REPORT
NOISE STUDY FOR THE DORSTFONTEIN COAL MINES EAST OPERATIONS PIT 1 NW EXTENSION

JUNE 2017

Report No 16/5/1

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GLOSSARY OF ACOUSTIC TERMINOLOGY

Absorption	The process by which a fluid (such as air), material or structure absorbs sound by dissipating the impinging or transmitted sound energy as heat.
Absorption coefficient	The ratio of the absorbed sound energy to the impinging sound energy on a material or structure.
A-weighting	An electronic filter that simulates the human hearing characteristic which is less sensitive to sounds at low frequencies than at high frequencies.
Broad band noise	Noise that contains a wide range of frequencies and cannot be associated with a specific frequency or tone. 'White noise' (like the sound of a radio that is not tuned on a station) is a typical example of broad band noise.
C-weighting	An electronic filter that primarily was developed for evaluating human hearing at very high levels of noise (seldom encountered in environmental studies)
Decibel (dB)	A descriptor that is used to indicate a level determined as 10 times the logarithmic ratio of two quantities of the same physical unit.
dBA	A descriptor that is used to indicate that 10 times the logarithmic ratio of two quantities of the same physical unit has been A-weighted.
Equivalent noise level	A single value noise level that has the same energy content as a time varying noise level measured over a given period of time. Therefore, it is in essence a time-and energy averaged noise level.

Frequency	The characteristic of a time varying signal that describes the number of cycles per second, expressed in Hertz, Hz.
Impulse, impulsiveness	A sound signal that changes it's level very abruptly. Usually of very short duration, e.g. hammer blows, riveting etc.
Integrated noise level	A time- and energy averaged measure of a noise signal varying as a function time
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor because it provides an indication of what the L_{Aeq} could have been in the absence of noisy single events.
L_{Aeq}	The A-weighted equivalent sound pressure level. This descriptor is internationally used for quantifying and evaluating noise in human-related circumstances. A vast amount of research links this parameter to human physiological and psychological responses.
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged, i.e. L_{Aeq} (10 min) indicates that the L_{Aeq} was measured over a period of 10 min.
Level	The property of any parameter that expresses it's magnitude as 10x the logarithm of the ratio of the value of the parameter to a reference value of the same physical unit. The reference value is 20 µPa (micro- or 20×10^{-6} Pascal, or N/m^2) for a sound pressure level and 1 pW (pico or 1×10^{-12} Watt) for a sound power level.
Noise	Unwanted sound

Noise emission — The noise energy that is emitted by a noise source into the environment.

Noise immission — The noise energy that impinges on a receiver.

Octave frequency band — The frequency spectrum is divided into bands with centre frequencies an octave apart from each other, an octave being a doubling in frequency. In practice the standard octave bands most often used are 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. Used for specifying sound power emission levels of equipment and calculating sound propagation over longer distances.

Sound level meter — An instrument used to measure sound/noise

Sound power level — The level of the sound energy radiated by a given source per unit time. The magnitude does not depend on physical surroundings, e.g. distance, screening, weather. Cannot be directly measured, but has to be calculated from sound pressure level measurements.

Sound pressure level — The level of the varying sound pressure caused by a sound/noise source. The magnitude depends on the physical parameters of the surroundings.

Third octave frequency band — The frequency spectrum is divided into bands with centre frequencies a third of an octave apart from each other, an octave being a doubling in frequency. Examples of third octave bands are 50 Hz, 63 Hz, 80Hz, 100 Hz, 125 Hz, 160 Hz, 200 Hz, 250 Hz, 315 Hz, 400 Hz, 500 Hz, 630 Hz etc. Often used for analysing an acoustic signal or noises, since it provides a higher resolution than an octave band spectrum.

EXECUTIVE SUMMARY

Introduction

Dorstfontein East is an opencast mine located almost 18km from Ga-Nala, formerly known as Kriel. The mine is located within Emalahleni Municipality and started its operations in 2011. Dorstfontein Coal Mines (Pty) Ltd is now planning to extend its operations on the western side of the mine referred to as Pit 1 NW Extension.

Two mining options are being considered.

In Option 1 the opencast method of mining will continue as normal from the existing Pit 1 until its reserves are depleted. The Pit 1 NW Extension will follow with a slight change in the mining direction until the complete Reserve is depleted.

Option 2 is to mine the Pit 1 NW Extension by means of opencast methods on the eastern side of an igneous intrusion-sill break through. The western side of the Pit 1 extension will be mined by means of conventional mechanized underground mining techniques using continuous miners.

This report describes the methodology, results and findings of the noise study.

Purpose of the noise study

The purpose of this noise study is to:

- Conduct field measurements at representative locations and periods of the day and night in order to obtain estimates of the general ambient noise levels in the environment of the mine;
- Identify the major contributing sources to the present ambient noise levels and the nearest noise sensitive receivers;
- Model the future noise emissions from Option 1 and 2 during different periods of the operations;
- Calculate the impact that these emissions will have on existing ambient noise levels;
- Assess the noise impacts in terms of national standards and the methodology specified by SRK; and
- If found to be necessary give recommendations for mitigating the noise impacts.

Regulatory framework

In terms of the setting of standards the regulations published on 2 July 2010 under the Air Quality Act, 2005 [4]make direct and extensive reference to SANS 10103 [5]. This document successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa. It also provides guidelines to typical ambient noise levels that may be expected in different types of districts. SANS 10103 [5] is completely in line with the recommendations of the World Health Organisation [6] and international best practice. Therefore, the methodology described in SANS10103 [5] was followed for the purpose of this noise impact study.

Measurement of existing ambient noise levels

A site visit was conducted on 6 June 2016 in order to identify representative measurement points and identify the nearest noise sensitive receivers.

Four measurement points were chosen. Their locations are shown in the Figure below.

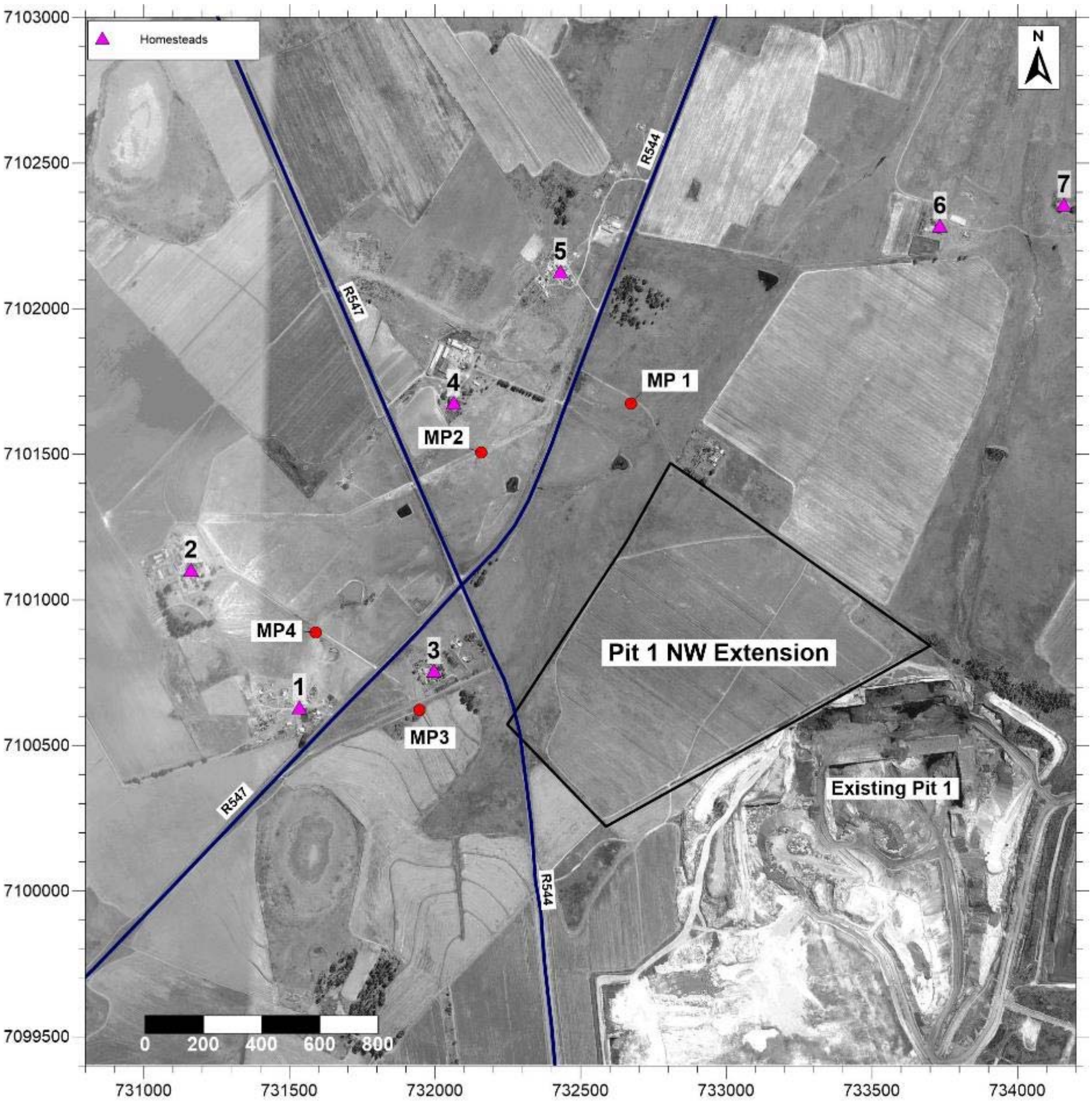

Image illustrating the locations of the measurement points.

The noise measurements were taken in accordance with the procedures specified in SANS 10103 [5]. A list of the measurement instrumentation is given in Appendix A to this report. They were taken at representative times during the day- and night-time as defined in SANS 10103 [5], i.e. 06:00 to 22:00 and 22:00 to 06:00, respectively.

The measurement results were processed in order to determine base noise levels which could serve as day- and night-time reference ambient noise levels onto which future noise emissions from the DCME Pit 1 NW Extension could then be projected.

Modelling of noise emissions and immissions

During the measurements it became clear that road traffic on the R547 and R544 provided the dominating noise contributions to ambient noise levels in the local environment. A detailed three dimensional model was developed for calculating representative noise contributions during day- and night-time.

For this purpose the calculation procedures specified in SANS 10210 [7] were followed.

The future noise emissions and immissions caused by the operations were calculated in accordance with the CONCAWE methodology as described in SANS 10357 [8].

The modelled Option 1 and 2 scenarios are summarised in the following table.

Scenario	Description	Main noise sources
Option 1.1 2018	• Open cast mining only • Roll over mining operation • Continuous stripping, mining and rehabilitation • Hauling of coal and overburden • 180 kt/m • 24 hr operation	• 777 rear dump haul truck • Bulldozer D10 • FEL 988 • Excavator Liebherr 944 • Tamrock drilling rig • General noise
Option 1.2 2023	• As in 2018	• As in 2018
Option 1.3 2027	• As in 2018	• As in 2018
Option 2 2023	• As for Option 1	• As for Option 1

The modelling results were presented as contours of the resulting future ambient noise levels and the increases in existing ambient noise levels, superimposed on a scaled satellite image of the project and its environment.

The results were assessed in terms of the guidelines provided by SANS 10103 [5] and the SRK methodology, reproduced in Appendix C.

The following general remarks can be made regarding the modelled results and their assessment:

- The maximum extent of the noise impacts occurs during night-time when meteorological and other atmospheric conditions favour the propagation of sound over long distances. This characteristic is enhanced during winter when average temperatures are low;
- It is clear that the noise impacts will be limited, since the resulting total ambient noise levels largely conform to those recommended by SANS 10103 [5]. At the locations where there is an excess this is due to road traffic noise determining existing ambient noise levels;
- Furthermore, it must be noted that the predicted road traffic noise levels do not include the contributions caused by rumble strips, which were not included in the modelling. As a result the noise impacts caused by the future DCME mining operations tend to be over rather than under estimated;
- This is not really reflected in the assessments according to the SRK methodology which indicate a ***Significance*** rating of ***Medium Low***. Although the severity of the noise impact is insignificant the higher ***Significance*** rating is the result of the ***Likelihood*** being the product of high ***Frequencies of Activity*** and ***of Impacts***; and
- It is the considered opinion of the consultant that the assessment result should rather be ***Low***.

Conclusions

The following conclusions can be drawn from this noise study:

- The ambient noise levels in immediate environment of the DCME Pit 1 NW Extension are dominated by road traffic on the R547 and R544 which includes a large percentage of heavy vehicles;
- These noise contributions will to a large extent mask the impact of the noise immissions caused by the future mining operations;
- The resulting total ambient noise levels largely conform to those recommended by SANS 10103 [5];
- There will either be no increase in ambient noise levels or it will range between 'Negligible' and 'Insignificant'. According to SANS 10103 [5] the expected community response to these increase will range between 'No reaction' and 'Little with sporadic complaints'; and
- Although the assessments according to the SRK methodology result in a ***Significance*** rating of ***Medium Low*** the consultant is of the considered opinion that it should rather be ***Low***.

Recommendations

The following recommendations can be made:

- The roll over mining method must include the construction of a noise barrier on the NW side of each current pit area using the removed topsoil and stripped overburden; and
- During the measurements the backing alarms of earth moving equipment was often noticed. The high pitched sound these alarms produce are often cited as a particularly disturbing aspect of mining operations. It is strongly recommended that the high pitched alarms be replaced with devices that produce high levels of broadband noise. Although these alarms are very audible in close proximity to the equipment their noise energy is rapidly attenuated over longer distances, thereby causing much less disturbance.

REPORT
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DORSTFONTEIN COAL MINES EAST OPERATIONS PIT 1 NW EXTENSION

1. INTRODUCTION

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This report describes the methodology, results and findings of the noise study.

2. PURPOSE OF THE NOISE STUDY

The purpose of this noise study is to:

- Conduct field measurements at representative locations and periods of the day and night in order to obtain estimates of the general ambient noise levels in the environment of the mine;
- Identify the major contributing sources to the present ambient noise levels and the nearest noise sensitive receivers;
- Model the future noise emissions from Option 1 and 2 during different periods of the operations;
- Calculate the impact that these emissions will have on existing ambient noise levels;
- Assess the noise impacts in terms of national standards and the methodology specified by SRK; and
- If found to be necessary give recommendations for mitigating the noise impacts.

3. REGULATORY FRAMEWORK

The original noise regulations were published in 1990 under the Environment Conservation Act, 1989 [1]. They were at first made non-compulsory with a local authority having to apply to make them compulsory in its area of jurisdiction. Since this lead to an unsatisfactory number of applications, the noise regulations were made compulsory in 1992. However, the arrival of the new Constitution in 1994 voided the legal driving force behind the regulations, since the responsibility for them was devolved from national to provincial level. The Minister of the Environment did circulate sample noise regulations to the provinces in 1997 [2], which they could adopt unchanged or adapt to their own requirements. This has happened in only three provinces, i.e. the Free State, Gauteng and Western Cape.

The original sample noise regulations contain a number of serious flaws and a revision was undertaken by the Department of Environmental Affairs. The resulting new regulations [3] were published on 2 July 2010 under the Air Quality Act, 2005 [4]. They are in essence also a model that can be adapted by municipalities.

In terms of the setting of standards the new regulations make direct and extensive reference to SANS 10103 [5]. This document successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa. It also provides guidelines to typical ambient noise levels that may be expected in different types of districts. SANS 10103 [5] is completely in line with the recommendations of the World Health Organisation [6] and international best practice. Therefore, the methodology described in SANS10103 [5] was followed for the purpose of this noise impact study.

4. METHODOLOGY OF THE NOISE STUDY

4.1 Site visit

A site visit was conducted on 6 June 2016 in order to identify representative measurement points and identify the nearest noise sensitive receivers.

4.2 Measurement points

Four measurement points were chosen. Their locations are described in Table 4.2.1 and illustrated in Figure 4.2.1.

TABLE 4.2.1
Locations of the measurement points

Measurement Points	UTM 35 J WGS 84	
	mE	mS
MP 1	732672	7101674
MP2	732159	7101506
MP3	731947	7100623
MP4	731590	7100888

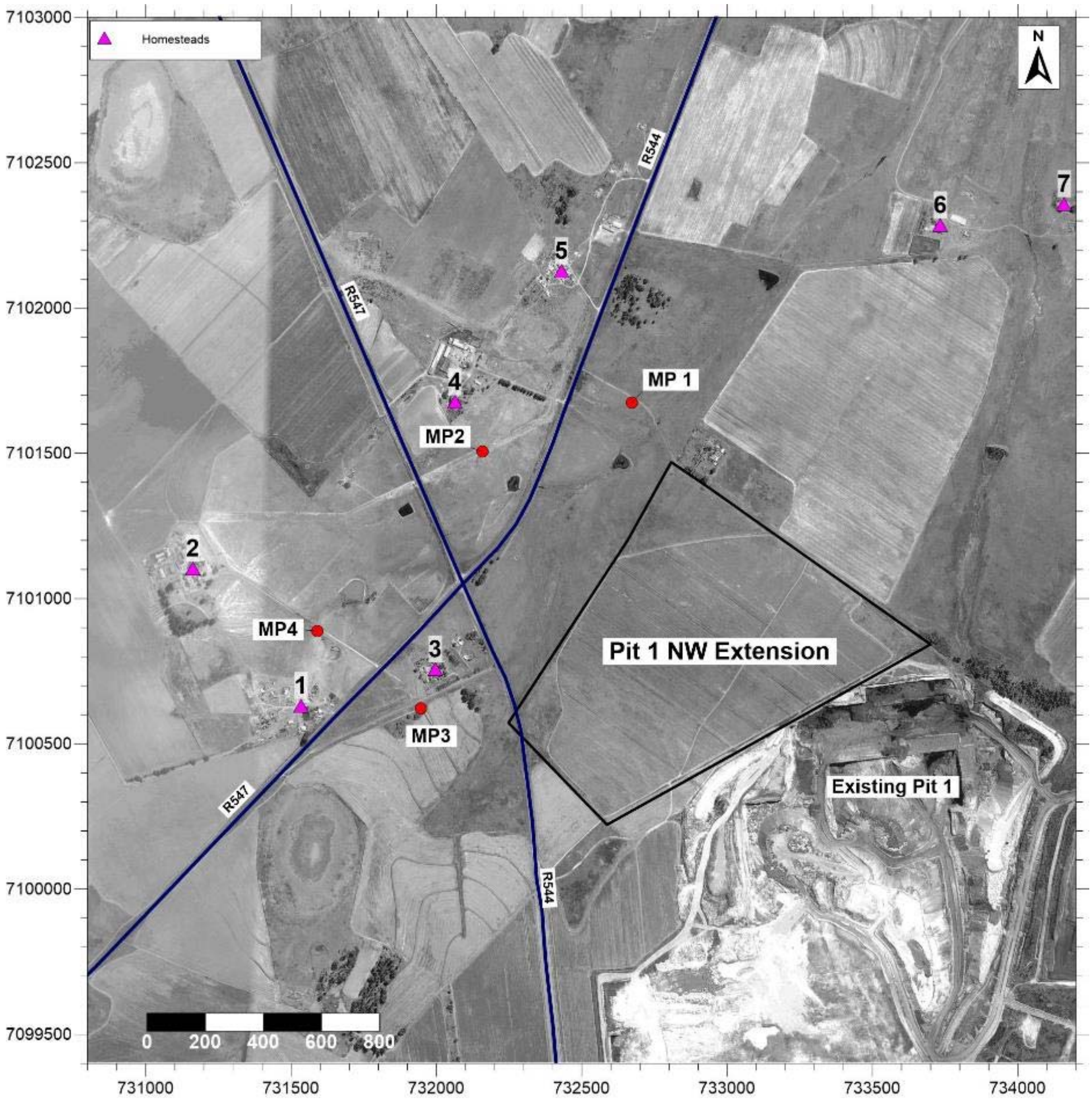

Figure 4.2.1: Image illustrating the locations of the measurement points.

4.3 Measurement methodology

The noise measurements were taken in accordance with the procedures specified in SANS 10103 [5]. A list of the measurement instrumentation is given in Appendix A to this report.

In addition to the measurement parameter specified in SANS 10103 [5], i.e. L_{Aeq} (T). In addition the concurrent 90 percentile A-weighted sound pressure level, L_{A90}, and the time-averaged frequency spectra were also measured. Although the L_{A90} and frequency spectra are not required in terms of SANS 10103 [5] they are very useful for characterising the measured noise levels.

Furthermore, the subjective observations during each measurement were noted. This greatly facilitated the identification of the general noise character and occurrence of single noisy events during post processing.

Measurements were taken at representative times during the day- and night-time as defined in SANS 10103 [5], i.e. 06:00 to 22:00 and 22:00 to 06:00, respectively.

4.4 Processing of the measurement results

The measurement results were processed in order to determine base noise levels which could serve as day- and night-time reference ambient noise levels onto which future noise emissions from the DCME Pit 1 NW Extension could then be projected.

4.5 Modelling of noise emissions: Road traffic noise

During the measurements it became clear that road traffic on the R547 and R544 provided the dominating noise contributions to ambient noise levels in the local environment. A detailed three dimensional model was developed for calculating representative noise contributions during day- and night-time.

For this purpose the calculation procedures specified in SANS 10210 [7] were followed. This procedure takes account of the following main parameters:

- Estimated traffic flow, Q, in terms of vehicles/hour and percentage heavy vehicles;
- Average speed of the traffic on the roads;
- Three dimensional geometry of the roads;
- Attenuation of noise due to geometric spreading of noise energy as a function of distance;
- Topography of the environment and the typical ground conditions, acoustically hard or soft; and
- The screening against noise propagation by the topography and other structures.

The traffic flow, Q, was estimated from the noise profiles of the measurement results and are given in Appendix B to this report, together with the other parameters.

4.6 Modelling of future noise emissions: DCME Pit 1 NW Extension

The future noise emissions and immissions caused by the operations were calculated in accordance with the CONCAWE methodology as described in SANS 10357 [8]. The detailed three dimensional model took account of the following key parameters:

- Octave frequency band sound power levels of typical mining equipment;
- Operational procedures, as described in the documentation [9] provided by the client;
- Geometric spreading of noise energy as a function of distance;
- Prevalent meteorological and other atmospheric conditions;
- Ground conditions between source and receiver; and
- Acoustic screening provided by topography and manmade structures, such as pit walls and barriers.

A summary of the parameters used in the calculations is provided in Appendix B to this report.

4.7 Modelled Option 1 and 2 scenarios

The modelled Option 1 and 2 scenarios are summarised in Table 4.7.1.

TABLE 4.7.1
Summary of the calculated and assessed scenarios

Scenario	Description	Main noise sources
Option 1.1 2018	• Open cast mining only • Roll over mining operation • Continuous stripping, mining and rehabilitation • Hauling of coal and overburden • 180 kt/m • 24 hr operation	• 777 rear dump haul truck • Bulldozer D10 • FEL 988 • Excavator Liebherr 944 • Tamrock drilling rig • General noise
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Option 1.3 2027	• As in 2018	• As in 2018
Option 2 2023	• As for Option 1	• As for Option 1

4.8 Presentation and assessment of the results

The modelling results were presented as contours of the resulting future ambient noise levels and the increases in existing ambient noise levels, superimposed on a scaled satellite image of the project and its environment.

The contours calculated for resulting future ambient noise levels were:

- 35 dBA;
- 40 dBA;
- 45 dBA;
- 50 dBA;
- 55 dBA; and
- 60 dBA.

Table 5 of SANS 10103 [5] provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- Δ ≤ 0 dB: An increase of 0 dB or less will not cause any response from a community. Any increase of less than 1 dB is negligible. For a person with average hearing acuity an increase of less than 3 dB in the general ambient noise level will not be noticeable. Therefore, 3 dB is a useful ‘significance indicator’ that will be used in this study to assess whether a noise impact is significant or not;
- 0 dB < Δ ≤ 10 dB: An increase of between 0 dB and 10 dB will elicit ‘little’ community response with ‘sporadic complaints’. However, between 5 dB and 15 dB the strength of the response will gradually change to ‘medium’ with ‘widespread complaints’;
- 5 dB < Δ ≤ 15 dB: An increase of between 5 dB and 15 dB will elicit a ‘medium’ community response with ‘widespread complaints’. It is also worth noting that an increase of 10 dB is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dB the community reaction will be ‘strong’ with ‘threats of community action’;
- 15 dB < Δ: For an increase in excess of 15 dB the community response will gradually increase in strength to ‘very strong’ with ‘vigorous community action’; and

- 10 dB < Δ ≤ 20 dB: For an increase of between 10 dB and 20 dB the community response will gradually increase in strength to ‘strong’ with ‘threats of community action’;

The overlapping ranges of community responses reflect the fact that there is no clear-cut transition from one community response to another. Instead the transition is more gradual and may differ substantially from one scenario to another, depending on a large number of variables.

The increase in the ambient noise level was expressed as contours of:

- Δ = 0 dB
- Δ = 1 dB
- Δ = 3 dB (significance indicator)
- Δ = 5 dB
- Δ = 10 dB
- Δ = 15 dB

The results were also assessed in terms of the SRK methodology which is reproduced in Appendix C.

5. NOISE MEASUREMENT RESULTS

5.1 Measurement results

The measurement results are summarised in Tables 5.1.1 (day-time) and 5.1.2 (night-time). The detailed results are given in Appendix D to this report.

TABLE 5.1.1
Summary of the measurement results 06/06//2016: DAY-TIME

Measurement Point	Start time hh:mm:ss	L_{Aeq} (20 min) dBA	L_{A90} dBA	L_{Aeq} - L_{A90} dB	Comments
MP1	16:00:05	52.5	43.7	8.8	• Constant noise from traffic. Noise caused by rumble strips. Humming of mining operations in the background. Bird calls. Constant light wind in grass land foliage. Occasional hammering sounds from nearby work site.
MP2	16:41:03	54.9	45.2	9.7	• Constant noise from traffic flow dominates. Noise caused by rumble strips very noticeable. Bird calls and farm animal sounds. Constant light wind in grass lands.
MP3	17:11:10	54.0	47.1	6.9	• Constant noise from traffic including numerous heavy vehicles. Noise caused by rumble strips clearly audible. Bird calls and insect noise. Crackling of veldt fire in the distance. No wind.
MP4	17:38:05	51.7	42.9	8.9	• Constant noise from traffic. Noise caused by rumble strips. Voices and calls from people in nearby settlement. Bird calls and insect noise. Light wind in grass land foliage. Three warning gun shots at nearby farm house. Later measurement paused when security patrol arrives.

TABLE 5.1.2
Summary of the measurement results 06/06//2016: NIGHT-TIME

Measurement Point	Start time hh:mm:ss	L_{Aeq} (20 min) dBA	L_{A90} dBA	L_{Aeq} - L_{A90} dB	Comments
MP1	21:51:13	52.8	34.1	18.7	• Constant noise from traffic, including numerous heavy vehicles dominates. Noise caused by rumble strips. Constant light wind in grass land foliage. Insect noise.
MP2	22:20:03	49.6	35.6	14.0	• Constant noise from traffic flow dominates. Noise caused by rumble strips very noticeable. Constant humming noise from mining operations. Occasional barking dogs. Constant light wind in grass lands.
MP3	22:47:22	46.7	35.6	11.1	• Reduced but constant noise from traffic. Noise caused by rumble strips clearly audible. Constant humming noise of mining operations clearly audible. Beeping reversing alarms and noise of heavy mining equipment dumping material. Periodically siren sounds from the mine. Especially later on dogs continuously barking. No wind.
MP4	23:12:35	41.4	31.1	10.3	• Constant noise from traffic picking up again. Noise caused by rumble strips. Constant humming noise of mining operations audible. Beeping reversing alarms. Light wind in grass land foliage. Dogs barking in the nearby settlement and on farms.

The following remarks are of relevance to the results listed in Tables 5.1.1 and 5.1.2:

- It is clear that the high noise levels measured at all the measurement points is dominated by road traffic. This includes the impulsive noise caused by the rumble strips at the crossing of the R547 and R544. The traffic flow includes a large number of heavy vehicles. The traffic flow reduces slightly later at night although the noise it causes still dominates;
- During day-time mining operations have less of an influence on measurement results than road traffic, although it is noticeable at times. During night-time, when traffic flow is somewhat lower and meteorological and other atmospheric conditions favour the propagation of sound over long distances, mining activities become much more audible; and
- The differences between the concurrently measured L_{Aeq} and L_{A90} during night-time are significantly higher than during day-time. The deduction can be made that although ambient background noise levels were lower during night-time the single noise events caused by passing road traffic, the effect of the rumble strips and the more audible noise contributions from the mining operation very much determined the measurement results.

5.2 Processed measurement results

As described in section 4.4 the measurement results listed in Tables 5.1.1 and 5.1.2 were processed in order to establish representative estimates of the general day- and night-time ambient noise levels onto which the future noise emissions from the DCME Pit NW Extension operations could be projected.

The processing involved the removal of the noise energy caused by single events that can not be described as characteristic of the environment. A good example are three warning shots fired by a farmer near MP4 during day-time!

The significant noise contributions caused by vehicles crossing the rumble strips were as far as possible also removed from the measurement results. This may seem counter intuitive in respect to the noise characteristics at the measurement points. However, it must be remembered that the aim of the measurements was to estimate ambient noise levels in the general environment of the mining operations, i.e. also for locations distant from the measurement positions.

A typical frequency spectrum measured at MP4 during the present noise study is given in Figure 5.2.1. The sharp increase of noise levels in the third octave frequency bands between 315 Hz and approximately 2500 Hz is to a large degree caused by the rumble strips.

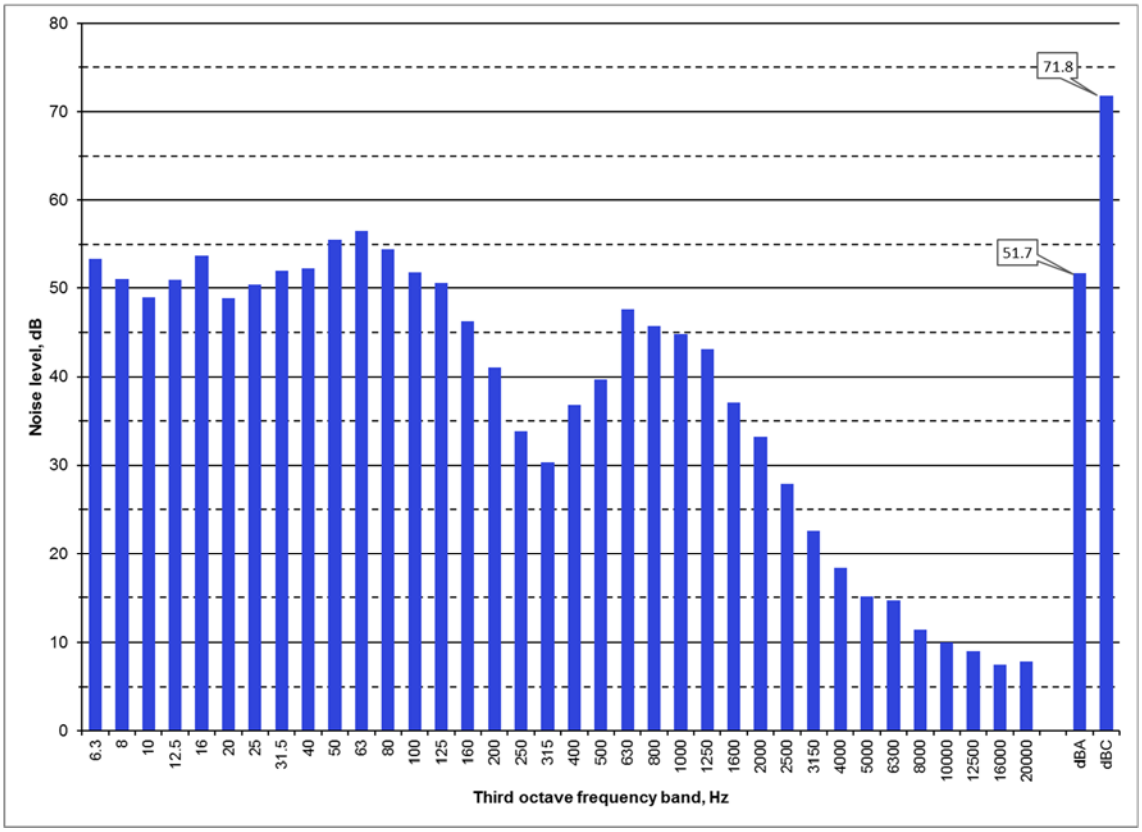

Figure 5.2.1: The averaged frequency spectrum measured at MP4 during day-time.

The effect of removing the noise energy caused by the rumble strips is illustrated in Figure 5.2.2.

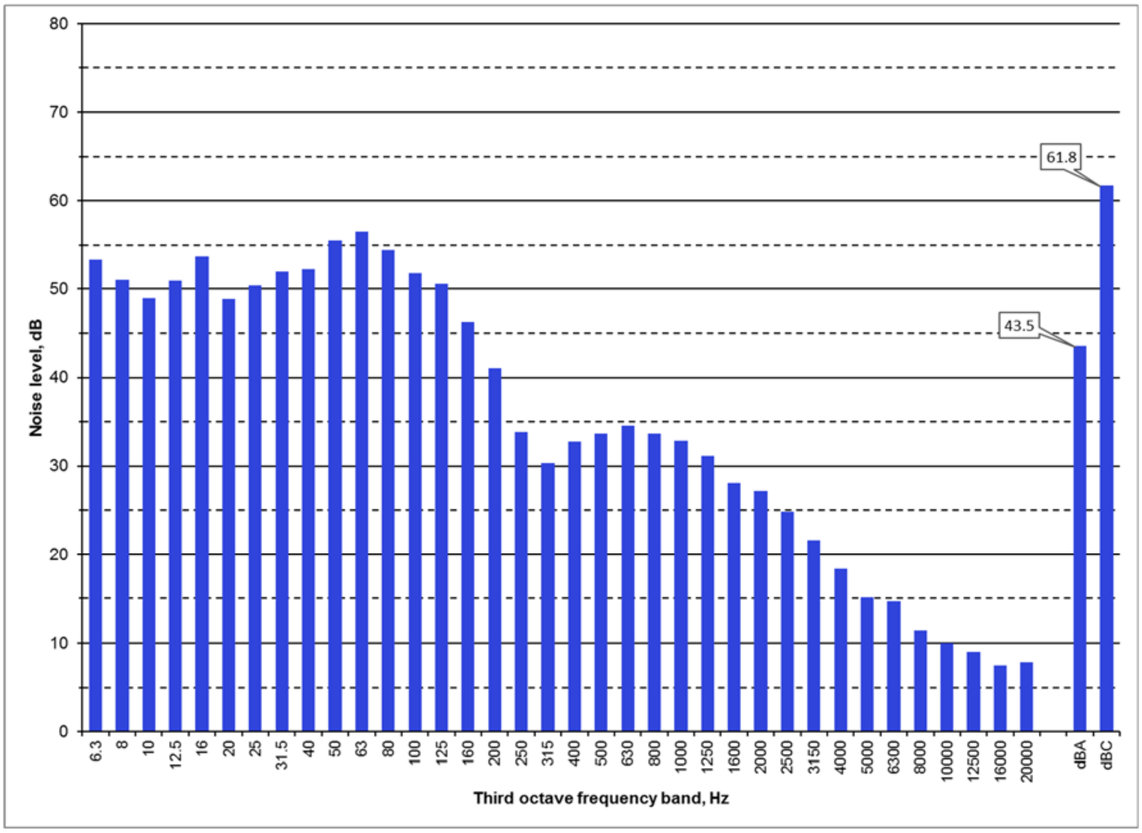

Figure 5.2.2: The effect of reducing the rumble strip noise in the frequency spectrum shown in Figure 5.2.1.

Comparing the processing results shown in Figure 5.2.2 to the measured results in Figure 5.2.1 indicates that the L_{Aeq} has been reduced from 51.7 dBA to 43.5 dBA, i.e. a significant 8.2 dB.

The processed measurement results are summarised in Table 5.2.1.

TABLE 5.2.1
Comparison of measured and processed L_{Aeq}

Measurement Point	Day-time			Night-time		
	Measured dBA	Processed dBA	Difference dB	Measured dBA	Processed dBA	Difference dB
MP1	52.5	44.7	7.8	52.8	43.6	9.2
MP2	54.9	45.1	9.8	49.6	43.5	6.1
MP3	54.0	47.1	6.9	46.7	41.5	5.2
MP4	51.7	43.5	8.2	41.4	37.4	4.0

It is clear that the processing of the measurement results effected a significant reduction in noise levels. The processed were used to test the reliability of the road traffic noise model (see section 4.5).

5.3 Estimation of the background noise levels

The parameter L_{A90} is often used as an indication of the background noise level, i.e. the noise level that excludes the intruding noise contributions from single events, e.g. passing vehicles on a road. Therefore, it was decided to use the averages of the L_{A90} determined at MP1 to MP4 as the reference noise levels onto which the noise emissions from road traffic and future DCME Pit 1 Extension are to be projected. The average L_{A90} for day- and night-time are 44.7 dBA and 34.1 dBA, respectively.

6. MODELLING RESULTS

6.1 Reliability of the prediction model

The calculated and the processed measurement results are compared in Table 6.1.1.

TABLE 6.1.1
Comparison of measurement and calculation results

Measurement Point	L_{Aeq}, dBA, Day-time		Difference dB	L_{Aeq}, dBA, Night-time		Difference dB
	Processed	Calculated		Processed	Calculated	
MP1	44.7	46.8	2.1	43.6	41.0	-2.6
MP2	45.1	46.8	1.7	43.5	43.1	-0.4
MP3	47.1	45.9	-1.2	41.5	43.1	1.6
MP4	43.5	44.9	1.4	37.4	41.2	3.8
	Average difference		1.0	Average difference		0.6

The results in Table 6.1.1 indicate that:

- On average the model over predicts to a negligible degree. This will tend to over rather than under predict the noise impacts;
- At the individual measurement points the differences between measured and calculated results are within 3 dB of the target levels, i.e. they are insignificant;
- The exception is at MP4 during the night where the difference is in excess of 3 dB, i.e. significant. However, this again means that the noise impacts will be over rather than under predicted.

It is the considered opinion of the consultant that the results calculated with the prediction model may be considered reliable.

6.2 Present ambient noise levels

The noise contours calculated for the present, i.e. pre-development ambient noise levels are presented in Figures 6.2.1 and 6.2.2 and Table 6.2.1.

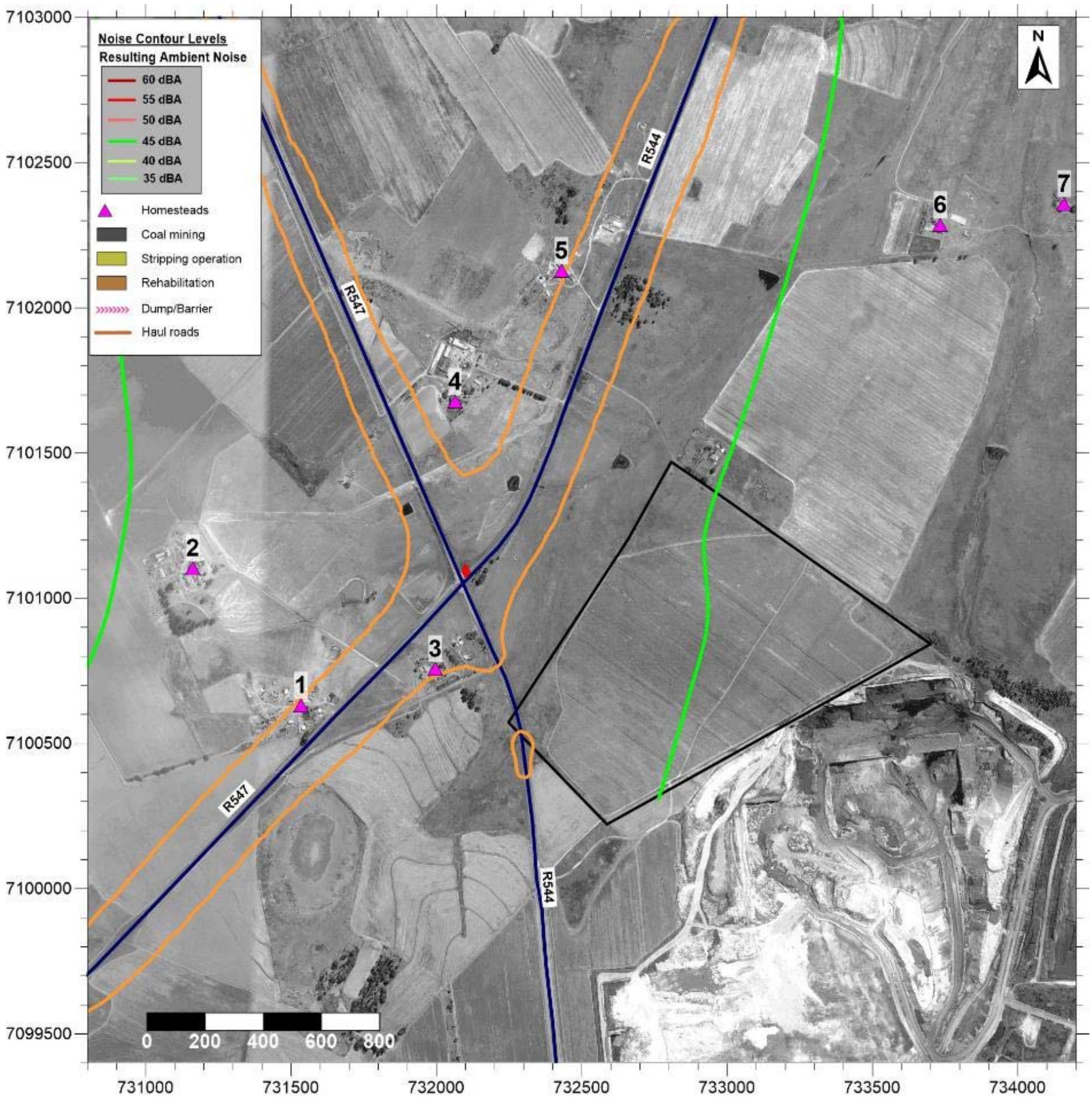

Figure 6.2.1: Noise contours of the calculated ambient noise levels during day-time.

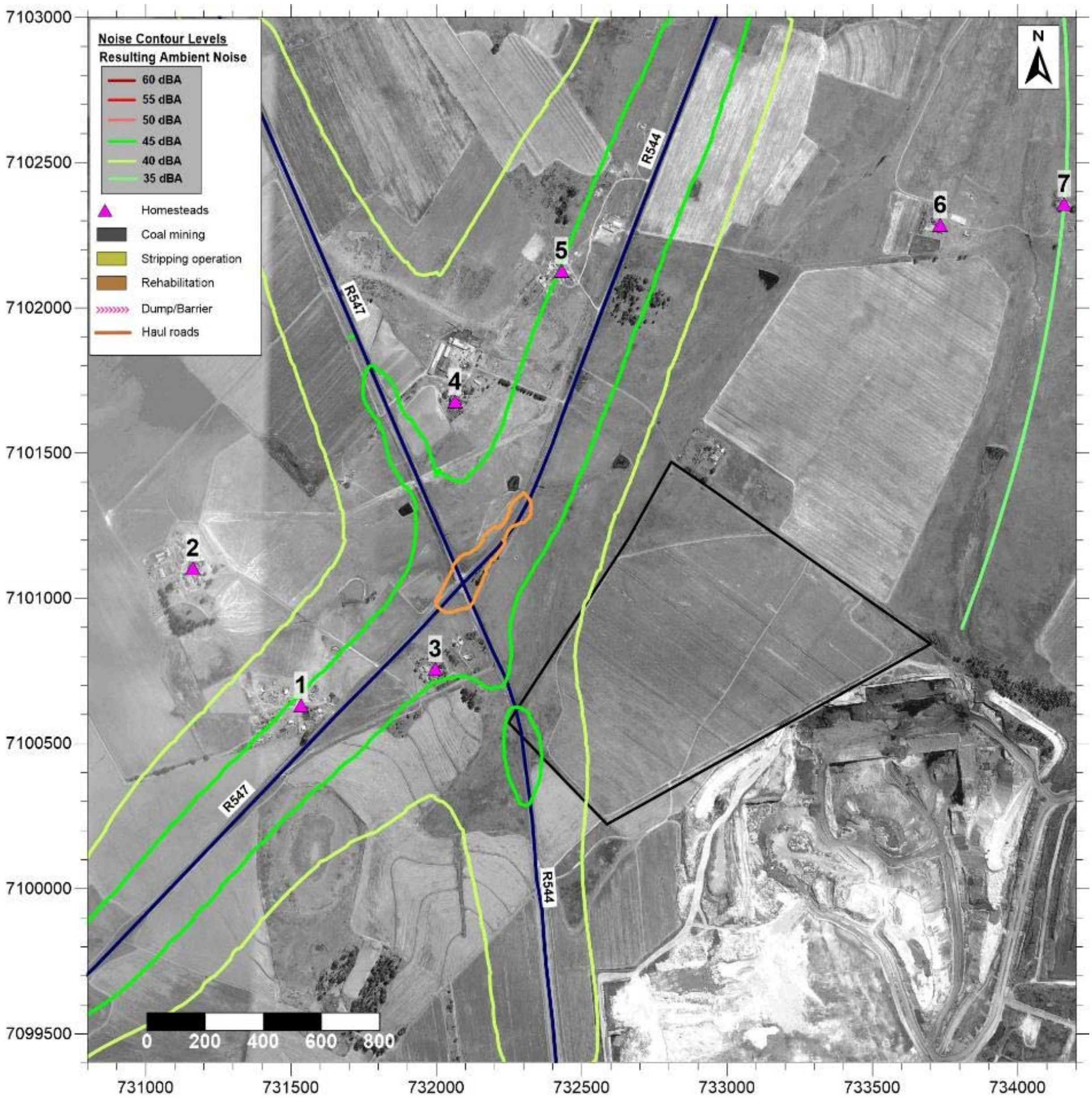

Figure 6.2.2: Noise contours of the calculated ambient noise levels during night-time.

TABLE 6.2.1
Background ambient noise levels at homesteads

Homestead	Day	Night
1	50.7	46.3
2	45.4	38.0
3	50.4	46.0
4	48.1	42.3
5	45.1	37.6
6	49.7	45.4
7	44.4	35.7
8	44.2	35.0

6.3 Noise impact: Option 1.1

The noise impact contours for Option 1.1 (see Table 4.7.1 in section 4) are given in Figures 6.3.1 and 6.3.2. Please note that only the noise contours for night time are reproduced here since the maximum noise impacts occur during that time period. This is due to meteorological and other atmospheric conditions favouring the propagation of sound.

The day-time contours are given in Appendix E to this report.

A summary of the noise impacts for the homesteads is given in Table 6.3.1 and assessed in Tables 6.3.2 and 6.3.3.

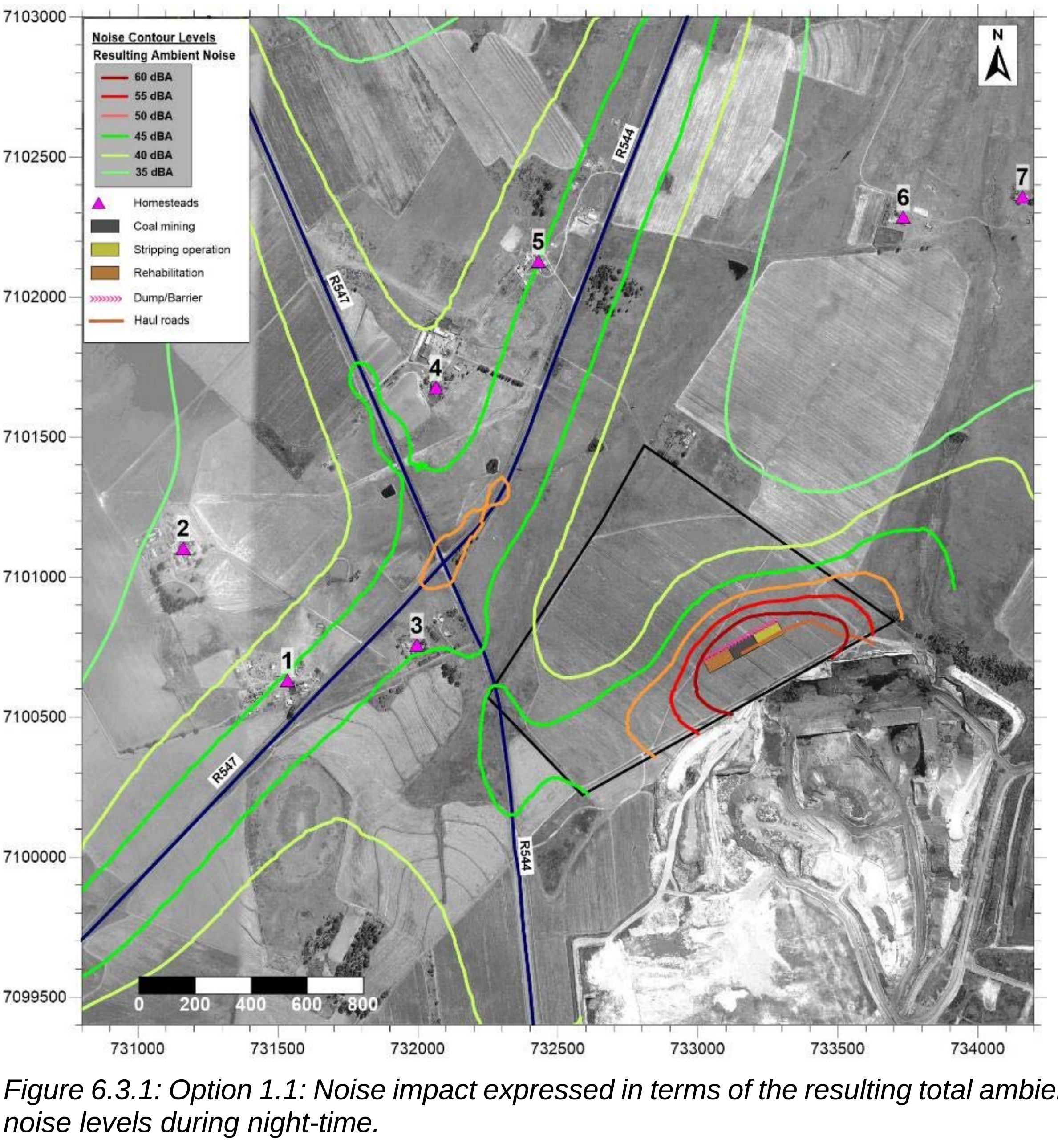

Figure 6.3.1: Option 1.1: Noise impact expressed in terms of the resulting total ambient noise levels during night-time.

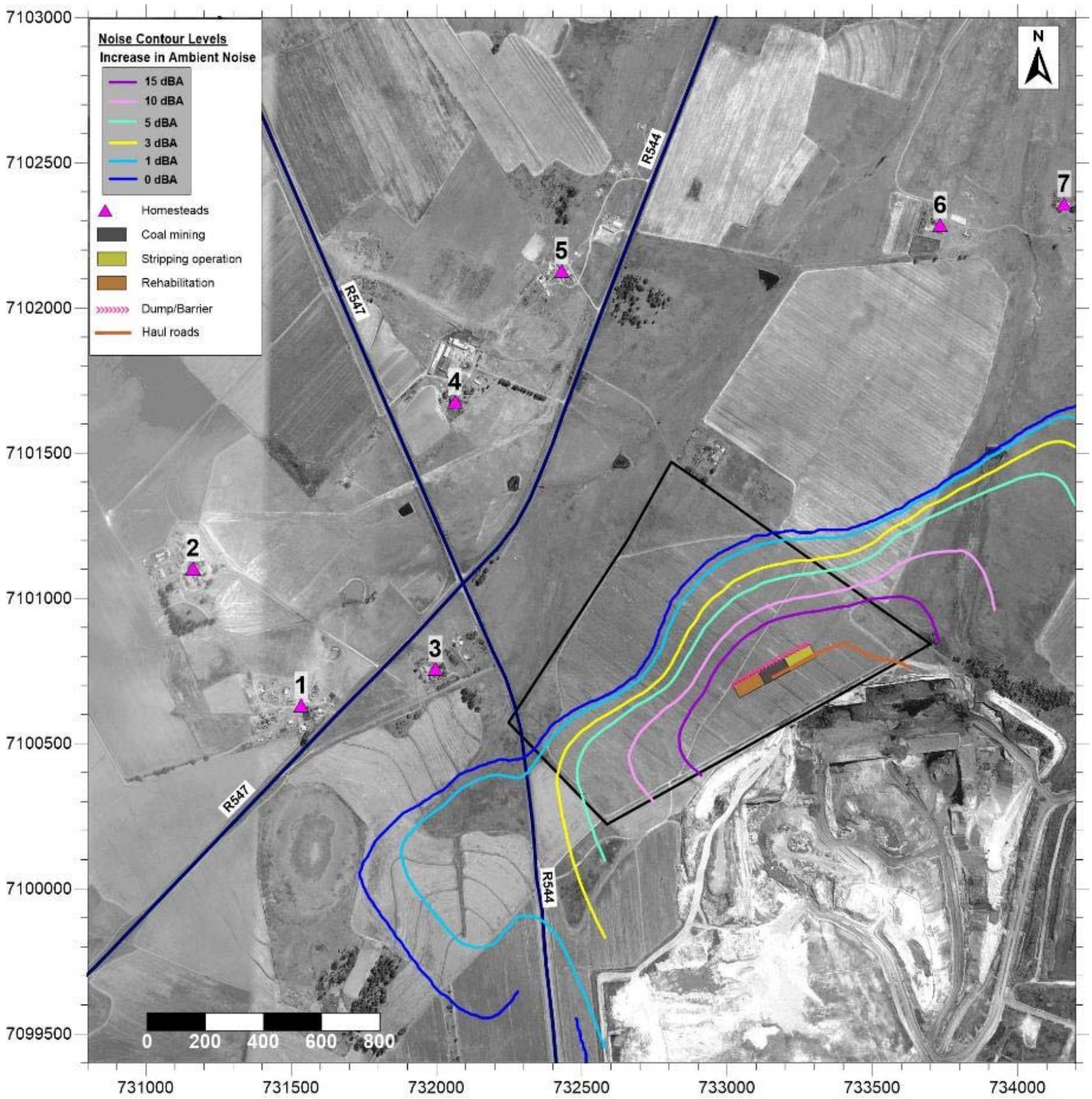

Figure 6.3.2: Option 1.1: Noise impact expressed in terms of the increase in ambient noise levels during night-time.

TABLE 6.3.1
Summarised results: Option 1.1

Homestead	Pit 1 NW Extension noise contribution dBA		Background ambient noise levels dBA		Resulting total ambient noise levels dBA		Increase, Δ, in ambient noise levels dB	
	Day	Night	Day	Night	Day	Night	Day	Night
1	12.9	17.6	50.7	46.3	50.7	46.3	0.0	0.0
2	9.4	14.5	45.4	38.0	45.4	38.0	0.0	0.0
3	17.3	21.7	50.4	46.0	50.4	46.0	0.0	0.0
4	15.4	20.1	48.1	42.3	48.1	42.4	0.0	0.0
5	14.5	19.3	49.7	45.4	49.7	45.4	0.0	0.0
6	11.9	19.8	44.4	35.7	44.4	35.8	0.0	0.1
7	9.6	18.2	44.2	35.0	44.2	35.1	0.0	0.1

The results given in Figures 6.3.1 and 6.3.2 and Table 6.3.1 clearly show that the noise impact caused by the noise emissions from the DCME Pit 1 NW Extension during Option 1.1 will be negligible. The results are assessed in Tables 6.3.2 and 6.3.3.

TABLE 6.3.2
Assessment in terms of the SANS 10103[5] guidelines: Option 1.1

Homestead	Period	Criterion	Resulting total ambient noise levels dBA	Compliance	Increase, Δ, in ambient noise levels dB	Community reaction
1	Day	≤ 55 dBA	50.7	Yes	0.0	'No community reaction'
2		≤ 45 dBA	45.4	Yes[1]	0.0	'No community reaction'
3		≤ 55 dBA	50.4	Yes	0.0	'No community reaction'
4		≤ 55 dBA	48.1	Yes	0.0	'No community reaction'
5		≤ 55 dBA	49.7	No Due to road traffic	0.0	'No community reaction'
6		≤ 45 dBA	44.4	Yes	0.0	'No community reaction'
7		≤ 45 dBA	44.2	Yes	0.0	'No community reaction'
1	Night	≤ 45 dBA	46.3	No Due to road traffic	0.0	'No community reaction'
2		≤ 35 dBA	38.0	No Due to road traffic	0.0	'No community reaction'
3		≤ 45 dBA	46.0	Yes[1]	0.0	'No community reaction'
4		≤ 45 dBA	42.4	Yes	0.0	'No community reaction'
5		≤ 45 dBA	45.4	Yes[1]	0.0	'No community reaction'
6		≤ 35 dBA	35.8	Yes[1]	0.1 Negligible[2]	'No community reaction'
7		≤ 35 dBA	35.1	Yes[1]	0.1 Negligible[2]	'No community reaction'

Note 1: If the resulting total ambient noise level is within 1 dBA of the criterion level it is deemed to comply.

Note 2: See section 4.8.

TABLE 6.3.3
Assessment in terms of the SRK methodology (Appendix C): Option 1.1

Severity	Spatial scope	Duration	Frequency of Activity	Frequency of Impact
1 Insignificant	1 Activity specific	2 One month to a year	4 Likely	4 Likely
Consequence	4		Likelihood	8
Significance		36	Medium Low	

6.4 Noise impact: Option 1.2

The noise impact contours for Option 1.2 (see Table 4.7.1 in section 4) are given in Figures 6.4.1 and 6.4.2. Please note that only the noise contours for night time are reproduced here since the maximum noise impacts occur during that time period. This is due to meteorological and other atmospheric conditions favouring the propagation of sound.

The day-time contours are given in Appendix E to this report.

A summary of the noise impacts for the homesteads is given in Table 6.4.1 and assessed in Tables 6.4.2 and 6.4.3.

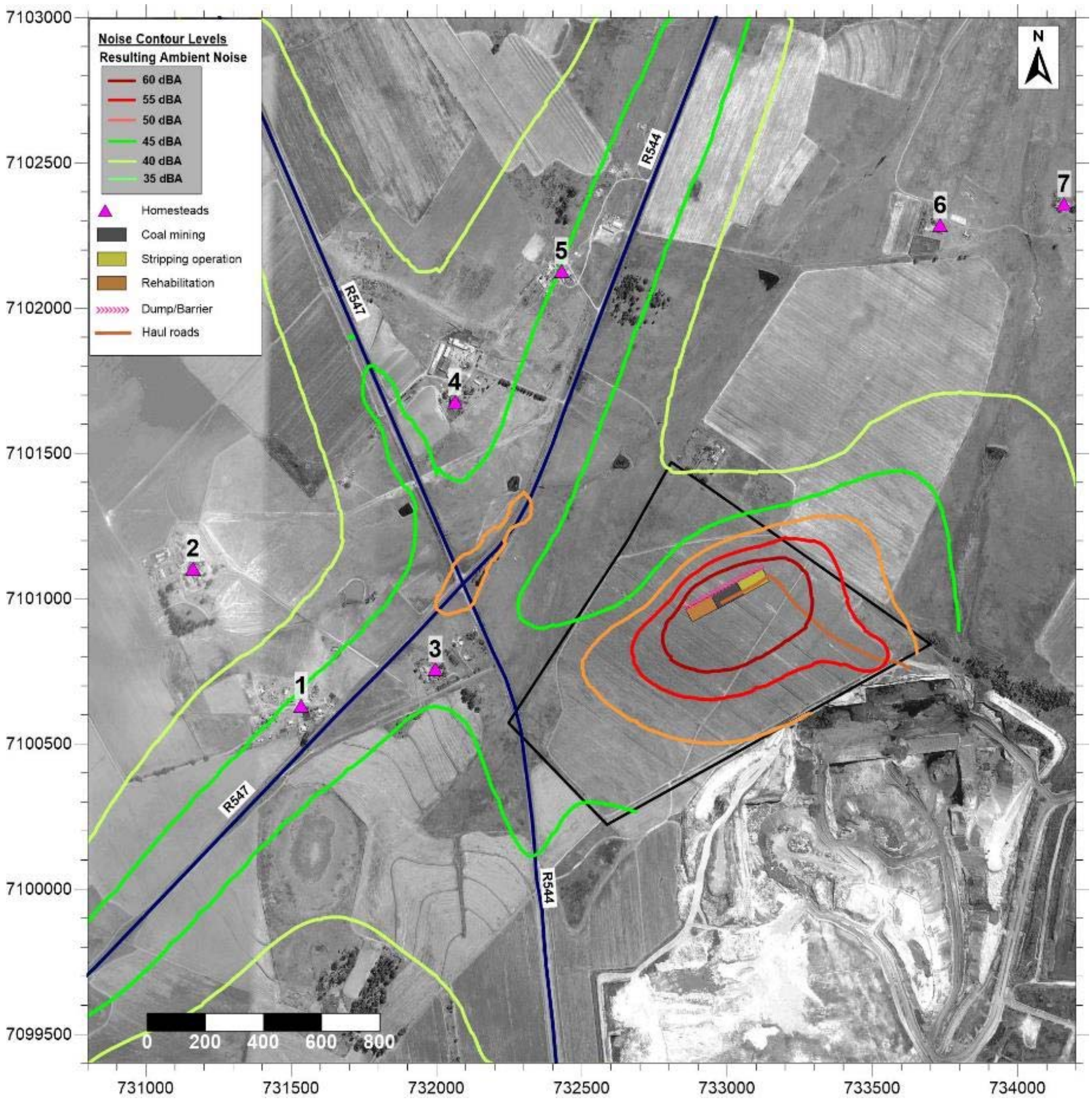

Figure 6.4.1: Option 1.2: Noise impact expressed in terms of the resulting total ambient noise levels during night-time.

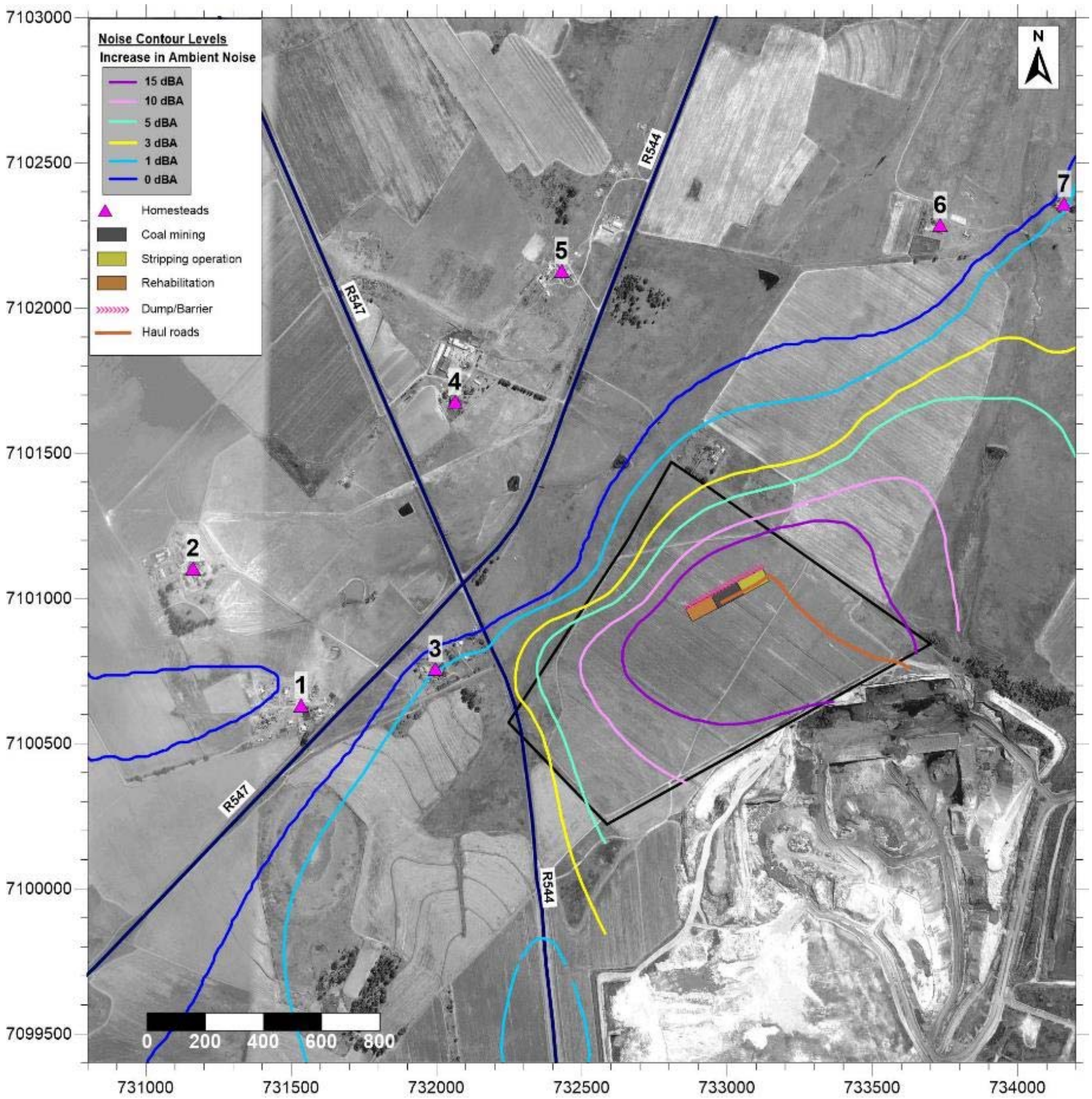

Figure 6.4.2: Option 1.2: Noise impact expressed in terms of the increase in ambient noise levels during night-time.

TABLE 6.4.1
Summarised results: Option 1.2

Homestead	Pit 1 NW Extension noise contribution dBA		Background ambient noise levels dBA		Resulting total ambient noise levels dBA		Increase in ambient noise levels dB	
	Day	Night	Day	Night	Day	Night	Day	Night
1	29.3	34.2	50.7	46.3	50.7	46.6	0.0	0.3
2	12.3	17.3	45.4	38.0	45.4	38.0	0.0	0.0
3	34.7	39.2	50.4	46.0	50.5	46.8	0.1	0.8
4	18.7	23.0	48.1	42.3	48.1	42.4	0.0	0.1
5	18.4	22.9	49.7	45.4	49.7	45.4	0.0	0.0
6	14.6	22.5	44.4	35.7	44.4	35.9	0.0	0.2
7	21.5	30.7	44.2	35.0	44.3	36.4	0.0	1.4

The results given in Figures 6.4.1 and 6.4.2 and Table 6.4.1 clearly show that the noise impact caused by the noise emissions from the DCME Pit 1 NW Extension during Option 1.2 will mostly be negligible and at most insignificant. The results are assessed in Tables 6.4.2 and 6.4.3.

TABLE 6.4.2
Assessment in terms of the SANS 10103[5] guidelines: Option 1.2

Homestead	Period	Criterion	Resulting total ambient noise levels dBA	Compliance	Increase, Δ, in ambient noise levels dB	Community reaction
1	Day	≤ 55 dBA	50.7	Yes	0.0	'No community reaction'
2		≤ 45 dBA	45.4	Yes[1]	0.0	'No community reaction'
3		≤ 55 dBA	50.5	Yes	0.1 Negligible[2]	'No community reaction'
4		≤ 55 dBA	48.1	Yes	0.0	'No community reaction'
5		≤ 55 dBA	49.7	No Due to road traffic	0.0	'No community reaction'
6		≤ 45 dBA	44.4	Yes	0.0	'No community reaction'
7		≤ 45 dBA	44.3	Yes	0.0	'No community reaction'
1	Night	≤ 45 dBA	46.6	No	0.3 Negligible[2]	'No community reaction'
2		≤ 35 dBA	38.0	No Due to road traffic	0.0	'No community reaction'
3		≤ 45 dBA	46.8	No	0.8 Negligible[2]	'No community reaction'
4		≤ 45 dBA	42.4	Yes	0.1 Negligible[2]	'No community reaction'
5		≤ 45 dBA	45.4	Yes[1]	0.0	'No community reaction'
6		≤ 35 dBA	35.9	Yes[1]	0.2 Negligible[2]	'No community reaction'
7		≤ 35 dBA	36.4	Yes[1]	1.4 Insignificant[2]	'Little with sporadic complaints'

Note 1: If the resulting total ambient noise level is within 1 dBA of the criterion level it is deemed to comply.

Note 2: See section 4.8.

TABLE 6.4.3
Assessment in terms of the SRK methodology (Appendix C): Option 1.2

Severity	Spatial scope	Duration	Frequency of	
			Activity	Impact
1 Insignificant	1 Activity specific	2 One month to a year	4 Likely	4 Likely
Consequence	4		Likelihood	8
Significance		32	Medium Low	

6.5 Noise impact: Option 1.3

The noise impact contours for Option 1.3 (see Table 4.7.1 in section 4) are given in Figures 6.5.1 and 6.5.2. Please note that only the noise contours for night time are reproduced here since the maximum noise impacts occur during that time period. This is due to meteorological and other atmospheric conditions favouring the propagation of sound.

The day-time contours are given in Appendix E to this report.

A summary of the noise impacts for the homesteads is given in Table 6.5.1 and assessed in Tables 6.5.2 and 6.5.3.

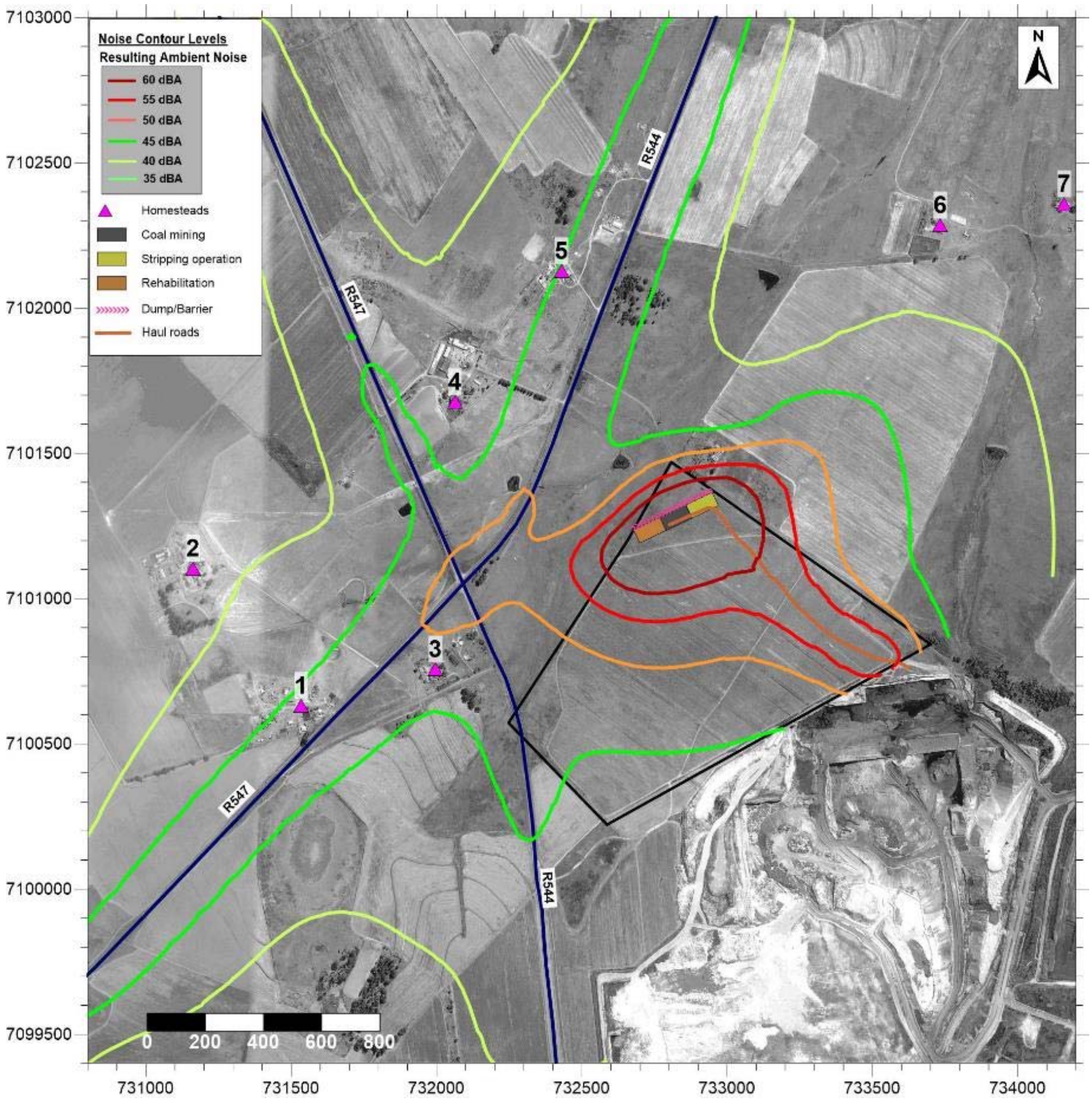

Figure 6.5.1: Option 1.3: Noise impact expressed in terms of the resulting total ambient noise levels during night-time.

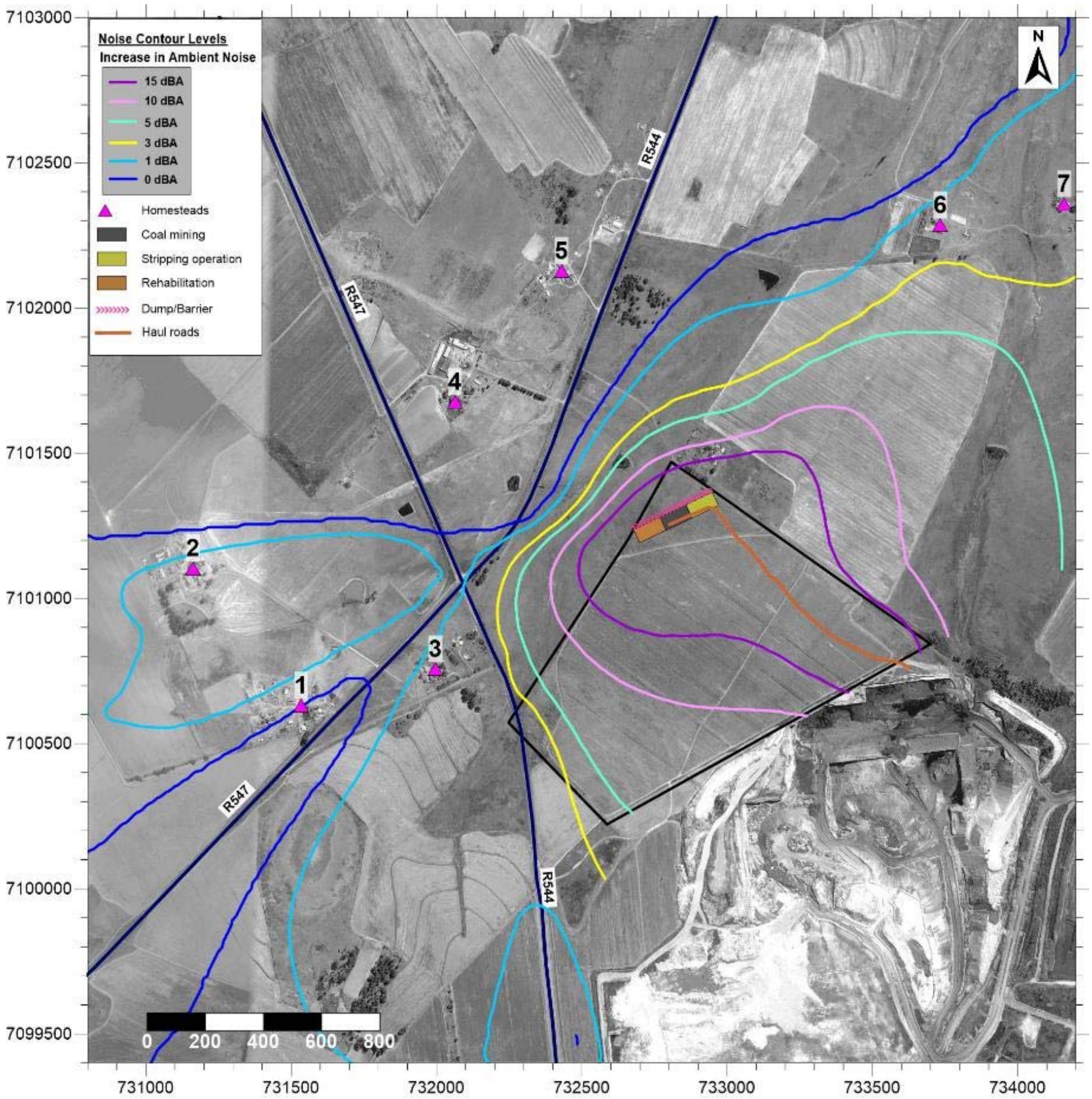

Figure 6.5.2: Option 1.3: Noise impact expressed in terms of the increase in ambient noise levels during night-time.

TABLE 6.5.1
Summarised results: Option 1.3

Homestead	Pit 1 NW Extension noise contribution dBA		Background ambient noise levels dBA		Resulting total ambient noise levels dBA		Increase in ambient noise levels dB	
	Day	Night	Day	Night	Day	Night	Day	Night
1	32.0	36.9	50.7	46.3	50.8	46.8	0.1	0.5
2	27.9	32.9	45.4	38.0	45.4	39.1	0.1	1.2
3	33.4	41.8	50.4	46.0	50.5	47.4	0.1	1.4
4	22.2	26.3	48.1	42.3	48.1	42.4	0.0	0.1
5	21.5	25.8	49.7	45.4	49.7	45.5	0.0	0.0
6	25.5	34.3	44.4	35.7	44.5	38.1	0.1	2.4
7	22.1	31.2	44.2	35.0	44.3	36.5	0.0	1.5

The results given in Figures 6.5.1 and 6.5.2 and Table 6.5.1 clearly show that the noise impact caused by the noise emissions from the DCME Pit 1 NW Extension during

Option 1.3 will mostly be negligible or insignificant. The exception is at homestead 5 during night-time, due to the short distance of the buildings to the mining operation.

The results are assessed in Tables 6.5.2 and 6.5.3.

TABLE 6.5.2
Assessment in terms of the SANS 10103[5] guidelines: Option 1.3

Homestead	Period	Criterion	Resulting total ambient noise levels dBA	Compliance	Increase, Δ, in ambient noise levels dB	Community reaction
1	Day	≤ 55 dBA	50.8	Yes	0.1 Negligible[2]	'No community reaction'
2		≤ 45 dBA	45.4	Yes[1]	0.1 Negligible[2]	'No community reaction'
3		≤ 55 dBA	50.5	Yes	0.1 Negligible[2]	'No community reaction'
4		≤ 55 dBA	48.1	Yes	0.0	'No community reaction'
5		≤ 55 dBA	49.7	No Due to road traffic	0.0	'No community reaction'
6		≤ 45 dBA	44.5	Yes	0.1 Negligible[2]	'No community reaction'
7		≤ 45 dBA	44.3	Yes	0.0	'No community reaction'
1	Night	≤ 45 dBA	46.8	No	0.5 Negligible[2]	'No community reaction'
2		≤ 35 dBA	39.1	No	1.2 Insignificant[2]	'Little with sporadic complaints'
3		≤ 45 dBA	47.4	No	1.4 Insignificant[2]	'Little with sporadic complaints'
4		≤ 45 dBA	42.4	Yes	0.1 Negligible[2]	'No community reaction'
5		≤ 45 dBA	45.5	Yes[1]	0.0	'No community reaction'
6		≤ 35 dBA	38.1	No	2.4 Insignificant[2]	'Little with sporadic complaints'
7		≤ 35 dBA	36.5	No	1.5 Insignificant[2]	'Little with sporadic complaints'

Note 1: If the resulting total ambient noise level is within 1 dBA of the criterion level it is deemed to comply.

Note 2: See section 4.8.

TABLE 6.5.3
Assessment in terms of the SRK methodology (Appendix C): Option 1.3

Severity	Spatial scope	Duration	Frequency of	
			Activity	Impact
1 Insignificant	1 Activity specific	2 One month to a year	4 Likely	4 Likely
Consequence	4		Likelihood	8
Significance		32	Medium Low	

6.6 Noise impact: Option 2

The noise impact contours for Option 2 (see Table 4.7.1 in section 4) are given in Figures 6.6.1 and 6.6.2. Please note that only the noise contours for night time are reproduced here since the maximum noise impacts occur during that time period. This is due to meteorological and other atmospheric conditions favouring the propagation of sound.

The day-time contours are given in Appendix E to this report.

A summary of the noise impacts for the homesteads is given in Table 6.6.1 and assessed in Tables 6.6.2 and 6.6.3.

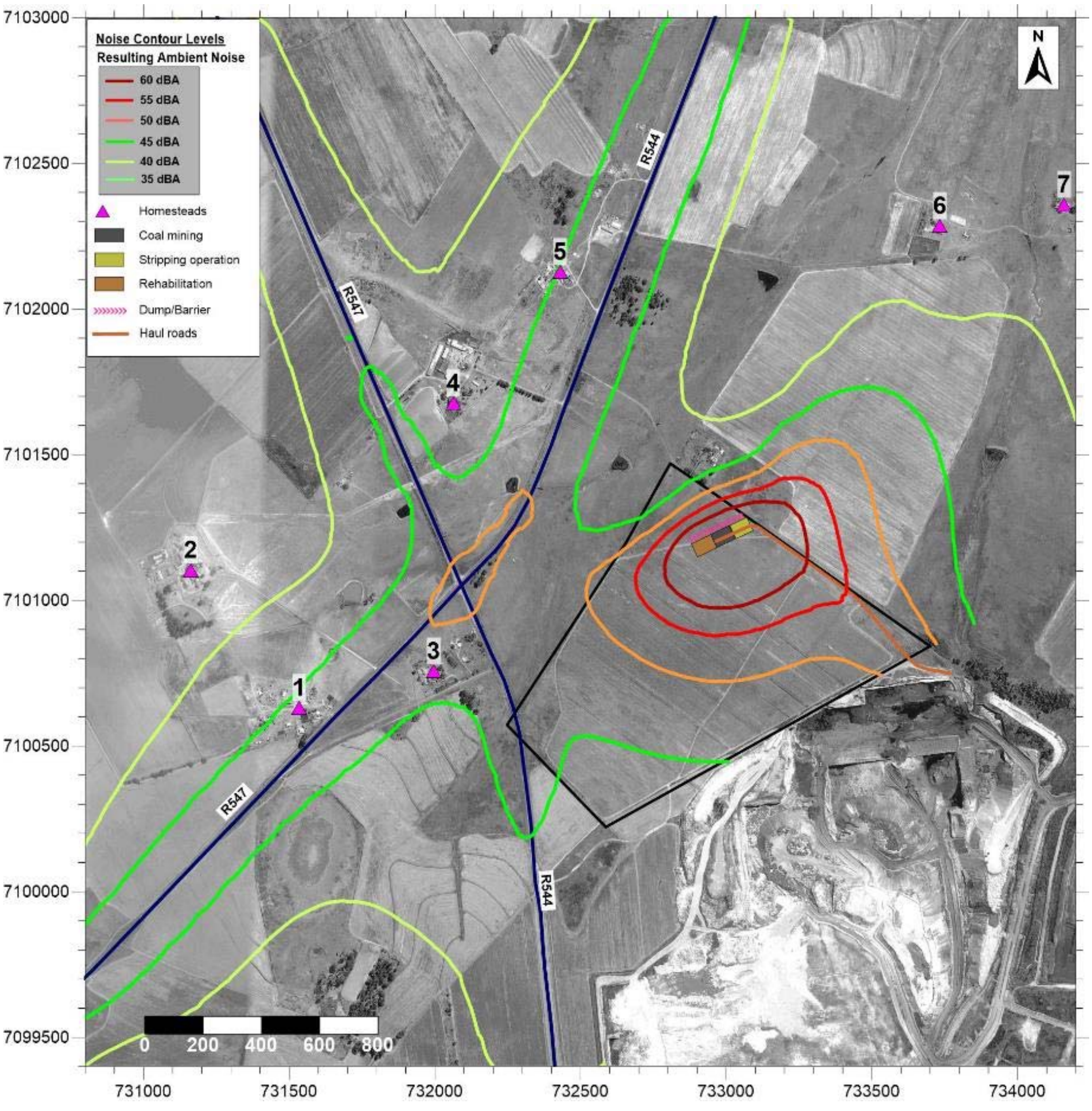

Figure 6.6.1: Option 2: Noise impact expressed in terms of the resulting total ambient noise levels during night-time.

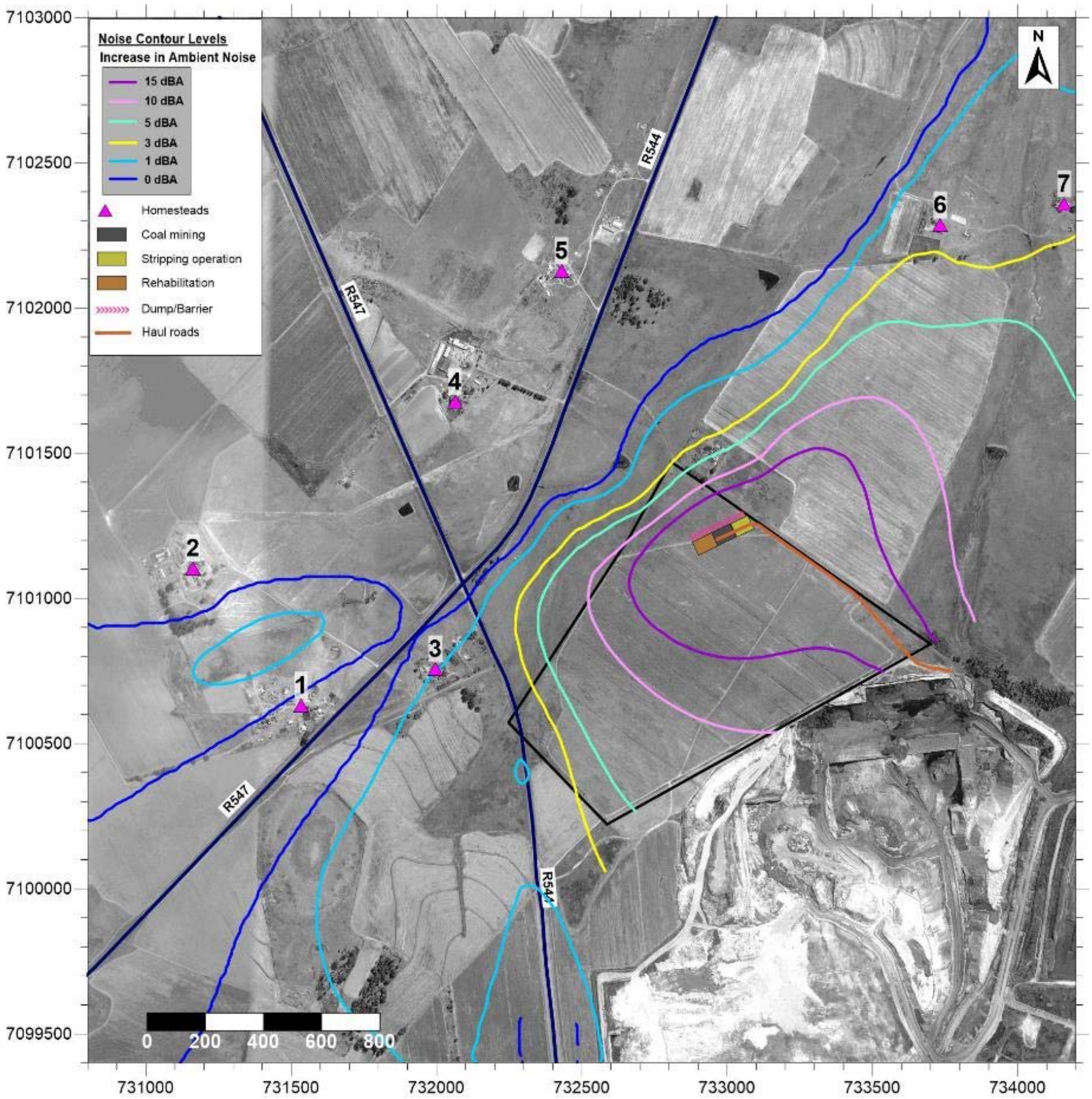

Figure 6.6.2: Option 2: Noise impact expressed in terms of the increase in ambient noise levels during night-time.

TABLE 6.6.1
Summarised results: Option 2

Homestead	Pit 1 NW Extension noise contribution dBA		Background ambient noise levels dBA		Resulting total ambient noise levels dBA		Increase in ambient noise levels dB	
	Day	Night	Day	Night	Day	Night	Day	Night
1	32.0	36.9	50.7	46.3	50.7	46.6	0.0	0.3
2	27.9	32.9	45.4	38.0	45.4	38.1	0.0	0.2
3	33.4	41.8	50.4	46.0	50.5	47.0	0.1	1.0
4	22.2	26.3	48.1	42.3	48.1	42.4	0.0	0.0
5	21.5	25.8	49.7	45.4	49.7	45.4	0.0	0.0
6	25.5	34.3	44.4	35.7	44.5	38.1	0.1	2.5
7	22.1	31.2	44.2	35.0	44.3	36.6	0.0	1.6

The results given in Figures 6.6.1 and 6.6.2 and Table 6.6.1 clearly show that the noise impact caused by the noise emissions from the DCME Pit 1 NW Extension during Option 2 will mostly be negligible or insignificant. The exception is at homestead 5 during night-time, due to the short distance of the buildings to the mining operation.

The results are assessed in Tables 6.6.2 and 6.6.3.

TABLE 6.6.2
Assessment in terms of the SANS 10103[5] guidelines: Option 2

Homestead	Period	Criterion	Resulting total ambient noise levels dBA	Compliance	Increase, Δ, in ambient noise levels dB	Community reaction
1	Day	≤ 55 dBA	50.7	Yes	0.0	'No community reaction'
2		≤ 45 dBA	45.4	Yes[1]	0.0	'No community reaction'
3		≤ 55 dBA	50.5	Yes	0.1 Negligible[2]	'No community reaction'
4		≤ 55 dBA	48.1	Yes	0.0	'No community reaction'
5		≤ 55 dBA	49.7	No Due to road traffic	0.0	'No community reaction'
6		≤ 45 dBA	44.5	Yes	0.1 Negligible[2]	'No community reaction'
7		≤ 45 dBA	44.3	Yes	0.0	'No community reaction'
1	Night	≤ 45 dBA	46.6	No	0.3 Negligible[2]	'No community reaction'
2		≤ 35 dBA	38.1	No	0.2 Negligible[2]	'Little with sporadic complaints'
3		≤ 45 dBA	47.0	No	1.0 Insignificant[2]	'Little with sporadic complaints'
4		≤ 45 dBA	42.4	Yes	0.0	'No community reaction'
5		≤ 45 dBA	45.4	Yes[1]	0.0	'No community reaction'
6		≤ 35 dBA	38.1	No	2.5 Insignificant[2]	'Little with sporadic complaints'
7		≤ 35 dBA	36.6	No	1.6 Insignificant[2]	'Little with sporadic complaints'

Note 1: If the resulting total ambient noise level is within 1 dBA of the criterion level it is deemed to comply.

Note 2: See section 4.8.

TABLE 6.6.3
Assessment in terms of the SRK methodology (Appendix C): Option 2

Severity	Spatial scope	Duration	Frequency of	
			Activity	Impact
1	1	2	4	4
Consequence	4		Likelihood	8
Significance		36	Medium Low	

6.7 General remarks

The following general remarks are of relevance to the modelling results:

- As already pointed out, the maximum extent of the noise impacts occurs during night-time when meteorological and other atmospheric conditions favour the propagation of sound over long distances. This characteristic is enhanced during winter when average temperatures are low;
- It is clear that the noise impacts will be limited, since the resulting total ambient noise levels largely conform to those recommended by SANS 10103 [5]. At the locations where there is an excess this is due to road traffic noise determining existing ambient noise levels;
- Furthermore, it must be noted that the predicted road traffic noise levels do not include the contributions caused by the rumble strips. As a result the noise impacts caused by the future DCME mining operations tend to be over rather than under estimated;
- This is not really reflected in the assessments according to the SRK methodology which indicate a ***Significance*** rating of ***Medium Low***. Although the severity of the noise impact is insignificant the higher ***Significance*** rating is the result of the ***Likelihood*** being the product of high ***Frequencies of Activity*** and ***of Impacts***; and
- It is the considered opinion of the consultant that the assessment result should rather be ***Low***.

7. CONCLUSIONS

The following conclusions can be drawn from this noise study:

- The ambient noise levels in immediate environment of the DCME Pit 1 NW Extension are dominated by road traffic on the R547 and R544 which includes a large percentage of heavy vehicles;
- These noise contributions will to a large extent mask the impact of the noise immissions caused by the future mining operations;
- The resulting total ambient noise levels largely conform to those recommended by SANS 10103 [5];
- There will either be no increase in ambient noise levels or it will range between ‘Negligible’ and ‘Insignificant’. According to SANS 10103 [5] the expected community response to these increase will range between ‘No reaction’ and ‘Little with sporadic complaints’; and
- Although the assessments according to the SRK methodology result in a ***Significance*** rating of ***Medium Low*** the consultant is of the considered opinion that it should rather be ***Low***.

8. RECOMMENDATIONS

The following recommendations can be made:

- The roll over mining method must include the construction of a noise barrier on the NW side of each current pit area using the removed topsoil and stripped overburden; and

- During the measurements the backing alarms of earth moving equipment was often noticed. The high pitched sound these alarms produce are often cited as a particularly disturbing aspect of mining operations. It is strongly recommended that the high pitched alarms be replaced with devices that produce high levels of broadband noise. Although these alarms are very audible in close proximity to the equipment their noise energy is rapidly attenuated over longer distances, thereby causing much less disturbance.

9. REFERENCES

In this report reference was made to the following documentation:

(1) Noise Regulations, 1990, published under the Environment Conservation Act, 1989 (Act No. 73 of 1989), Government Gazette No. 12435, 27 April 1990.

(2) Model noise regulations published under the Environment Conservation Act, Act 73 of 1989, by the Minister of the Environment in 1997.

(3) Model air quality management by-law for easy adoption and adaptation by municipalities, 2010.

(4) National Environment Management Air Quality Act, Act 39 of 2004, Government Gazette No. 33342, 2 July 2010.

(5) SANS 10103:2008 'The measurement and rating of environmental noise with respect to annoyance and to speech communication', Edition 6.

(6) Guidelines for Community Noise, World Health Organisation, Geneva, 1999.

(7) SANS 10210:2004 'Calculating and predicting road traffic noise', Edition 2.2.

(8) SANS 10357:2004 'The calculation of sound propagation by the Concawe method'. Edition 1.2.

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APPENDIX A

Measurement instrumentation

10. MEASUREMENT INSTRUMENTATION

The measurement instrumentation that was used in this noise study is summarised in Table A-1. The measurement instrumentation complies with the accuracy requirements specified for a Type 1 instrument in:

- SANS 61672-1/IEC 61672-1, *Electro acoustics – Sound level meters – Part 1: Specifications.* **Amdt 1**
- SANS 60942/IEC 60942 (SABS IEC 60942), *Electro acoustics – Sound calibrators*.

TABLE A-1
Measurement instrumentation

Instrument	Type	Serial Number	Date calibrated	Calibration Certificate
Sound analyser	B&K 2250	3004727	2016/05/26	AV\AS 4560
Microphone	B&K 4189	2888663	2016/05/26	AV\AS 4560
Sound level calibrator	B&K 4230	1511916	2016/05/26	AV\AS 4560

The calibration status of the instrumentation was checked before and after each set of measurements against a calibrated signal with a level of 94,0 dB at 1 kHz. In each case the instrument displayed a reading of within 1 dB of the calibrated value. A windshield supplied by the manufacturer of the instrument was used during all the measurements.

APPENDIX B

Assumed modelling parameters

11. ASSUMED MODELLING PARAMETERS

11.1 Traffic flow

The traffic flow and other key parameters used in the calculations are summarised in Table B-1.

Table B-1
Summary of the assumed traffic flow

Road	Period	Q	%H	v	gr	st
R547 S	Day	80	29.2	70	0	smooth
	Night	63	10.0	70	0	smooth
R547 N	Day	70	14.7	70	0	smooth
	Night	20	7.0	70	0	smooth
R544 S	Day	27	11.9	70	0	smooth
	Night	15	11.9	70	0	smooth
R544 N	Day	129	10.3	70	0	smooth
	Night	63	15.0	70	0	smooth

Where: Q = Total number of vehicles per hour in both directions
%H = Percentage heavy vehicles
v = Average speed of the traffic, km/h
gr = The gradient of the road
st = Road surface texture

11.2 Meteorological conditions

The meteorological and atmospheric conditions assumed for the calculations are given in Table B-2.

TABLE B-2
Assumed meteorological conditions

Parameter	Assumed value	
	Day	Night
Temperature	18.4 °C	4.8 °C
Wind	1.2 m/s SE	0.5 m/s SE
Humidity	35 % RHD	67 % RHD
Static air pressure	86.1 kPa	
Solar irradiation	700 W/m^2	NA
Cloud cover	None	None
Acoustically soft ground conditions	50%	

11.3 Sound power emission levels

The octave frequency band sound power emission levels of equipment used in the calculations are summarised in Table B-3.

TABLE B-3
Sound power emission levels for mining equipment

Equipment	Sound power emission level, dB re 1 pW, in octave band, Hz						
	63	125	250	500	1000	2000	4000
Haul truck, Cat 50	107.9	113.2	116.9	114.4	110.6	106.8	100.2
Bell D40	108.2	108.0	106.8	106.9	104.0	101.8	98.7
Bulldozer Cat d10n	100.2	117.6	110.9	109.1	107.4	102.6	97.1
FEL, 988	105.0	117.0	113.0	114.0	111.0	107.0	101.0
Liebherr 944 Excavator	118	120	121	120	113	110	104
Tamrock drill	112	119	111	109	108	108	103

APPENDIX C

SRK assessment methodology

12. APPENDIX C: SRK ASSESSMENT METHODOLOGY

Table 13-1: Criteria for Assessing Significance of Impacts

SEVERITY OF IMPACT	RATING
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful	5

SPATIAL SCOPE OF IMPACT	RATING
Activity specific	1
Mine specific (within the mine boundary)	2
Local area (within 5 km of the mine boundary)	3
Regional (Greater Rustenburg area)	4
National	5

DURATION OF IMPACT	RATING
One day to one month	1
One month to one year	2
One year to ten years	3
Life of operation	4
Post closure / permanent	5

CONSEQUENCE

FREQUENCY OF ACTIVITY / DURATION OF ASPECT	RATING
Annually or less / low	1
6 monthly / temporary	2
Monthly / infrequent	3
Weekly / life of operation / regularly / likely	4
Daily / permanent / high	5

FREQUENCY OF IMPACT	RATING
Almost never / almost impossible	1
Very seldom / highly unlikely	2
Infrequent / unlikely / seldom	3
Often / regularly / likely / possible	4
Daily / highly likely / definitely	5

LIKELIHOOD

Table 13-2: Interpretation of Impact Rating

Consequence

Likelihood

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	20	30	40	50	60	70	80	90	100	110	120	1	140	150

Rating	Range	Action
High	76 to 150	Improve current management
Medium High	40 to 75	Maintain current management
Medium Low	26 to 39	Maintain current management
Low	1 to 25	No management required

SIGNIFICANCE = CONSEQUENCE x LIKELIHOOD

APPENDIX D
Detailed measurement results

13. APPENDIX D: DETAILED MEASUREMENT RESULTS

The detailed measurement results are given in Figures D-1 to D-8.

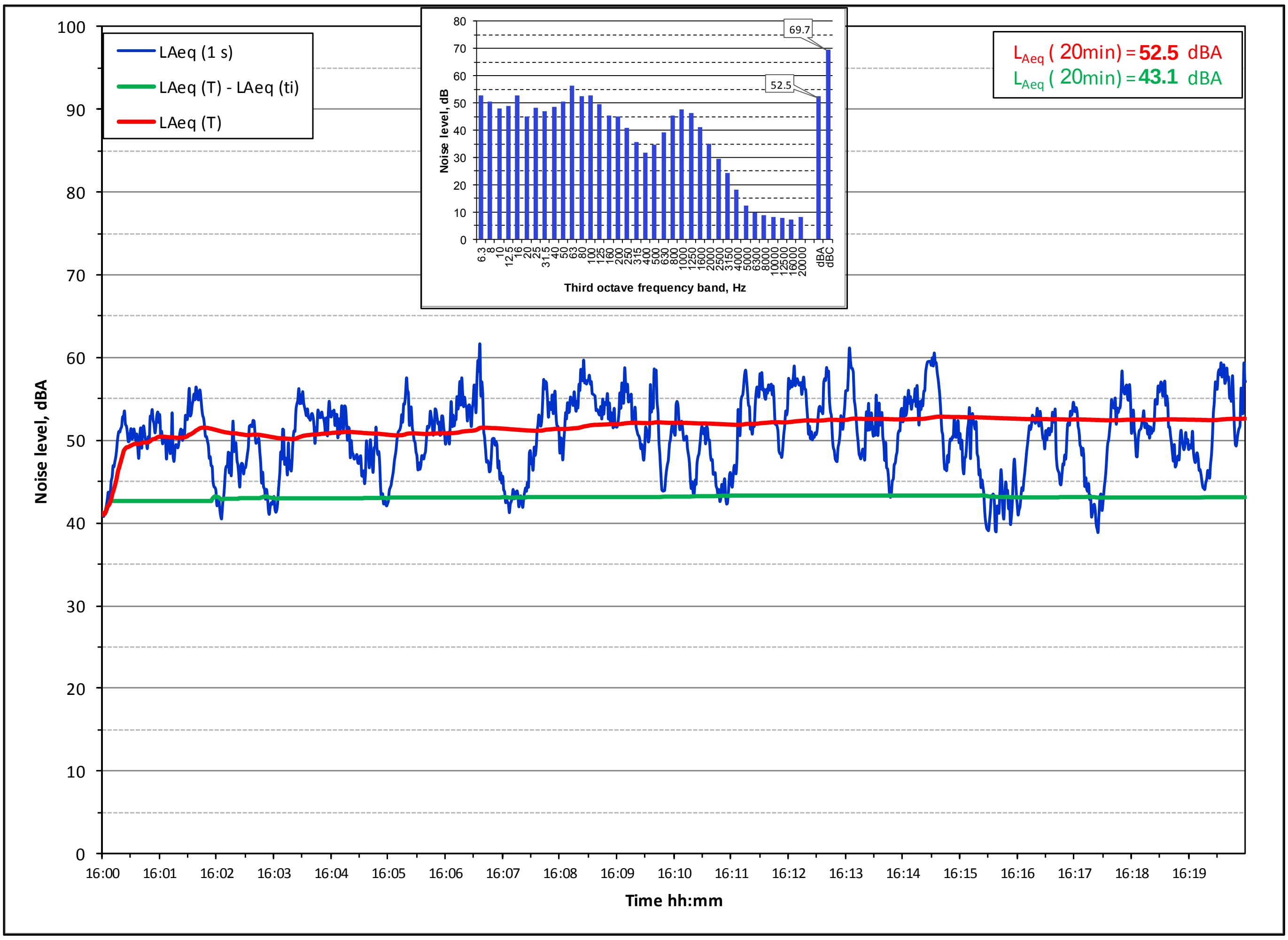

Figure D-1: Time profile and frequency spectrum measured at MP1 during day-time.

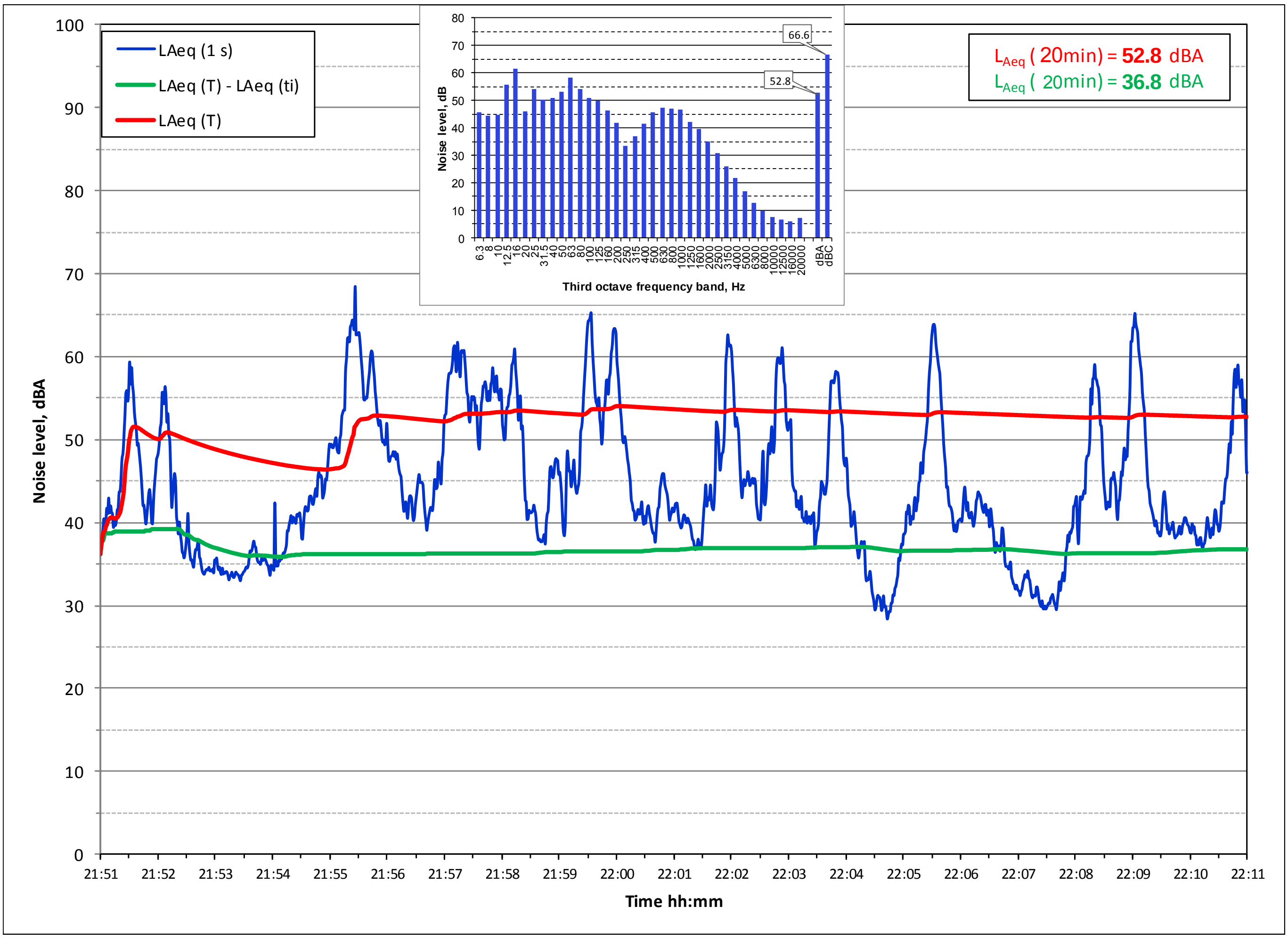

Figure D-2: Time profile and frequency spectrum measured at MP1 during night-time.

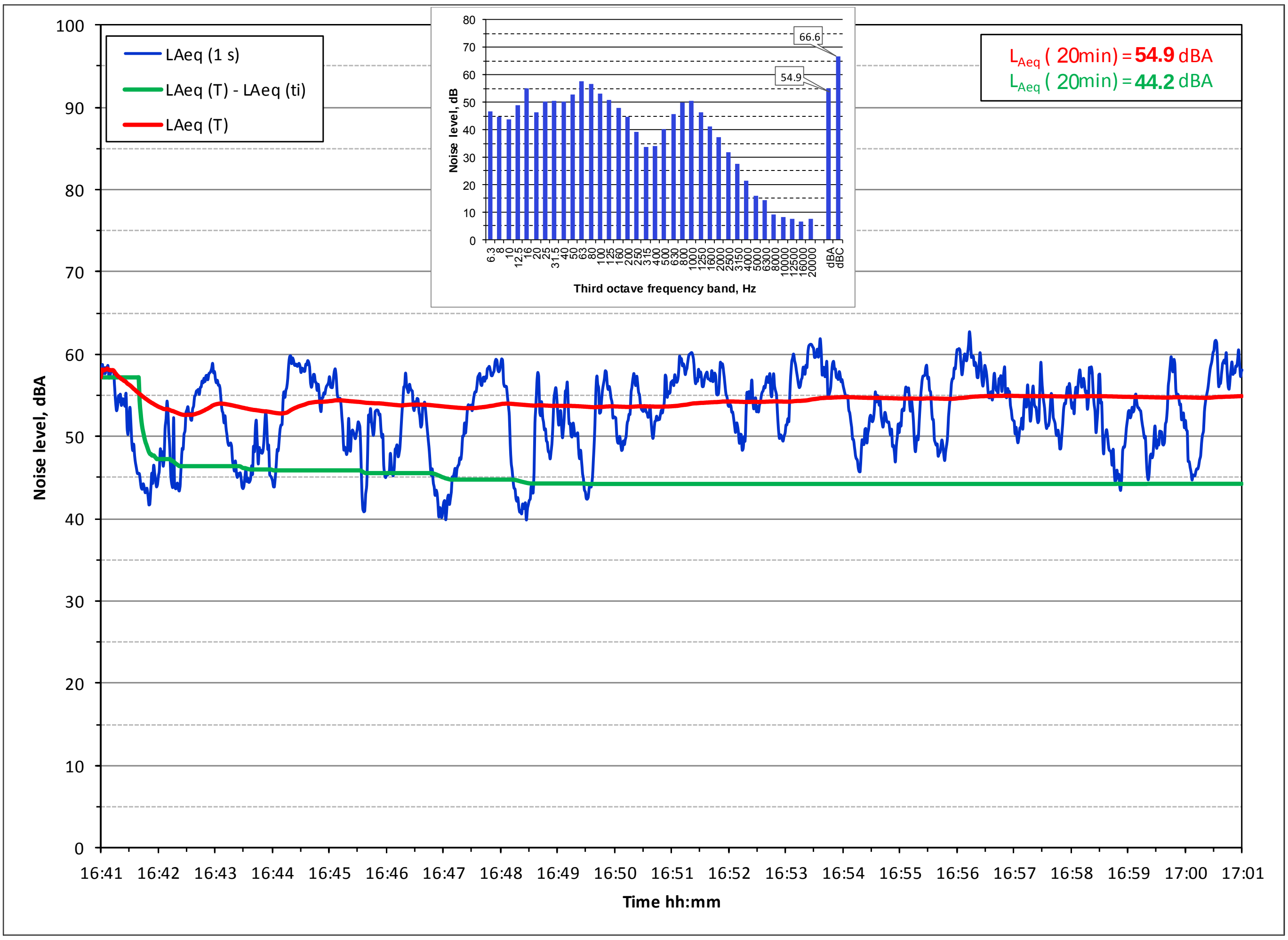

Figure D-3: Time profile and frequency spectrum measured at MP2 during day-time.

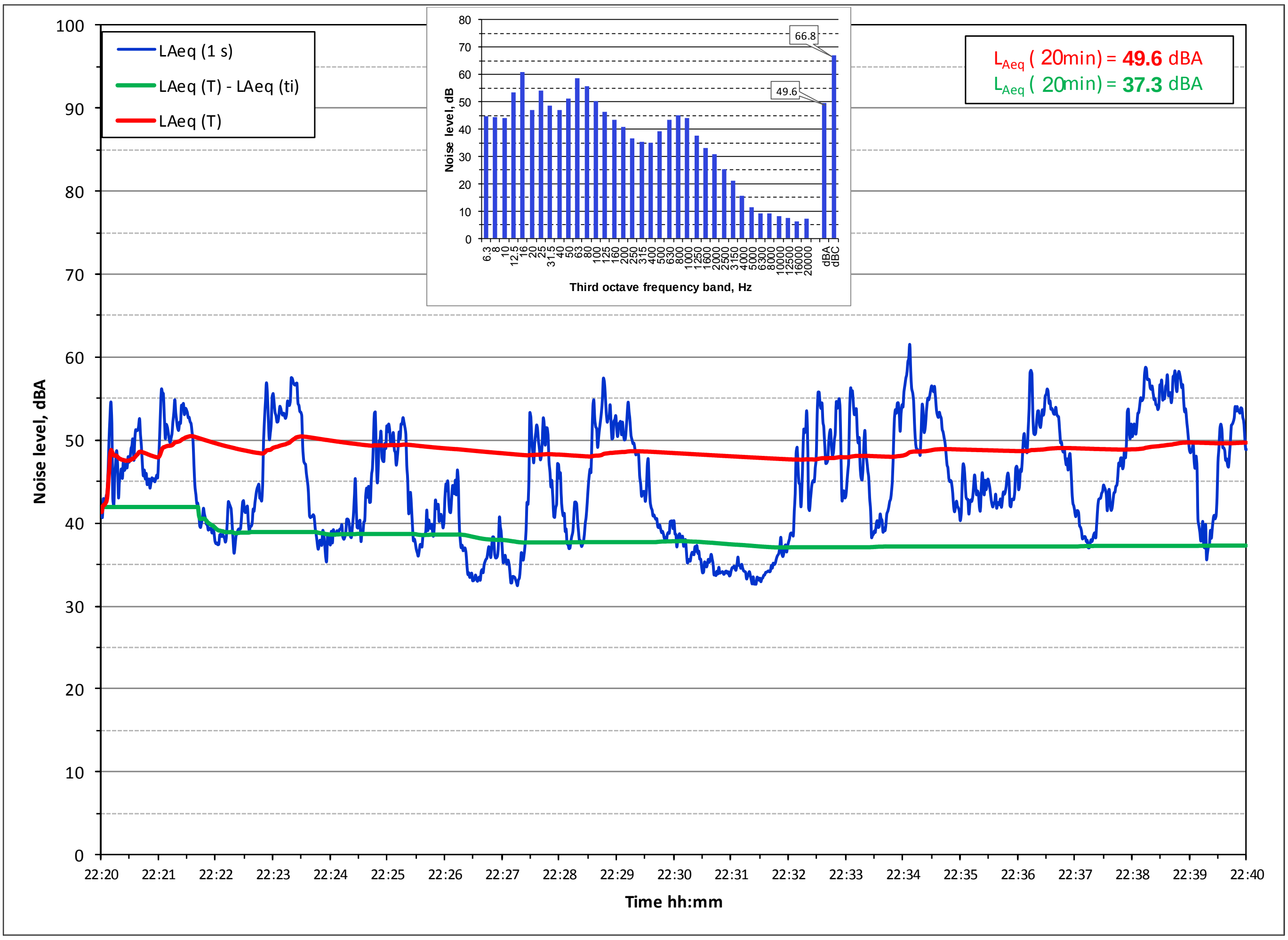

Figure D-4: Time profile and frequency spectrum measured at MP2 during night-time.

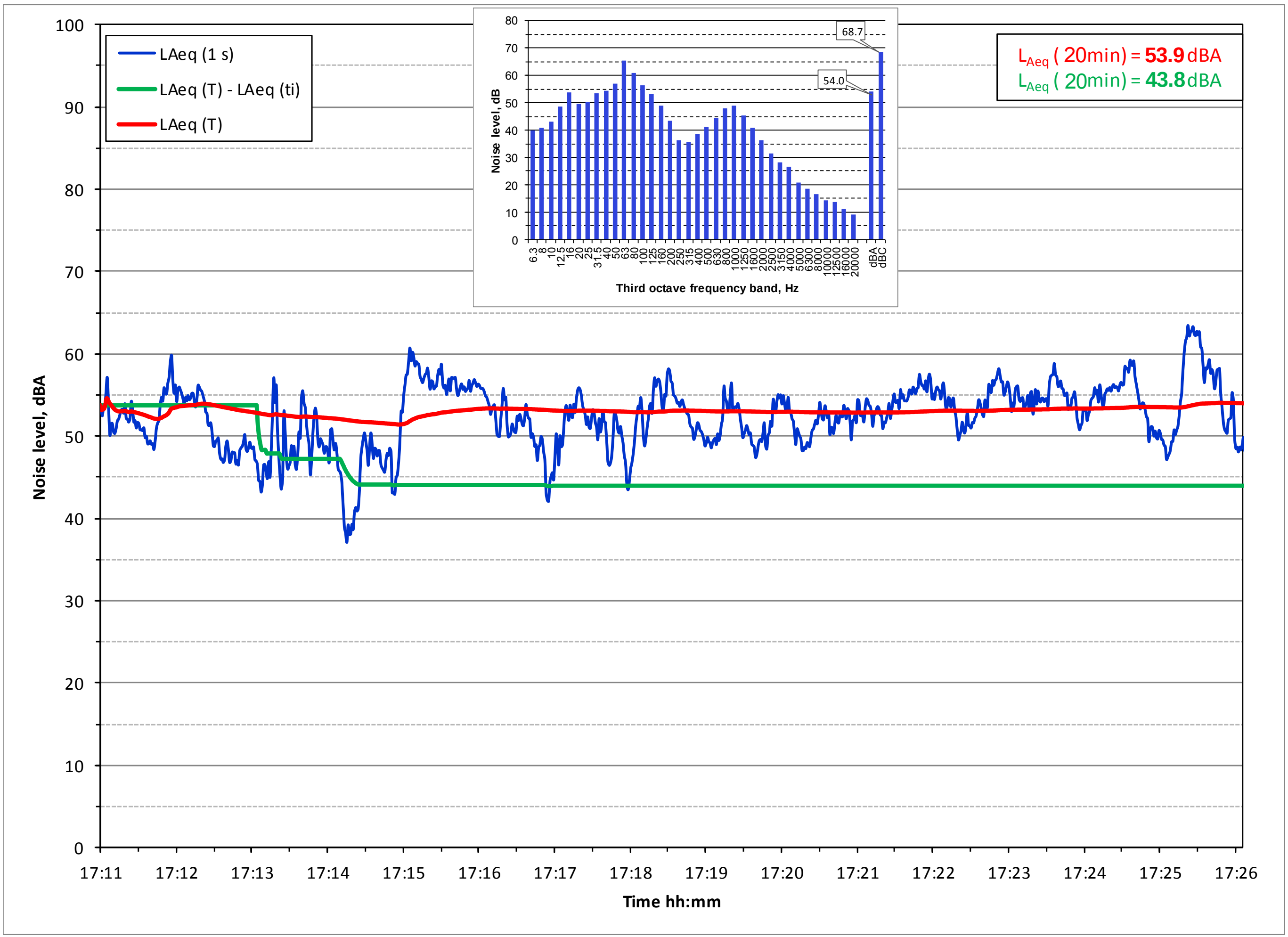

Figure D-5: Time profile and frequency spectrum measured at MP3 during day-time.

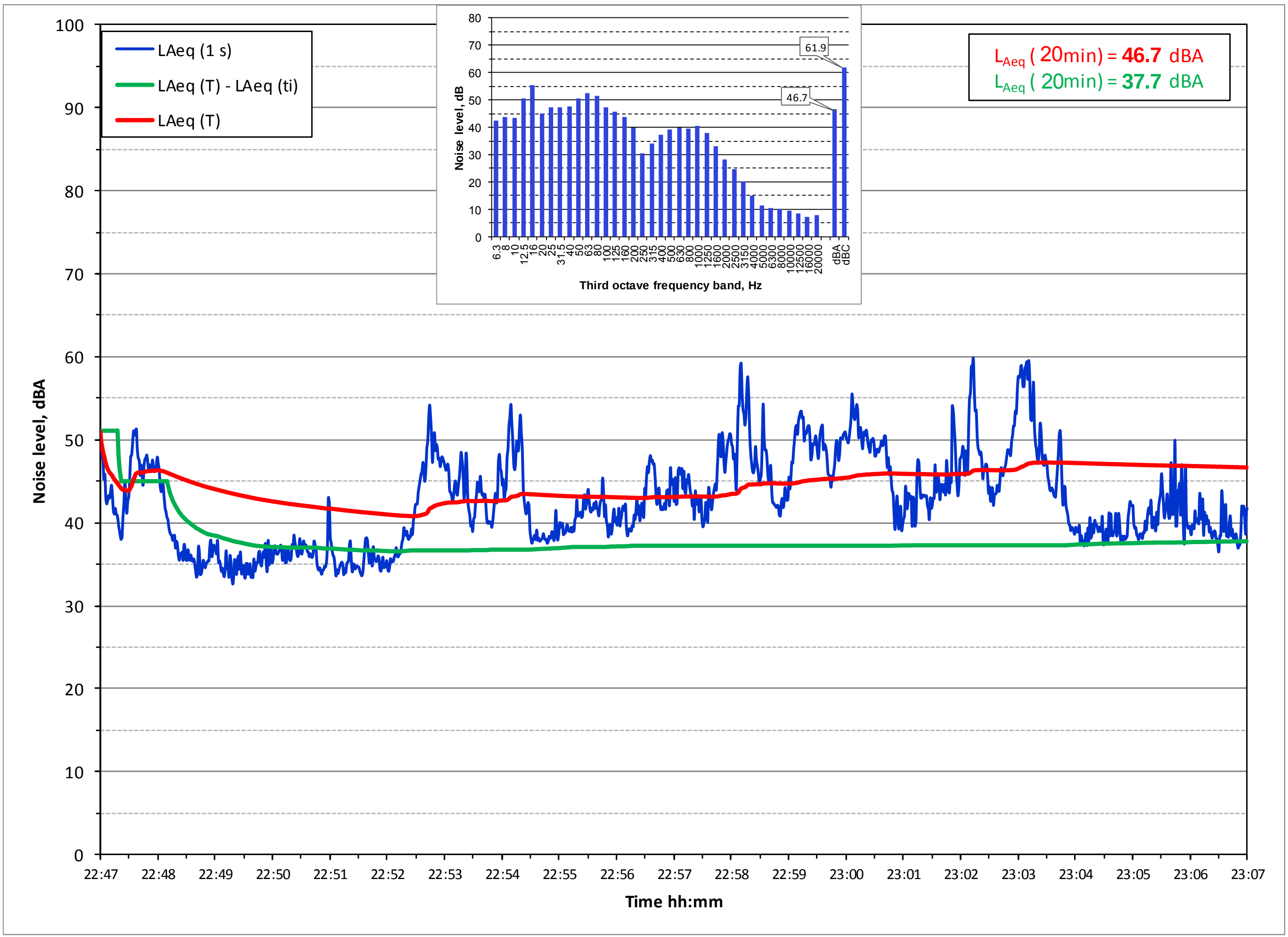

Figure D-6: Time profile and frequency spectrum measured at MP3 during night-time.

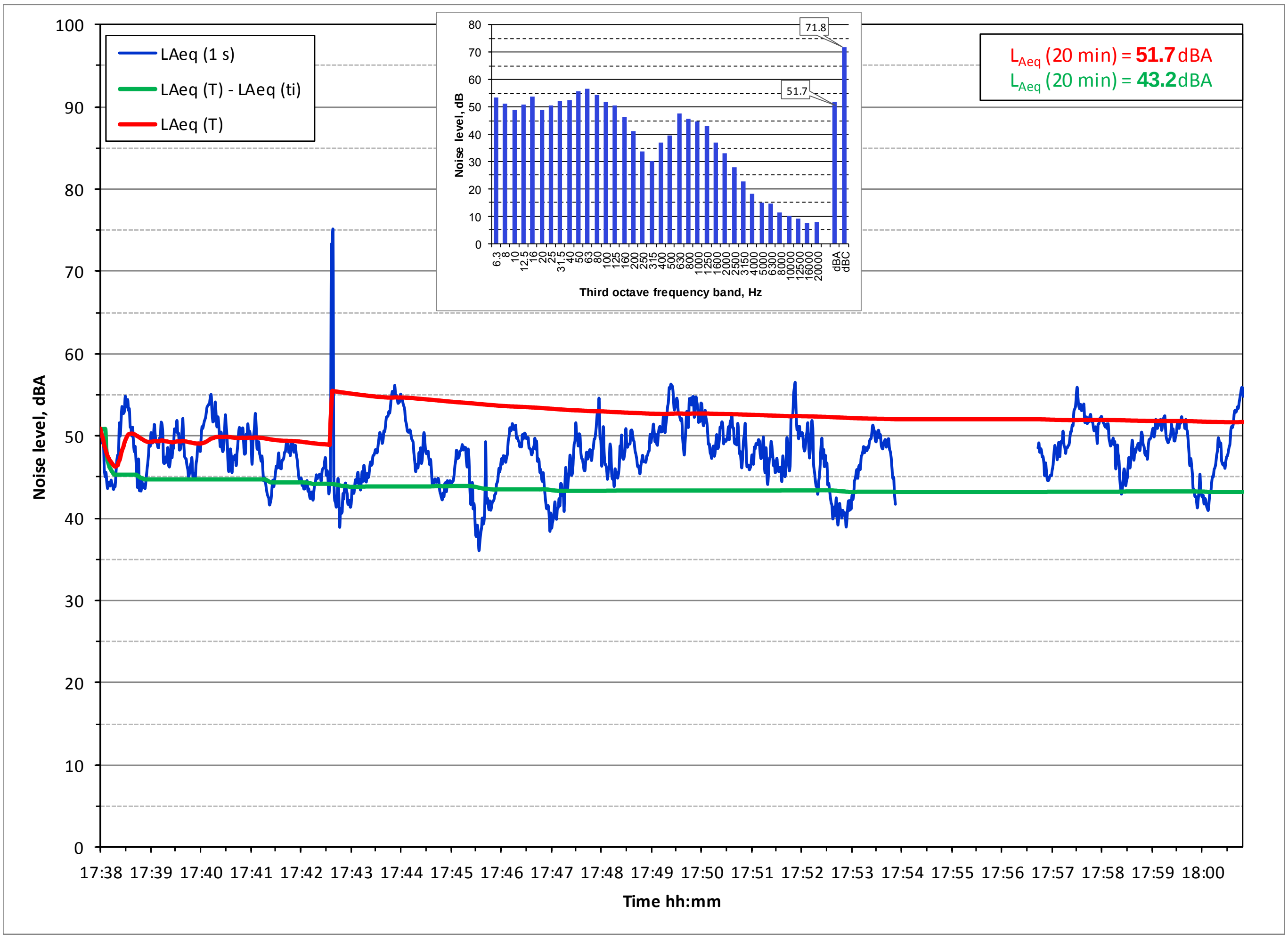

Figure D-7: Time profile and frequency spectrum measured at MP4 during day-time.

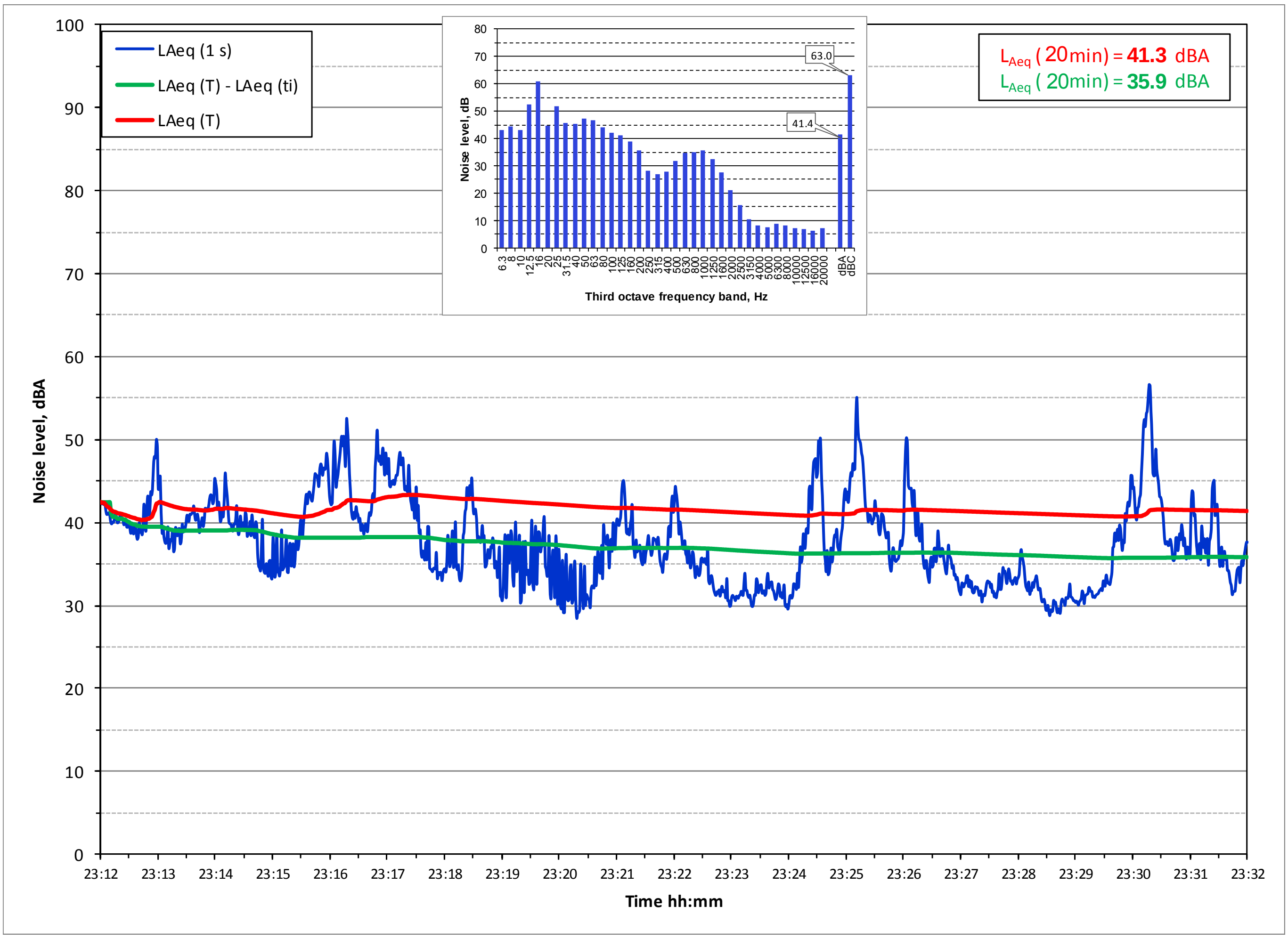

Figure D-8: Time profile and frequency spectrum measured at MP4 during night-time.

APPENDIX E

Day-time noise impact contours

14. APPENDIX E: DAY-TIME NOISE IMPACT CONTOURS

The day-time noise impact contours are given in Figures E-1 to E8.

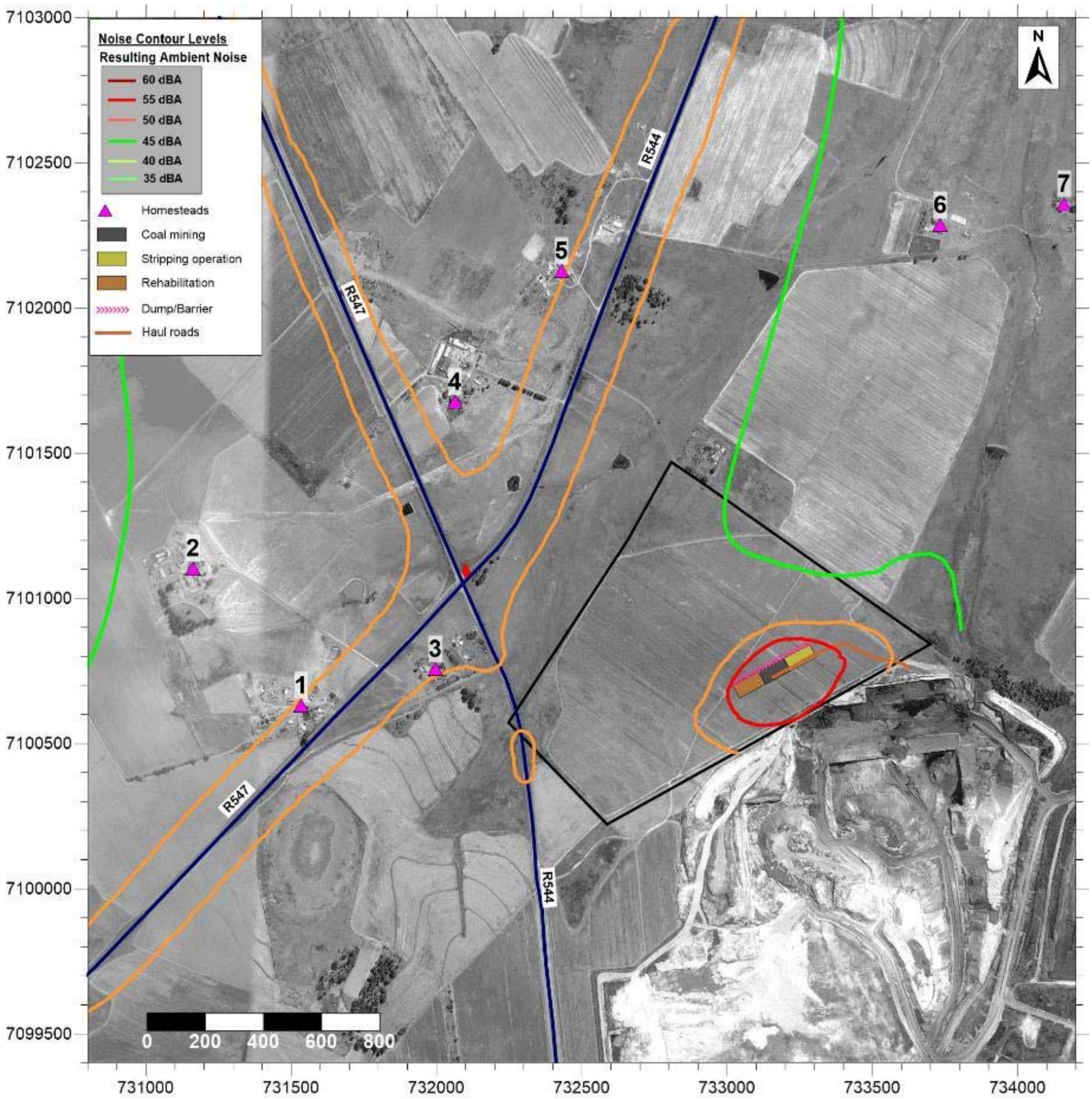

Figure E-1: Option 1.1: Noise impact expressed in terms of the resulting total ambient noise levels during day-time.

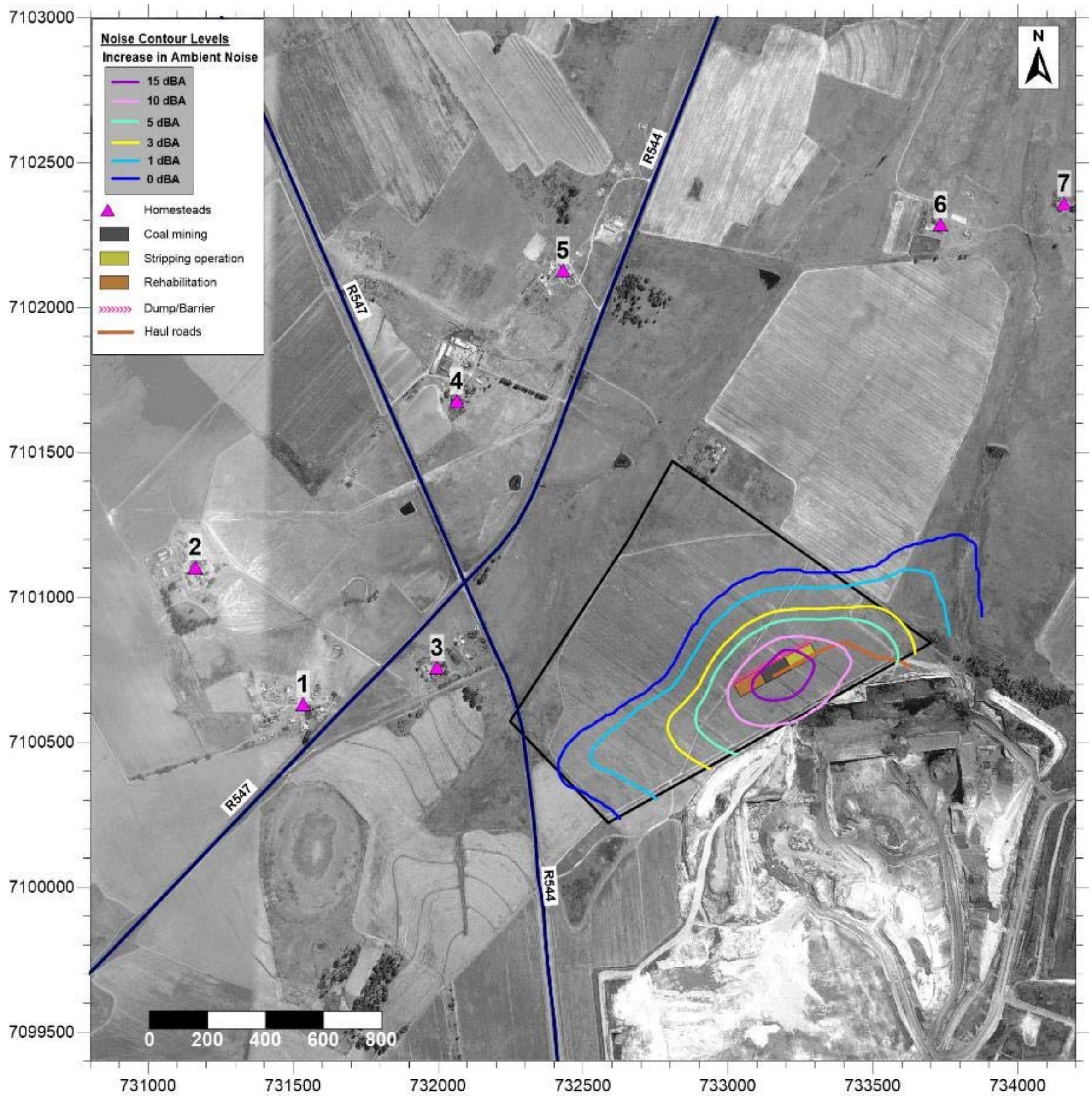

Figure E-2: Option 1.1: Noise impact expressed in terms of the increase in ambient noise levels during day-time.

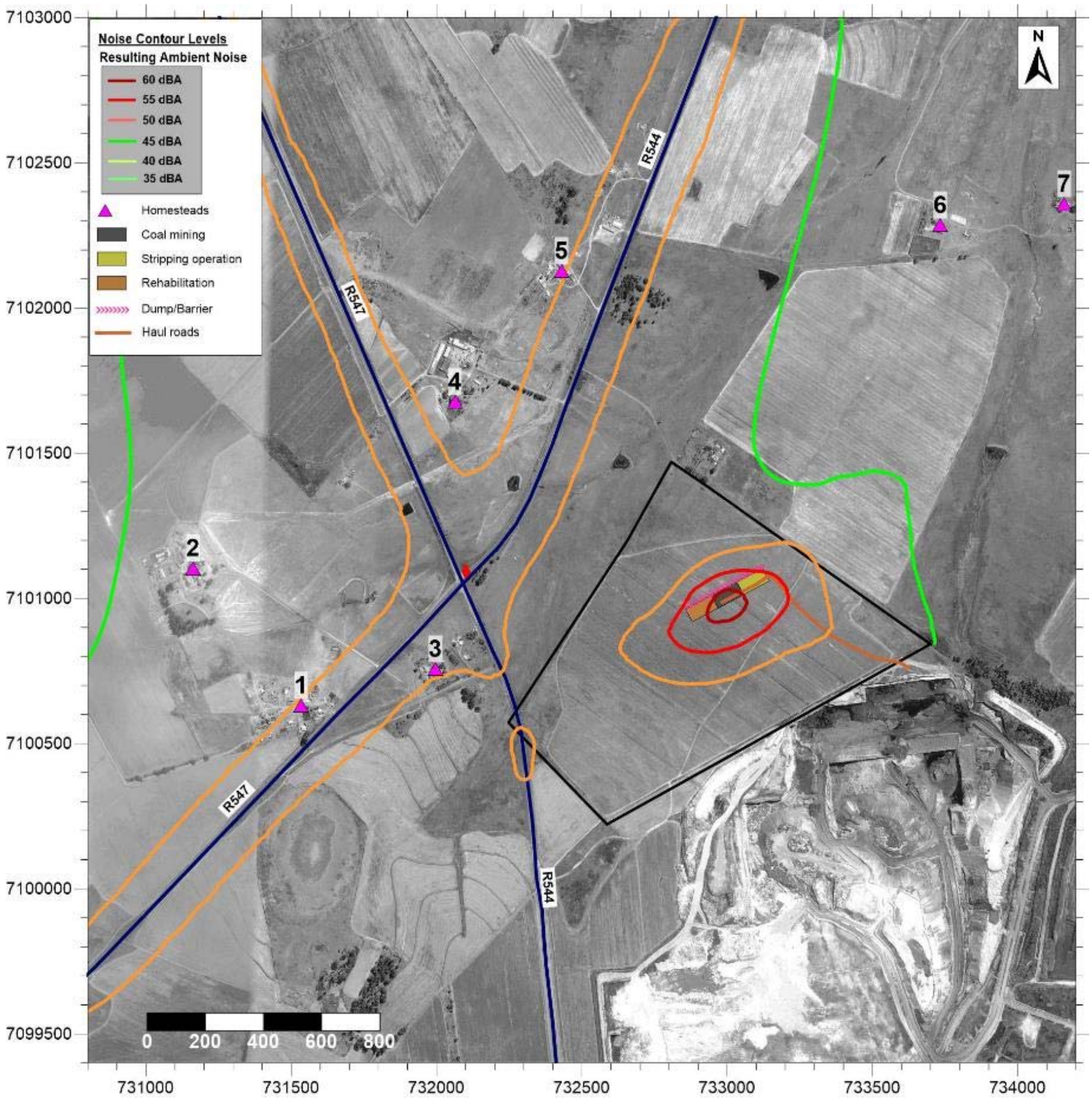

Figure E-3: Option 1.2: Noise impact expressed in terms of the increase in ambient noise levels during day-time.

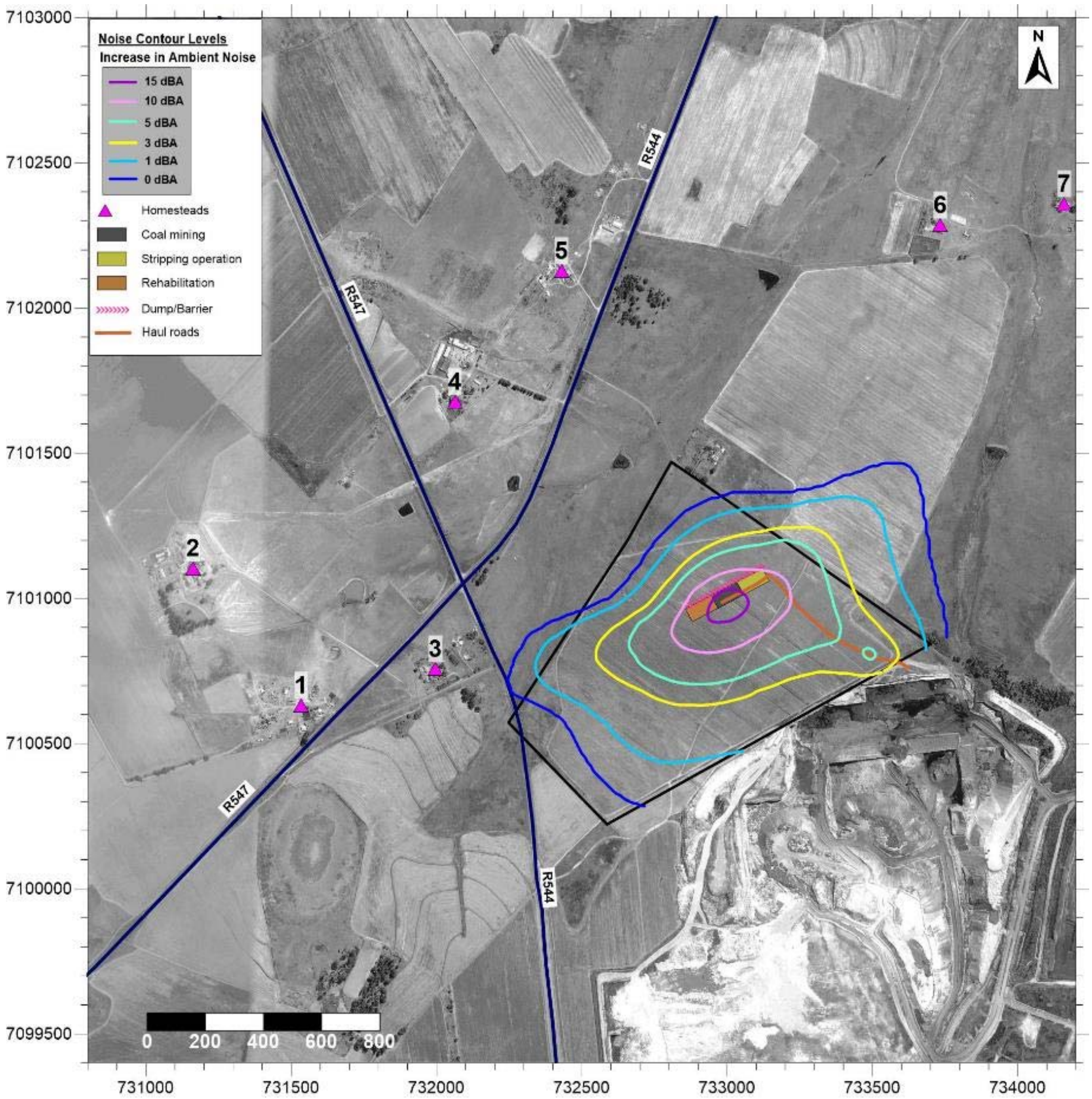

Figure E-4: Option 1.2: Noise impact expressed in terms of the increase in ambient noise levels during day-time.

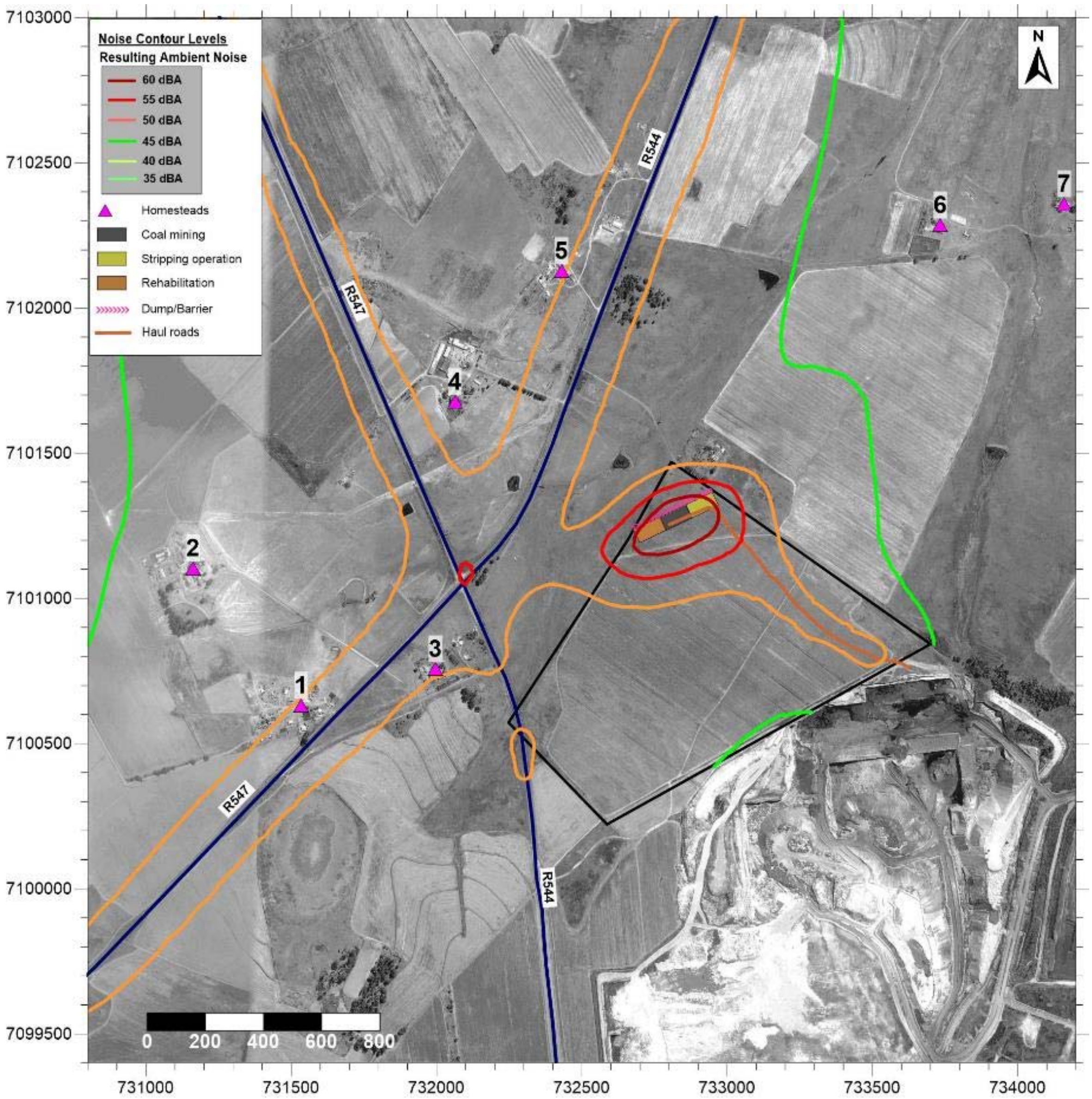

Figure E-5: Option 1.3: Noise impact expressed in terms of the total resulting ambient noise levels during day-time.

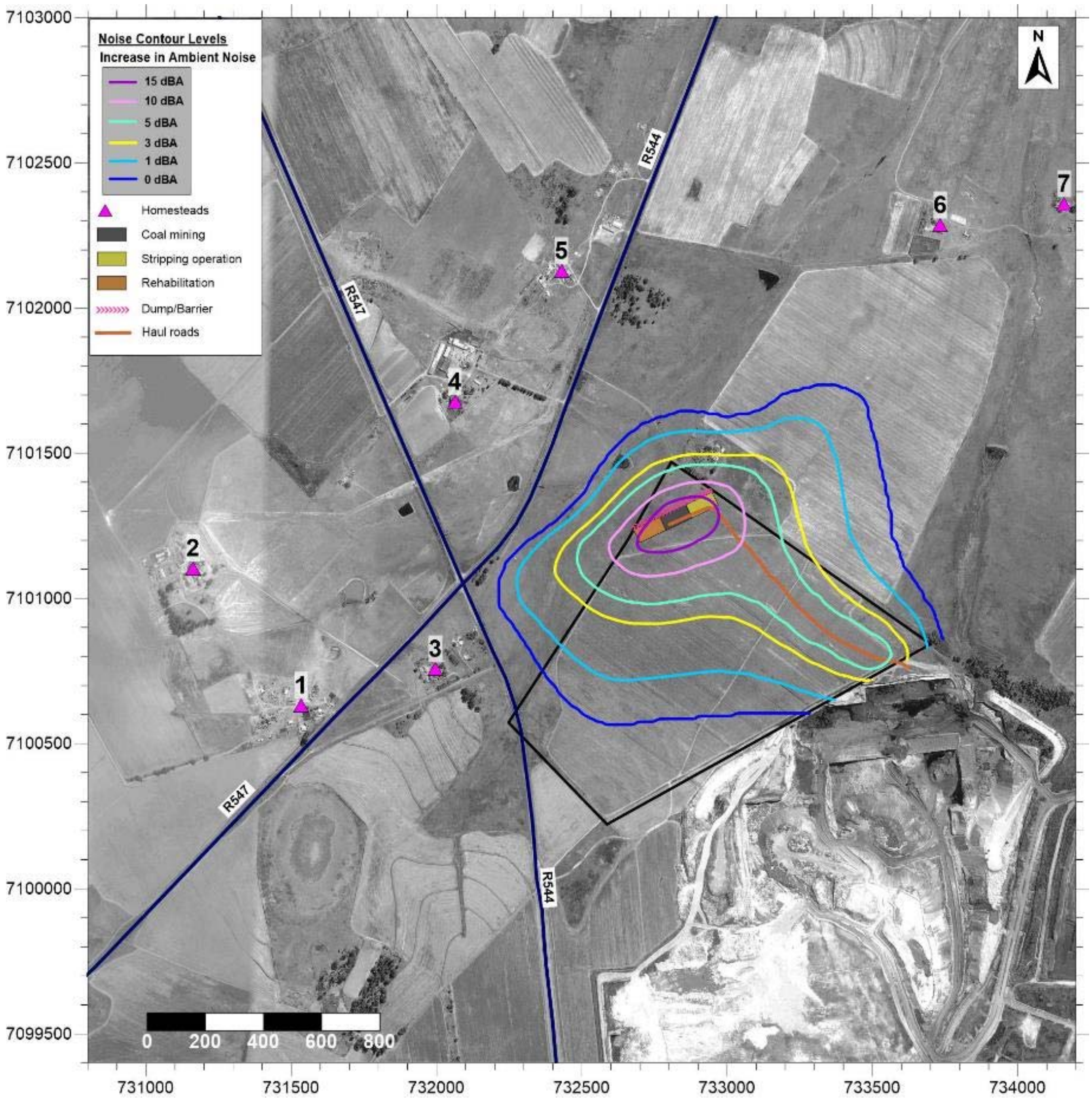

Figure E-6: Option 1.3: Noise impact expressed in terms of the increase in ambient noise levels during day-time.

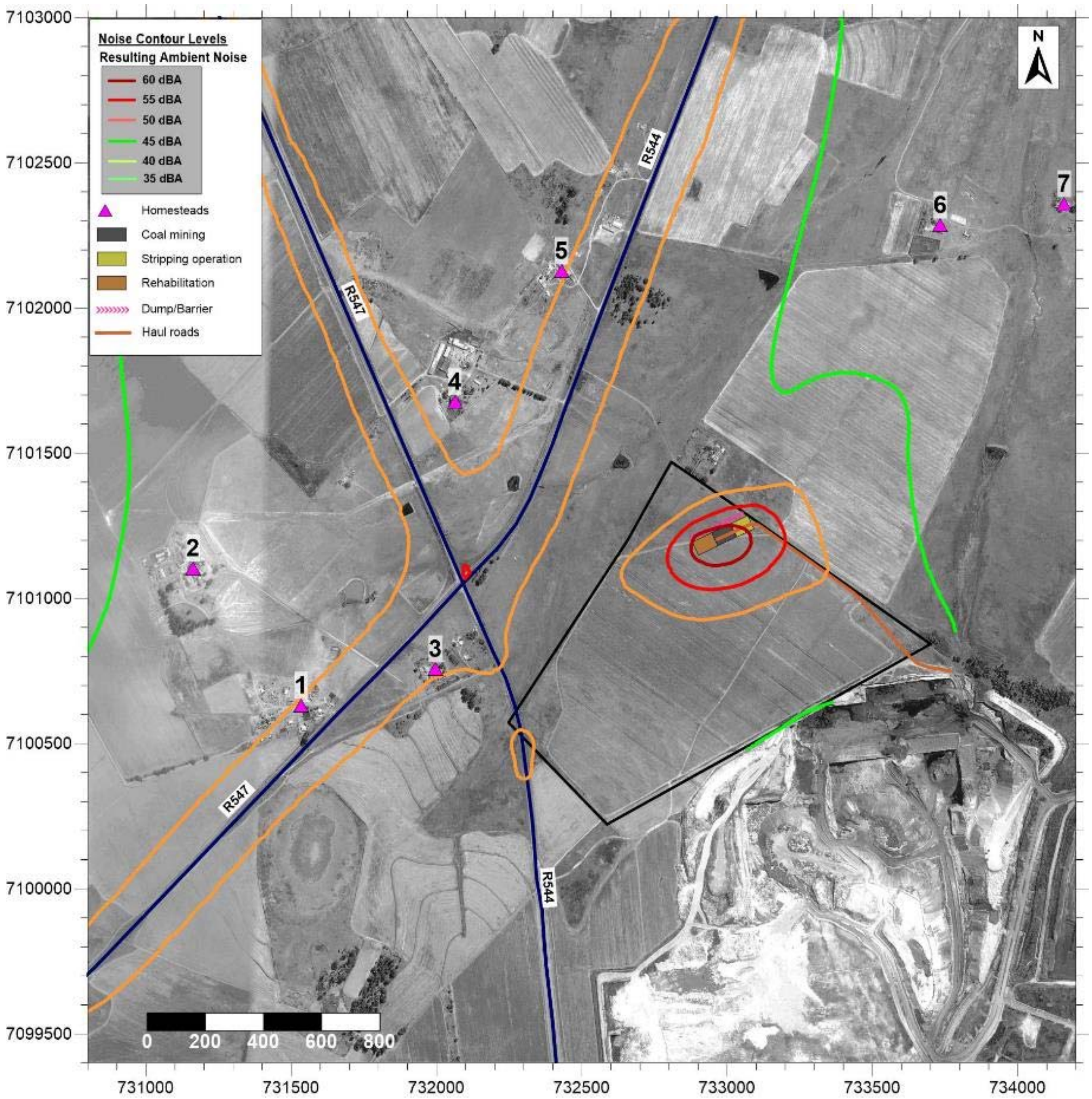

Figure E-7: Option 2: Noise impact expressed in terms of the total resulting ambient noise levels during day-time.

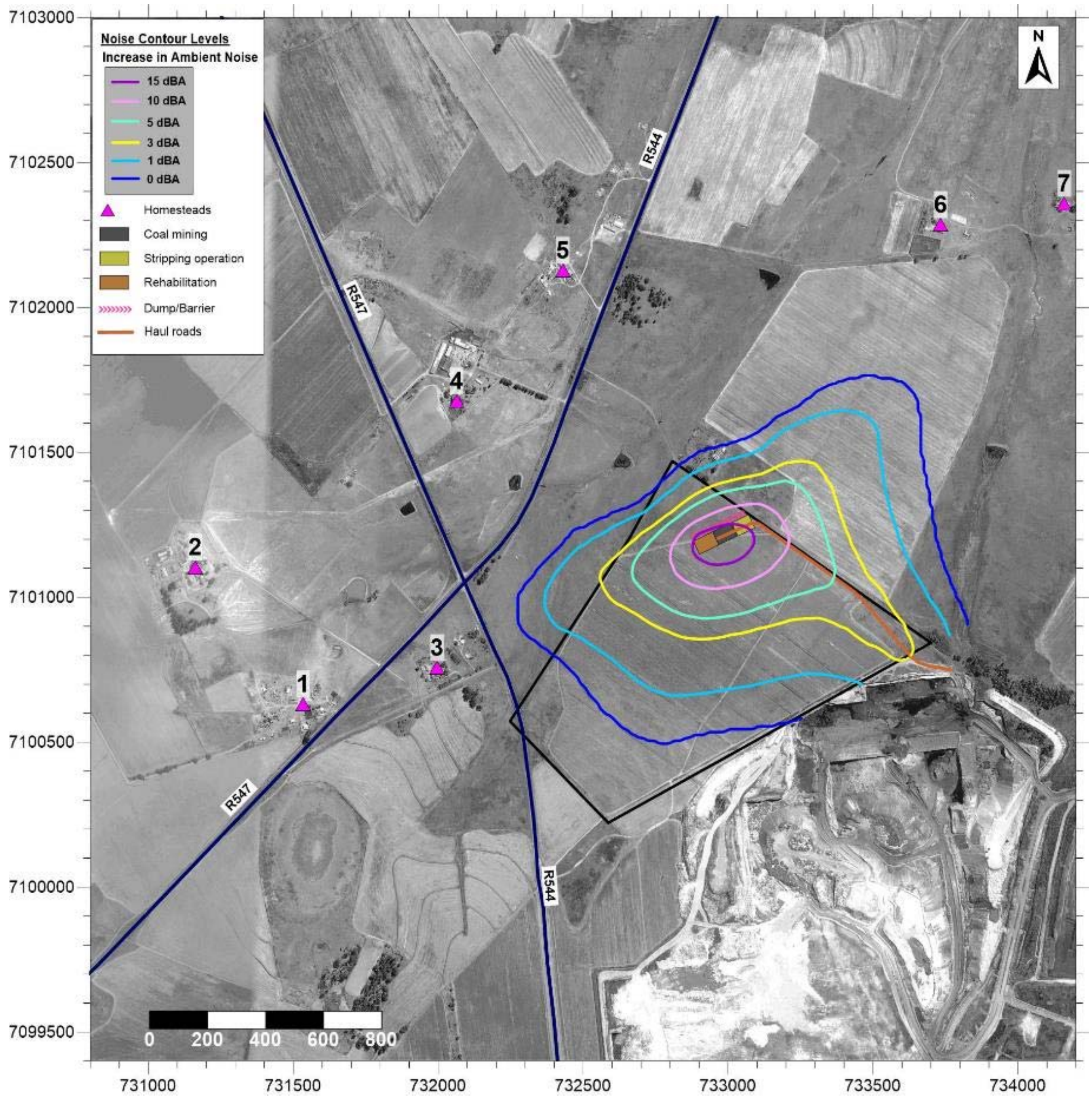

Figure E-8: Option 2: Noise impact expressed in terms of the increase in ambient noise levels during day-time.