points are defined and the measurements reported in Section 3.5.

3.2 Equipment Used

01dB Type SdB01+ Precision Integrating Sound Level Meter, serial number 10167, fitted with 01dB Microphone Type MCE210, serial number 001194, and windscreen. Field calibration using and Bruel and Kjaer Type 4230 Sound Level Calibrator, serial number 522170.

3.3 Calibration Certificates

All equipment with valid calibration certificates, from the testing laboratories of De Beer Calibration Services. The calibration certificates are available for viewing if required.

3.4 Procedures Used

Measurements were carried out strictly in accordance with SOUTH AFRICAN NATIONAL STANDARD - Code of practice, SANS 10103:2008, *The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication.*

and as required by the regulations of the DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM. NO. R. 154. *Noise Control Regulations in Terms of Section 25 of the Environmental Conservation Act, 1989 (Act No. 73 of 1989)*. Govt. Gaz. No. 13717, 10 January 1992, e.g. Gauteng province, Department of Agriculture, Conservation and Environment, Notice 5479 of 1999. *Noise control regulations, 1999*, Provincial gazette extraordinary, 20 august 1999.

3.5 Measurements at the Proposed Site

Ambient noise measurements were carried out at four positions near to the legal boundaries of the property, and as described under each noise measurement position reported below. These positions were chosen for one or more of the following reasons:

1) Easily definable and with easy future access in case of need for comparison measurements after completion of the project.
2) Most likely to continue to exist after development of the site.

3) Representative of important background noise regimes.
4) Near sensitive receptors likely to be affected by future mine noise.
5) In the vicinity of proposed plant or operations likely to produce significant noise.

Note 1: All noise levels in this report are A-weighted noise levels expressed in dB(A).

Note 2: $\mathbf{L_{Aeq,I}}$ is the A-weighted equivalent sound level using the 'I' (Impulse) dynamic response characteristic as recommended in SANS 10103:2008 (ref. 1)

Note 3: The noise level exceeded for 90% of the time ($\mathbf{L_{90}}$) is taken as an expression of the background noise in the absence of intrusive noisy events, primarily road traffic and random noise events such as pedestrians, animals, birds, and local road or air traffic.

Note 4: In the Comments column of the noise tables, C - Car, Minibus or LDV, HGV – Heavy Goods Vehicle or Bus, A/c – Commercial airliner, La/c – light aircraft, H – Helicopter, cN - noise level calculated from traffic count, for the measurement period, usually (but at least) 10 minutes.

Measurement Position 1

On the dirt road from the N4 Highway to the south of the site, opposite the 5km milestone, as shown in the following photographs. GPS co-ordinates (WGS 84, Latitude/Longitude, hddd°mm.mmm') – S25° 47.856′, E30° 00.000′. Height 1799m (±4.8m)

View across eastern boundary to R33

View north towards position of N4 Highway

Measurement Table

Day/Date	Time	T °C	RH %	Wind m/s	L_{eq}	L_{90}	Comments
Mon 23/11/09	09:54-10:08	21.5	33	4.8E	44.7	37	No Traffic
Mon 23/11/09	10:10-10:20	21.5	33	4.8E	40.8	32	No Traffic
Mon 23/11/09	10:22-10:32	21.5	33	4.8E	43.6	34	No Traffic
Mon 23/11/09	10:34-10:44	21.5	33	4.8E	46.1	36	No Traffic
Mon 23/11/09	13:00-13:10	24.5	36	3.5E	46.5	36	No Traffic
Mon 23/11/09	13:11-13:21	24.5	36	3.5E	42.7	34	No Traffic
Mon 23/11/09	13:23-13:33	24.5	36	3.5E	45.7	34	No Traffic
Mon 23/11/09	16:00-16:11	24.5	36	<4.7E	38.2	30	No Traffic
Mon 23/11/09	16:12-16:22	24.5	36	<4.7E	38.7	33	No Traffic
Mon 23/11/09	16:23-16:33	24.5	36	<4.7E	37.8	31	No Traffic
Mon 23/11/09	18:56-19:06	17	64	<2.3SE	45.1	40	No Traffic, Frogs
Mon 23/11/09	19:07-19:17	17	64	<2.3SE	44.2	40	No Traffic, Frogs
Tues 24/11/09	07:33-07:43	20.5	42	<3.2SE	32.8	23	No Traffic
Tues 24/11/09	07:45-07:55	20.5	42	<3.2SE	33.6	24	No Traffic
Tues 24/11/09	12:05-12:15	25	32	<3.0SE	34.5	25	No Traffic
Tues 24/11/09	12:16-12:26	25	32	<3.0SE	32.8	22	No Traffic
Tues 24/11/09	13:52-14:02	25	32	<1.8SE	30.3	23	No Traffic

Observations: These values are typical of a remote rural area, with the noise climate, $\mathbf{L_{eq}}$, dominated at different times of the day by natural sounds such as bird call, insects, frogs and wind noise through foliage, with occasional noise from remote overflying aircraft, local vehicles, and farming activities. Truck traffic on the R33 is audible from this measurement position, but not a significant contributor to the noise climate. The background noise, the $\mathbf{L_{90}}$, varies significantly between 22 and 40 dB(A) depending primarily on the wind strength, and insect, bird, and frog activity.

Measurement Position 2

On the dirt road verge opposite the 9km milestone, as shown in the following photographs. GPS co-ordinates (WGS 84, Latitude/Longitude, hddd°mm.mmm') – S25° 50.759′, E29° 56.308′. Height 1731m (±4.0m)

View across eastern boundary to the R33

View southwest to the proposed plant site

Measurement Table

Day/Date	Time	T °C	RH %	Wind m/s	L_{eq}	L_{90}	Comments
Mon 23/11/09	11:31-11:43	24.5	33	3.5E	41.8	30	No Traffic
Mon 23/11/09	11:45-11:55	24.5	33	3.5E	37.1	32	No Traffic
Mon 23/11/09	11:56-12:06	24.5	33	3.5E	39.0	33	No Traffic
Mon 23/11/09	12:07-12:17	24.5	33	3.5E	38.3	32	No Traffic
Mon 23/11/09	17:05-17:15	24	36	3.4E	37.5	30	No Traffic
Mon 23/11/09	17:17-17:27	24	36	3.4E	36.1	30	No Traffic
Mon 23/11/09	18:20-18:30	18	65	<2.1E	39.8	35	No Traffic, Frogs
Mon 23/11/09	18:31-18:41	18	65	<2.1E	39.6	35	No Traffic, Frogs
Tues 24/11/09	08:11-08:18	20.5	42	<3.0SE	31.2	25	No Traffic
Tues 24/11/09	08:20-08:30	20.5	42	<3.0SE	31.8	26	No Traffic
Tues 24/11/09	08:32-08:42	20.5	42	<1.4SE	33.0	26	No Traffic
Tues 24/11/09	12:35-12:45	25	32	<1.4SE	39.8	28	No Traffic
Tues 24/11/09	13:31-13:41	25	32	<1.4SE	35.8	26	No Traffic

Observations: These values are typical of a remote rural area, with the noise climate, L_{eq}, dominated at different times of the day by natural sounds such as bird call, insects, and wind noise through foliage, with occasional noise from remote overflying aircraft, local vehicles,

and farming activities. Truck traffic on the R33 is audible from this measurement position, but not a significant contributor to the noise climate. The background noise, the $\mathbf{L_{90}}$, varies between 25 and 35 dB(A) depending primarily on the wind strength, and insect, and bird, activity.

Measurement Position 3

On the farm access road at the rear of the garden of the dwelling on the north side of the dirt road, approximately 6km SE of the intersection with the N4 at Wonderfontein as shown in the following photographs. GPS co-ordinates (WGS 84, Latitude/Longitude, hddd°mm.mmm') – S25° 49.918′, E30° 00.295′. Height 1763m (±5.1m)

View north into the mining site

View northwest towards site boundary

Measurement Table

Day/Date	**Time**	**T °C**	**RH %**	**Wind m/s**	**L_{eq}**	**L_{90}**	**Comments**
Mon 23/11/09	12:28-12:38	24.5	33	<4.7E	46.9	36	No Traffic
Mon 23/11/09	12:40-12:50	24.5	33	<4.7E	46.8	36	No Traffic
Mon 23/11/09	12:28-12:38	24.5	33	<4.7E	44.9	36	No Traffic
Mon 23/11/09	17:40-17:50	22	43	<1.6E	38.2	33	No Traffic
Mon 23/11/09	17:51-18:01	22	43	<1.6E	38.7	36	No Traffic
Mon 23/11/09	18:02-18:12	22	43	<1.6E	39.3	37	No Traffic
Tues 24/11/09	12:55-13:05	25	32	<1.2SE	29.7	22	No Traffic
Tues 24/11/09	13:06-13:16	25	32	<1.2SE	35.8	26	No Traffic

Observations: These values are typical of a remote rural area, with the noise climate, **L_{eq}**, dominated at different times of the day by natural sounds such as bird call, insects, and wind noise through foliage, with occasional noise from remote overflying aircraft, local vehicles, and farming activities. The background noise, the **L_{90}**, varies widely between 22 and 37 dB(A) depending primarily on the wind strength, and insect, and bird, activity.

Measurement Position 4

60m from the centreline of the N4 on the southern side of the road as shown in the following photographs. GPS co-ordinates (WGS 84, Latitude/Longitude, hddd°mm.mmm') – S25° 44.301′, E30° 00.609′. Height 1914m (±4.5m)

View north toward N4 Highway

View south towards the proposed mine

Measurement Table

Day/Date	Time	T °C	RH %	Wind m/s	L_{eq}	L_{90}	Comments
Mon 23/11/09	15:30-15:40	24.5	33	<3.8E	58.7	47	No traffic count
Mon 23/11/09	15:42-15:52	24.5	33	<3.8E	58.8	47	C=88, HGV=16
Tues 24/11/09	07:15-07:25	20.5	42	<0.8SE	60.4	46	C=89, HGV=21
Tues 24/11/09	11:30-11:40	25	32	<2.8SE	57.0	43	C=79, HGV=24
Tues 24/11/09	14:20-14:30	25	32	<3.0SE	57.2	44	C=103, HGV=21

Observations: These values are typical of a rural area with no other noise sources than the highway, which completely dominates the noise climate. The background noise, the **L_{90}**, varies narrowly between 43 and 47 dB(A) depending primarily on the traffic count. The measured values agree well with calculations using the SANS recommended method of Ref. 2, and utilising the official SANRAL traffic counts.

4. OPERATION NOISE MEASUREMENTS FROM AN EXISTING MINE

In order to have actual measurements of operations from which to assess the forthcoming conditions at the proposed mine, noise from an existing mine's operations was measured. This existing mine's processing equipment is similar to and operates in a manner similar to that proposed for the proposed mine. The four main operations measured were the drilling of blast holes (earlier measurements taken at another mine), the loading of haul trucks, both screened by the pit walls, and the loading of road transport trucks and the crusher plant, which are both above the actual ground surface level.

4.1 The Drilling Operation

Measurements were made at a distance of 10m from the assumed acoustic centre of the drilling rig, over a full drilling cycle, including relocation of the rig. Temperature 24.5°C, Humidity 20%, Wind speed 3.3 m/s max. The following relevant measurements were recorded. These measurements were made at a similar operation at another mine.

Meas. Nr.	$\mathbf{L_{Amax}}$	$\mathbf{L_{AeqI}}$
1	93.9	84.8
2	94.6	88.2
3	92.5	87.5
4	94.8	89.5
Worst case	94.8	89.5

For calculation and prediction purposes the worst case maximum measurement cycle value of 89.5 dB(A) at 10m (normalised to 86.0 dB(A) at 15m) has therefore been used.

4.2 The in-pit Overburden Loading Operation

Measurements were made at a distance of 20m from the assumed acoustic centre of the operation, over a full loading cycle. Temperature 25°C, Humidity 31%, Wind speed 1.6 m/s max. The following relevant measurements were recorded.

Meas. Nr.	L_{Amax}	L_{AeqI}
1	91.4	76.9
2	89.9	77,0
Worst case	91.4	77.0

For calculation and prediction purposes the maximum measurement cycle value of 77.0 dB(A) at 20m (Nominal 79,5 dB(A) at 15m) has therefore been used.

4.3 The Crusher Plant

Measurements were made at a distance of 30m from the assumed acoustic centre of the plant, over a full load cycle. Temperature 25°C, Humidity 31%, Wind speed 1.5 m/s max. The following relevant measurements were recorded.

Meas. Nr.	L_{Amax}	L_{AeqI}
1	76.3	73.4
2	76.3	72.0
Worst Case	76.3	73.4

For calculation and prediction purposes the maximum cycle value, nominal 79.4 dB(A) at 15m[1], has therefore been used.

It has been assumed that both the proposed plants, the phase 1 crusher plant and the phase 2 washing plant will generate the same noise levels as the measured crusher plant at the Glisa Mine, operated by Exxaro, and will be placed at least 500m from each other.

4.4 The Transport Truck Loading Operation

Measurements were made at a distance of 20m from the assumed acoustic center of the operation, over a full loading cycle. Temperature 25°C, Humidity 31%, Wind speed 1.2 m/s max. The following relevant measurements were recorded.

[1] These measurements were made at 30m. They have been corrected to a nominal distance of 15m in line with the other measurements.

Meas. Nr.	L_{Amax}	L_{AeqI}
1	85.3	73.6
2	83.3	73.5
Worst Case	85.3	73.6

For calculation and prediction purposes the maximum measurement cycle value of 73.6 dB(A) at 20m (Nominal 76.1 dB(A) at 15m) has therefore been used.

5. IMPACT ASSESSMENT

5.1 General

Because of the highly mobile manner of opencast operation, this type of operation does not lend itself to simple static calculations of noise levels either at the site boundaries or at specific noise-sensitive locations for the following reasons:

1. The noise generating machinery migrates around the site in the long term as the material is extracted, with the consequent varying of distance from noise-sensitive areas.
2. Much of the machinery itself is mobile in the short term, e.g. excavators, front loaders, trucks, and road graders, giving rise to highly intrusive noise events for short periods, which stand out above the general background level, and are therefore more noticeable.
3. Noise sources may be more or less screened from receiver positions depending on the progress of the excavations. This is especially true of rock and soil removal, which may be well screened by their depth in the pit for long periods of their total operating time.

Noise levels may be impacted upon by adverse weather conditions. Adverse weather conditions are, however, not a quantifiable aspect due to a variety of limitations and assumptions that can be made in this regard. Storms / rain etc generate their own noise which may mask or amplify blasting noise, depending on other environmental conditions and location of receptors in respect of the blasting activity.

5.2 Continuous Noise Levels and Individual Noise Events

This report is an overall assessment designed to predict the collective response of a noise-exposed population and therefore the impact the operation is likely to have on them, and is

based on measured and predicted equivalent continuous noise levels according to SANS 10103:2008. It will be possible to detect and distinguish individual noise events, even if the noise impact is assessed as NONE, or VERY LOW, i.e. where a person with normal hearing will not be able to detect the predicted increase in ambient noise level attributable to operation of the mine, but where an individual noise-generating operation may nevertheless be audible to that person.

5.3 Existing Ambient Noise Levels at the Site

The ambient noise in such rural communities is generally similar to and sometimes lower than the suggested values for rural districts according to the relevant section (Table 2) of the recommendations of SANS 10103:2008 as follows.

Table3. Part of Table 2 of SANS 10103:2008.

Type of District	Daytime	Nighttime
Rural	45	35

The confirmatory measurements made on site agree very well with the recommendations of SANS 10103:2008 for a rural area, so for the purpose of this assessment the above stricter zone levels for a rural area at night have been used in the subsequent assessments:

5.4. Predicted Impact of General Site Operation Noise

The investigation shows that because of its remoteness to occupied dwellings, the proposed mine crusher plant is not likely to have a significant impact on the noise climate at the nearest dwellings.

With respect to the opencast mine, the two continuously noisy activities within the opencast pit are the drilling and the loading processes. The combination of both these sources at similar distances from the assessment position is the worst case. This gives a predicted value of 86.9 dB(A) at 15m. As all these activities are within the pit and therefore screened by the pit wall, a very conservative allowance for the noise barrier effect of the pit wall is taken as 8 dB. The investigation shows that activities within the proposed pit will have a minor impact on the noise climate of the surrounding environment for the opencast phase. In the worst

case, as described above, with no mitigating measures, and using the limit levels in 4.3. above, the daytime impact will be NONE beyond a distance of 600m (1900m should there be operations at night) from the pit or crusher plant and LOW at 330m (1050m at night) from the pit or crusher plant. There may be dwellings indicated within these distances from the pit or the crusher plant, depending on the progress of the pit and the policy

Table 4: Distances from the screened active pit or exposed crusher plant for a certain response intensity and noise impact for various increases over the ambient daytime and night-time noise.

Exceedance dB	Noise Impact	Distance - day	Distance – night
0	None	600m	1900m
3	Very low	420m	1320m
3 ≤ 5	Low	330m	1050m
5 ≤ 7	Moderate	260m	830m
7 ≤ 10	High	190m	600m
10 ≤ 15	Very high	110m	330m

The anticipated day time and night time impact zones are provided in Figure 1 and Figure 2 respectively.

The phase 1 crusher plant and the phase 2 washing plant are above ground with a predicted noise level of 79.4 dB(A) at 15m. The investigation shows that the proposed equipment will not have a significant impact on the noise climate of the nearest dwellings. In the worst case, as described above, with no mitigating measures, and using the limit levels in 4.1.3. above, the predicted noise emission of the exposed crusher plant turns out to be virtually identical with the screened combined activity in the pit. The impact will therefore also be identical with the above pit situation and will therefore be NONE during daytime beyond a distance of 600m (1900m at night) and LOW at 330m (1050m at night) from the crusher plant alone or the active pit as shown in Table 4. above.

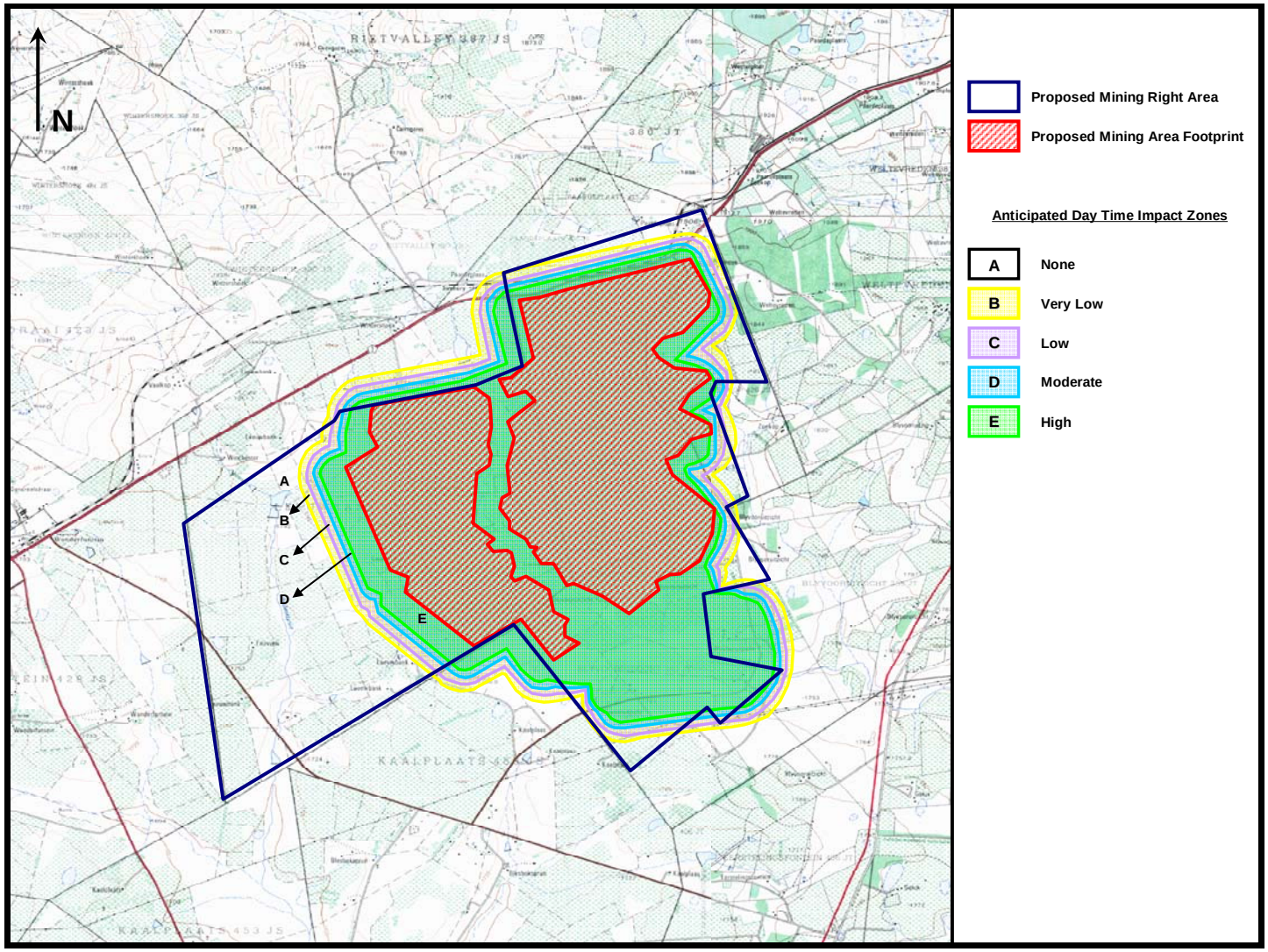

Figure 1: Anticipated Day Time Impact Zones.

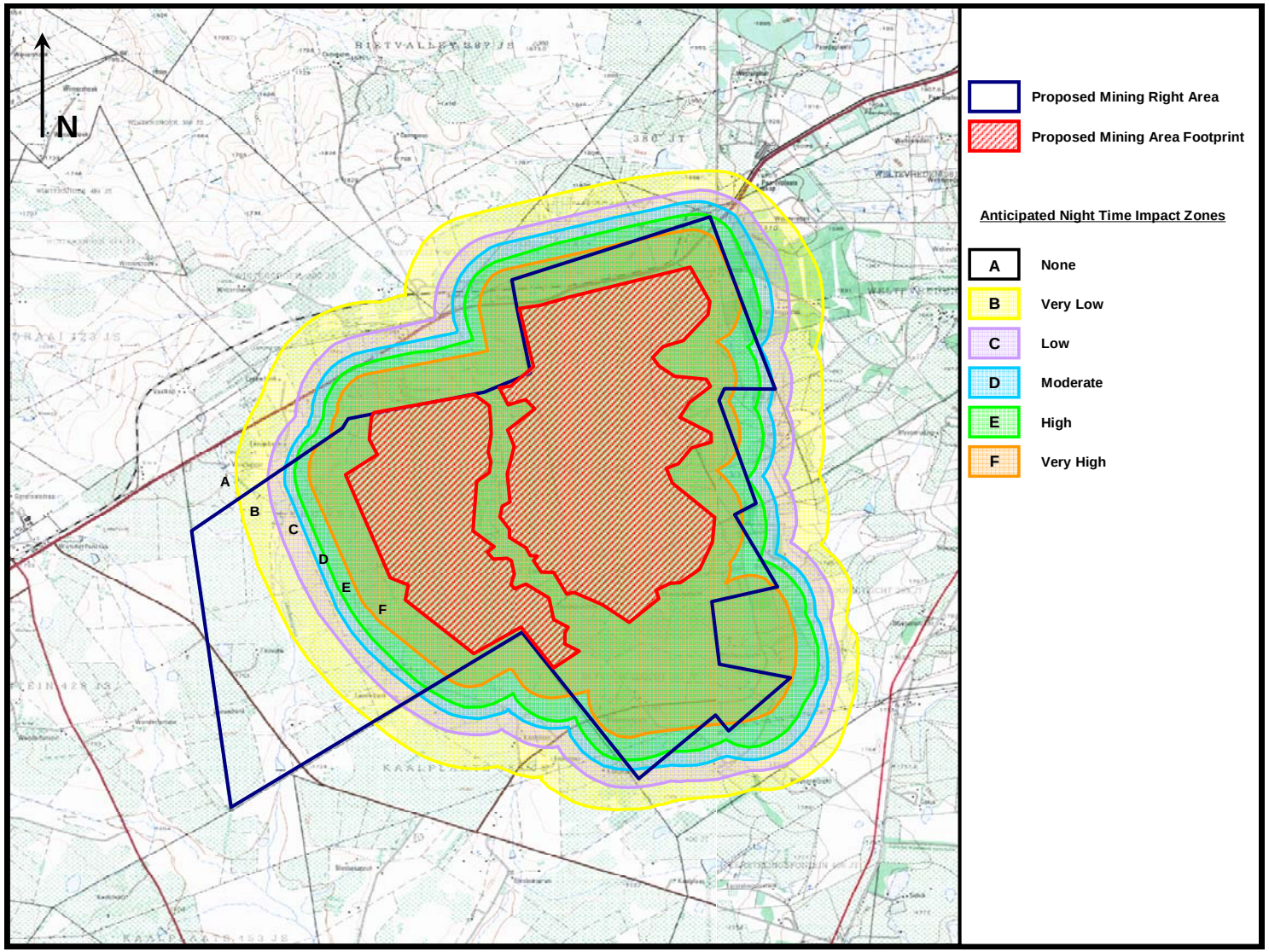

Figure 2: Anticipated Night Time Impact Zones.

These values represent the change of community response as described in Table 3, and Table 4 reflects the distance from the plant/pit at which these responses can be expected to occur. For the opencast situation, the values represent the worst case, where equipment is always assumed to be located at the nearest point to the boundary within the pit. This will only happen while the pit is being excavated in that position, and this worst case noise level will therefore only be applicable close to this position for a short period while this is the case. As the excavations progress, different areas will be affected by this worst case noise level, and other areas will be exposed to lower levels of noise as extraction progresses to a more remote location, and deeper. Where continuously operating machinery is permanently installed at the same location on the surface, such as the crusher plant, the noise levels are fixed for the life of the mine, and therefore dominate the noise climate at these site boundaries. For the noisiest opencast operations, these are thus generating a noise impact varying from 'LOW' to 'NONE' at the prediction location, depending on their proximity to this location and the extent of the local noise shielding provided by the pit sides, positioning of temporary stockpiles, and local ground contours, all of which mitigate the noise impact to a greater or lesser extent.

Table 5: Summary of worse case impacts of noise.

Phase	**Impact: Noise**						
	Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**	
						M	**No M**
Construction	Noise	Local to site	Short term	Very Low, Negative	Probable	Very Low	Low
Operation	Noise	Local to site	Long term	Low, Negative	Probable	None	Very Low
Decommissioning	Noise	Local to site	Short term	Very Low, Negative	Probable	None	Very Low
Residual	None	n/a	n/a	n/a	n/a	n/a	n/a
Latent	None	n/a	n/a	n/a	n/a	n/a	n/a

Note: M = With mitigation measures

No M = Without mitigation measures

Mitigation Measures:

1. Maintenance of equipment and operational procedures: Proper design and maintenance of silencers on diesel-powered equipment, systematic maintenance of all forms of equipment, training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events.
2. Placement of material stockpiles: Where possible earthworks and material stockpiles should be placed so as to protect the boundaries from noise from individual operations and especially from haul roads, which for greatest effect should be placed directly behind them. If a levee is constructed, it should be of such a height as to effectively act as a noise barrier, if line of sight calculations show this to be practicable.
3. Equipment noise audits: Standardised noise measurements should be carried out on individual equipment at the delivery to site to construct a reference data base and regular checks carried out to ensure that equipment is not deteriorating and to detect increases which could lead to increase in the noise impact over time and increased complaints.
4. Environmental noise monitoring: This should be carried out regularly at bi-annual intervals at specific positions to detect deviations from predicted noise levels and enable corrective measures to be taken where warranted.
5. Crusher Plant: It is specifically recommended that the crusher plant, (which operates continuously), wherever it is located, should be in a position where it may be surrounded on all sides by solid earth berms preferably sufficiently high that line of sight is prevented as far as possible from all boundaries of the site and any affected parties outside the site to activities in the crusher plant.

5.5 Predicted Impact of Delivery Truck Noise

At the maximum potential output of the mine and its crusher infrastructure, 3.0Mtpa, the hourly transport requirement for 1.5Mtpa to each of the two rail terminal destinations at Belfast and Pullenshope is assumed to be 10 collections, amounting to 20 vehicle movements per hour, daytime only, per 16 hour day, 365 days per year. The predicted noise levels generated by this truck activity alone meets the daytime criterion of 45 dB(A) at 55m from the proposed road extension eastwards to the R33 and the Belfast rail terminal, or from the

transport route westwards to the Pullenshope rail terminal. It is not expected that dwellings will be within that corridor.

Table 6. Summary of major sources of noise associated with mining operations, and possible remedial measures.

Source	Remedial measures
Mobile equipment noise	Select vehicle routes carefully by internalising the roads Fit efficient silencers and enclose engine compartments Damp mechanical vibrations Maintain equipment conscientiously Erect berm, screen or barrier at permanent sites and haul roads
Fixed plant noise	Carefully select permanent plant site Reduce noise at source by acoustic crusher, etc. Isolate source by acoustic enclosure, etc.

5.6 Predicted Response To Blasting Operations

5.6.1 Effects of Noise on Humans

The nature and magnitude of the response to noise from blasting operations will depend critically on the blasting regime chosen, the nature of the rock to be blasted, the size and depth of the charge, the type of explosive, the local topography, and the detonation sequence. As mentioned in section 2.7 above, there are at present no reliable national or international guidelines to accurately predict human or livestock response to blast noise. The closest habitations around the site are at distances of approximately 2.5km from the nearest point of blasting. Impulsive noise levels are likely to be a maximum of approximately 75 dB(A) at the nearest dwellings in the worst case that blasting is at the surface in the early stages of pit development.

Neither the air blast nor the ground vibration are likely, in the author's experience of mining operations of this type, to have any damaging effect on humans, livestock, or buildings in the vicinity, if they are designed and carried out with due regard to good blasting practice and with the desire to obtain cost-effective results in operational terms. However, both air blast

and ground vibration may give rise to secondary noise in a building, such as the rattling of windows and other loose objects in a state of neutral equilibrium, and this is often interpreted as a far more serious occurrence than it really is. An additional complication is that the blast will in general contain frequencies below those which can be heard by the human ear i.e. below 20Hz. These low frequencies also contain sufficient energy to give rise to secondary noise, just as with ground vibration, making it characteristically difficult to differentiate between what is attributable to airborne blast and what is attributable to ground borne vibration. The maximum A-weighted sound level from most blasts, as reported above is, in fact, not much greater than the maximum A-weighted sound level from other machinery such as loading, tipping, and permanent plant operations.

Humans are extremely sensitive to vibration and can detect levels of ground vibration of less than 0.1 mm/s, which is less than $1/100^{th}$ of the levels which could cause even minor cosmetic damage to a building. Complaints and annoyance regarding ground vibration are therefore much more likely to be determined by human perception than by noticing minor structural damage. However, these effects, and the startling effect of sudden impulses of both sound and vibration are often perceived as intrusion of privacy and could be a source of considerable annoyance to the local community. For this reason, and because of the absence of information on either the likely community response to blast noise or the likely levels of blast overpressure or audible noise, the noise impact for blasting operations should be considered MODERATE. However, minimization of the number of times when blasting occurs, and previous notification of blasting activities at predetermined times on stated days, and careful design of the blasting regime to reduce the levels of both airborne blast noise and groundborne vibration will contribute significantly to the minimisation of the overall impact of blasting on the surrounding community.

Mitigation Measures:

1. Calculating the charge size and blast regime to optimize required excavation and fragmentation and thus keep air blast and ground vibration levels below pre-determined acceptable values.
2. Monitoring blast, ground vibration and human response to ensure that accepted levels are in fact acceptable and are being adhered to, and to modify the blasting design as required.

3. Pre-notification of affected persons of the intention to blast and the time of blast, preferably at the same time of day to remove the element of surprise.
4. Correct stemming of blastholes.

5.6.2 Effect of Operating Noise and Blast Noise on Livestock

Very little information exists on the response of livestock, or indeed wildlife, to noise, blast noise, and ground vibration. (ref. 8). There is no evidence whether or not these will be adversely affected by the noise of operations and how, or how much, they will be affected. The impact on livestock of operating noise is considered VERY LOW, whereas the impact of blast noise, because its occurrence is sudden and unpredictable and its effects also unpredictable is probably MODERATE.

Mitigation Measures:

As for section 5.5.1 above, plus the following:

1. Regular monitoring of the exposed livestock to ascertain if there are any adverse reactions.

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