Environmental Management Assistance (Pty) Ltd

NOISE STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

Development of the proposed Spitsvale Chromite Mine near Steelpoort, Limpopo Province

Study done for:

Prepared by:

Enviro Acoustic Research

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EXECUTIVE SUMMARY

INTRODUCTION

Enviro-Acoustic Research cc (EARES) was commissioned by Environmental Management Assistance (Pty) Ltd (also referred to as EMA or the main consultant) to determine the potential noise impact on the surrounding environment due to the development of the proposed Spitsvale Chromite Mine. BCR Minerals (Pty) Ltd (the developer) proposes an open cast truck and shovel mine near the town of Steelpoort, Limpopo Province.

This report describes the Noise Rating Levels and potential noise impact that the operation of the development may have on the surrounding receptors sound environment, highlighting the methods used, potential issues identified, findings and recommendations.

Project Overview

The developer proposes to mine open cast chromite mineral body by means of a typical open cast truck and shovel method. The existing operations will not be investigated as it is too far from any receptors, nor is it within the scope of works. A workshop and weigh-bridge is proposed for the project which will be investigated.

BASELINE

Receptors

Residential areas and potential noise-sensitive developments/receptors were identified using tools such as Google Earth® with the areas up to a distance of 1,000m from closest project boundary. This was supported by a site visit to confirm the status of the identified dwellings. Eight receptors in the study area were numbered from NSD01 to NSD08.

NSD02 to NSD04 are all houses within a community, the numbers represent the closest dwellings to the project footprint (except for NSD03). NSD03 is an educational facility within the community, namely the Dithamaga Primary School. It must be noted that educational facilities have no special Rating Levels, only indoor design levels. This facility is also only in use during daytime hours (06:00 – 22:00, SANS10103:2008 daytime criteria) and is vacant during the night.

NSD05 to NSD06 are dwellings of Mr. Hendrik Mabelane. NSD07 represents a commercial facility (office) of a developer within the study area. NSD01 is a community in the furthermost norther section of the project footprint, namely the Tubatse community.

Measurements

Ambient sound levels were measured at two locations from the 22nd till 26th October 2015. One class-1 SLMs was used for measurements. The sound level meter would measure "average" sound levels over 10 minutes periods, save the data and start with a new 10 minute measurement till the instrument was stopped.

The measurement locations were numbered from BCR01 to BR02. During site investigations three feasible localities were investigated for longer-term measurements. Where longer-term measurements were not feasible (e.g. 12 hours or longer), shorter term measurements were conducted.

Due to safety limitations of equipment it was selected to implement longer term measurement equipment at the more secure dwelling of Mr. Hendrik Mabelane (NSD05). This measured locality is illustrated as BCR01. The selected measurement localities property had only one singular dwelling adjacent to it. Two communities (represented by NSD01 (Tubatse) and NSD02 – NSD04 in this document) was app. 3km and 700m respectively from measurement locality. The measurement locality would likely be representative of the two communities Rating Level without extraneous noises (community sounds) impacting on measurements. BCR02 was a measured point conducted at the Tubatse community itself.

Summary

Considering the $L_{Aleq,16/8hr}$ daytime and night-time measurements a suburban Rating Level is proposed for the study area. At times during night-time the L_{A90} and impulse setting may have indicated a rural setting, albeit briefly. However considering the entire set of $L_{Aleq,10min}$ set and $L_{Aleq,8hr}$ it is more akin of a suburban area. There is a moderate-high confidence in the ambient sound levels measured and the subsequent Rating Levels determined.

FINDINGS

Investigated Scenario

Assessments done in this document are as recommended by the National/International guidelines and regulations SANS 10103, SANS 10328 and GN R154. The report considers a worst-case scenario, evaluating the potential noise impact during peak hours.

Two phases were investigated and modelled. The construction phase, which entails the stripping of topsoil and overburden at open cast pits. The second phase is the operational, which entails the truck and shovel open cast mining, stockpile maintenance as well as new plant operations.

Conclusion

Considering this approach, there is a risk of a noise impact of medium-high significance during peak construction and operational noise levels and at the Tubatse community (**NSD01**) directly adjacent to the proposed furthermost northern pit. The assessment made use of the SANS 10103:2008 guideline and International Finance Corporation noise limits for residential areas. With proposed mitigation options implemented (see EMP) an acceptable low significance can be achieved.

MANAGEMENT AND MITIGATION OF NOISE IMPACT

Mitigation options

The most important mitigation options recommended would be to limit operations on the open cast pits adjacent to the Tubatse community to daytimes only (during all phases). Berms/barriers need to be constructed along either the noise sources or the receivers. In order for the berms/barriers to successfully act as an acoustical screen specifications indicated in this document mitigation section must be adhered to. Communication between the Tubatse community and the developer need to be implemented and maintained, highlighting the outcome of this study.

Measurements and Audit Programme

An annual Acoustical Measurement & Audit Programme is recommended to be conducted during the construction and operational phase. Measurements should be collected in 10-minute bins over a 48 hour measurement period. Variables and measurement recommended settings to be analysed include L_{AMin}, L_{Aeq}, L_{AMax}, L_{AMin} L_{A10}, L_{A90} and spectral analysis. Noise measurements must be continued as long as there are potential receptors living within 1,000m of the boundaries of the mining operation, or as long as a valid noise complaint is registered.

Feedback regarding noise measurements should be presented to all stakeholders and other Interested and Affected parties in the area. The feedback platform and interval periods should be defined by the developer, with an annual feedback period recommended.

RECOMMENDATIONS

Feedback regarding noise measurements should be presented to all stakeholders and other Interested and Affected parties in the area. The feedback platform and interval periods should be defined by the developer, with an annual feedback period recommended. If the layout of the mine changes significantly (or assumptions change) used in this report, that this Environmental Noise Impact Assessment be reviewed with the appropriate information supplied by the developer, including:

- Locality of the noise source;
- Operational time of the noise source; and
- If possible specifications regarding the noise source

CONTENTS OF THE SPECIALIST REPORT – CHECKLIST

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6	Cross-reference in this report
(a) details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	**Section 14**
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**Section 15**
(c) an indication of the scope of, and the purpose for which, the report was prepared;	**Section 1.1**
(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	**Section 3.1**
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	**Section 1.5**
(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	**Sections 3.2** and **Section 4**
(g) an identification of any areas to be avoided, including buffers;	**Section 10** and **Figure 10-1**
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	**Section 10** and **Figure 10-1**
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**Section 7**
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	**Sections 9** and **Section 10**
(k) any mitigation measures for inclusion in the EMPr;	**Section 10, Section 11** and **Section 12**
(l) any conditions for inclusion in the environmental authorisation;	**Section 11** and **Section 12**
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	**Section 12**
(n) a reasoned opinion— i. as to whether the proposed activity or portions thereof should be authorised; and ii. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	i. **Section 13** ii. **Section 11**
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None received, **Section 1.4**
(p) any other information requested by the competent authority	Nothing requested

Report should be sited as:

De Jager, M. (2015). "*Noise Study for Environmental Impact Assessment: Development of the proposed Spitsvale Mine near Steelpoort, Limpopo Province*", Enviro-Acoustic Research cc, Pretoria

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GLOSSARY OF ABBREVIATIONS

ADT	Average Day Traffic
App	Approximately
AZSL	Acceptable Zone Sound Level (Rating Level)
c/o	care off
CRN	Calculation of Railway noise
CWR	Continuous welded rails
dB	Decibel
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
DEDEA	Department of Economic Development and Environmental Affairs
e.g.	for example
EAP	Environmental Assessment Practitioner
EARES	Enviro-Acoustic Research cc
ECA	Environment Conservation Act, 1989 (Act No 78 of 1989)
ECO	Environmental Control Officer
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
ENIA	Environmental Noise Impact Assessment
ENPAT	Environmental Potential Atlas
EP	Equator Principle
EPFI	Equator Principle Financial Institutions
Etc.	etcetera / and so forth
F	Fast setting
GN	Government Notice
Hz	Hertz
I	Impulse setting
I&AP(s)	Interested and Affected Party(ies)
i.e.	that is
IEC	International Electrotechnical Commission
IEM	Integrated Environmental Management
IFC	International Finance Corporation
In/sec	inches per second
Kg/m^2	kilogram per square meter
km/h	kilometres per hour
m	Meters

m/s	Meters per second
m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
mm	millimetre
NCR	Noise Control Regulations (under Section 25 of the ECA)
NEMA	National Environmental Management Act, 1998 (Act No 107 of 1998)
NGO	Non-government Organisation
NR	Noise Reduction
NSD	Noise-Sensitive Development
p/d	per day
PPE	Personal Protective Equipment
PPP	Public Participation Process
PPV	Peak Particle Velocity
Rpm	Revolutions per minute
RSA	Republic of South Africa
ROM	Run of Mine
SABS	South African Bureau of Standards
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
SR	Significance rating
t	Time
tpm	Tons per month
TOR	Terms of Reference
USA	Unites States of America
UTM	Universal Transverse Mercator
VCI	Visual Condition Index
VdB	Vibration decibels
vs.	versus
WHO	World Health Organisation

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research cc (EARES) was commissioned by Environmental Management Assistance (Pty) Ltd (also referred to as EMA or the main consultant) to determine the potential noise impact on the surrounding environment due to the development of the proposed Spitsvale Chromite Mine. BCR Minerals (Pty) Ltd (the developer) proposes an open cast truck and shovel mine near the town of Steelpoort, Limpopo Province. This report describes the Noise Rating Levels and potential noise impact that the operation of the development may have on the surrounding receptors sound environment, highlighting the methods used, potential issues identified, findings and recommendations.

This report only briefly discusses the basic principles of potential noise impacts on wildlife as well as vibrations and sound issues due to blasting. The Terms of Reference (TOR) for this study is in the guidelines and regulations of SANS 10103:2008, 10328:2008 and GN R157 (Noise Control Regulations).

1.2 BRIEF PROJECT DESCRIPTION

1.2.1 Project Overview

The developer proposes to mine open cast chromite mineral body by means of a typical open cast truck and shovel method. The existing operations will not be investigated as it is too far from any receptors, nor is it the scope of works. A workshop and weigh-bridge is proposed for the project and will be investigated. The farm/portions of the project in its regional setting presented **Figure 1-1**[1].

1.2.2 Transportation of ore

Run of Mine (ROM) will be hauled via an unpaved haul route linking proposed open cast pits to the Spitsvale site. From there onwards it will be hauled via existing public routes to markets or preferred destination.

1.3 STUDY AREA

The study area (refer to **Figure 1-2**) concerns a number of dwellings or potential noise-sensitive receptors in the vicinity of the proposed development. The study area is further

[1] Farms only for representation purpose, source ENPATS

described in terms of environmental components that may contribute or change the sound character in the area.

1.3.1 Topography

ENPAT[2] (1998) describes the topography as *“low mountains”*. The project footprint is based on the foot or slope of a mountain.

1.3.2 Surrounding Land Use

Much of the surrounding area is of residential nature. Residential areas are based within the study area, these dwellings and communities are discussed in **Section 3** in more detail. No significant land use besides communities (farming, industries besides the Spitsvale operations) exists within 1,000m of the project footprint. The existing Spitsvale operations are based within 800m of the most southern pit.

Telephonically discussions with the Tubatse Local Municipality Town Planning department (Ms. Mogadime Department of Health) indicated there is no special legislation regarding controlled areas or Rating Levels within the study area. No discussions with the Environmental Affairs were sought.

1.3.3 Roads and Railway lines

The only existing road with any calculable acoustics is the R555 (presumably rural class 3, district distributor, single lanes in alternative directions) paved regional route. This route was not further investigated as it is well outside the study area at app. 8 km.

Many smaller single carriage paved roads exist in the study area, these secondary roads may not carry sufficient traffic to warrant considering their calculable contribution to the surrounding ambient soundscape. No industrial or commuting railway networks are within the study area.

1.3.4 Ground conditions and vegetation

The surrounding area consists of the Grassland and Savanna biomes, with the vegetation type been *“Sourish Mixed Bushveld”*. Taking into consideration available information it is the opinion of the author that the ground conditions (when considering acoustic propagation on a ground surface) can be classified as medium to medium-hard, which implies that it is only moderately acoustically absorbent. It should be noted that this factor is only relevant for

[2] Van Riet, W. Claassen, P. van Rensburg, J. van Viegen & L. du Plessis, “*Environmental Potential Atlas for South Africa*”, Pretoria, 1998.

air-borne waves being reflected from the ground surface, with certain frequencies slightly absorbed by the vegetation.

1.3.5 Potential Sensitive Receptors

Residential areas and potential noise-sensitive developments/receptors were identified using tools such as Google Earth® with the areas up to a distance of 1,000[3] m from closest project boundary (as illustrated in **Figure 1-2**). This was supported by a site visit to confirm the status of the identified dwellings. Eight receptors in the study area were numbered from NSD01 to NSD08.

The reason for the site visit, apart from measuring ambient sound levels was to confirm the presence/existence of derelict or abandoned dwellings that could possibly be seen as sensitive receptors, small dwellings that could not be identified on the aerial image and dwellings that might have been constructed after the date of the aerial photograph. The status of the building (derelict, commercial, industrial or residential) needed to be established as well.

Localities of receptors are further defined in **Appendix C** in latitude and longitude co-ordinates (WGS84). NSD02 to NSD04 are all houses within a community, the numbers represent the closest dwellings to the project footprint (except for NSD03). NSD03 is an educational facility within the community namely the Dithamaga Primary School.

It must be noted that educational facilities have no special Rating Levels, only indoor design levels. This facility is also only in use during daytime hours (06:00 – 22:00, SANS10103:2008 daytime criteria) and is vacant during the night.

NSD05 to NSD06 are dwellings of Mr. Hendrik Mabelane. NSD07 represents a commercial facility (office) of a developer within the study area. NSD01 is a community in the furthermost norther section of the project footprint, namely the Tubatse community.

1.4 AVAILABLE INFORMATION

The available information available includes a host of previous reports conducted by Enviro Acoustics as well as public domain online resources. These are also presented in **Table 1-1** below.

[3] SANS 10328:2008. *Methods for environmental noise impact assessments*. Pg. 13, Sometimes receptors are outside this criteria and are only identified for reference purpose.

Table 1-1: Available Reports/information

Date	Report/source
2013	De Jager, M. *“Noise Study for Environmental Impact Assessment: Development of the proposed Greater Soutpansberg Chapudi Project, Limpopo”.*
2013	De Jager, M. *“Development of the proposed Generaal and Mount Stuart Collieries, Limpopo Province”.*
2013	De Jager, M. *“Noise Study for Environmental Impact Assessment: Development of the proposed Greater Soutpansberg Mopane Project, Limpopo”*
Unknown	BCR Minerals (Pty) Ltd. Mining Works Programme.
2015	Specialist Inception Meeting minutes.
2015	Information requirements: Steelpoort Chrome Mine. ITS Engineers.

No specific comments during Public Participations have been received for this report regarding noise. During the inception meeting held (and subsequent minutes of meeting) the shifts indicated that operations will occur directly up to the night-time hours (as per SANS10103:2008) of 22h00. However a night-time scenario will be investigated as not only is the shift right up to the night-time criteria, it may be required to work late depending on work load etc..

1.5 TERMS OF REFERENCE

A noise impact assessment must be completed for the following reasons:

- if an industry is to be situated within 1, 000 m of a noise-sensitive development (SANS 10328:2008);
- It is a controlled activity in terms of the NEMA regulations and a ENIA is required, because:
  - o It may cause a disturbing noise that is prohibited in terms of section 18(1) of the Government Notice 579 of 2010;
- It is generally required by the local or district authority as part of the environmental authorization or planning approval in terms of Regulation 2(d) of GN R154 of 1992.

In addition, Appendix 6 of GN 982 of December 2014 (Gov. Gaz. 38282), issued in terms of the National Environmental Management Act, No. 107 of 1998 also defines minimum information requirements for specialist reports.

In South Africa the document that addresses the issues specifically concerning environmental noise is SANS 10103:2008. It has recently been thoroughly revised and brought in line with the guidelines of the World Health Organisation (WHO). It provides the maximum average ambient noise levels during the day and night to which different types of developments indoors may be exposed.

In addition, SANS 10328:2008 (Edition 3) specifies the methodology to assess the potential noise impacts on the environment due to a proposed activity that might impact on the environment. This standard also stipulates the minimum requirements to be investigated for Scoping purposes. These minimum requirements are:

1. The purpose of the investigation;
2. A brief description of the planned development or the changes that are being considered;
3. A brief description of the existing environment;
4. The identification of the noise sources that may affect the particular development, together with their respective estimated sound pressure levels or sound power levels (or both);
5. The identified noise sources that were not taken into account and the reasons why they were not investigated;
6. The identified noise-sensitive developments and the estimated impact on them;
7. Any assumptions made with regard to the estimated values used;
8. An explanation, either by a brief description or by reference, of the methods that were used to estimate the existing and predicted rating levels;
9. The location of the measurement or calculation points, i.e. a description, sketch or map;
10. Estimation of the environmental noise impact;
11. Alternatives that were considered and the results of those that were investigated;
12. A list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
13. A detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them;
14. Conclusions that were reached;
15. Recommendations, i.e. if there could be a significant impact, or if more information is needed, a recommendation that an environmental noise impact assessment be conducted; and
16. If remedial measures will provide an acceptable solution, which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after a certain time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority.

Furthermore the SANS 10328:2008 and Noise Control Regulations defines a noise sensitive development as:

a) 'residential districts;
b) non-residential districts;
c) educational, residential, office and health care buildings and their surroundings;
d) churches and their surroundings;
e) auditoriums and concert halls and their surroundings; and
f) recreational areas'.

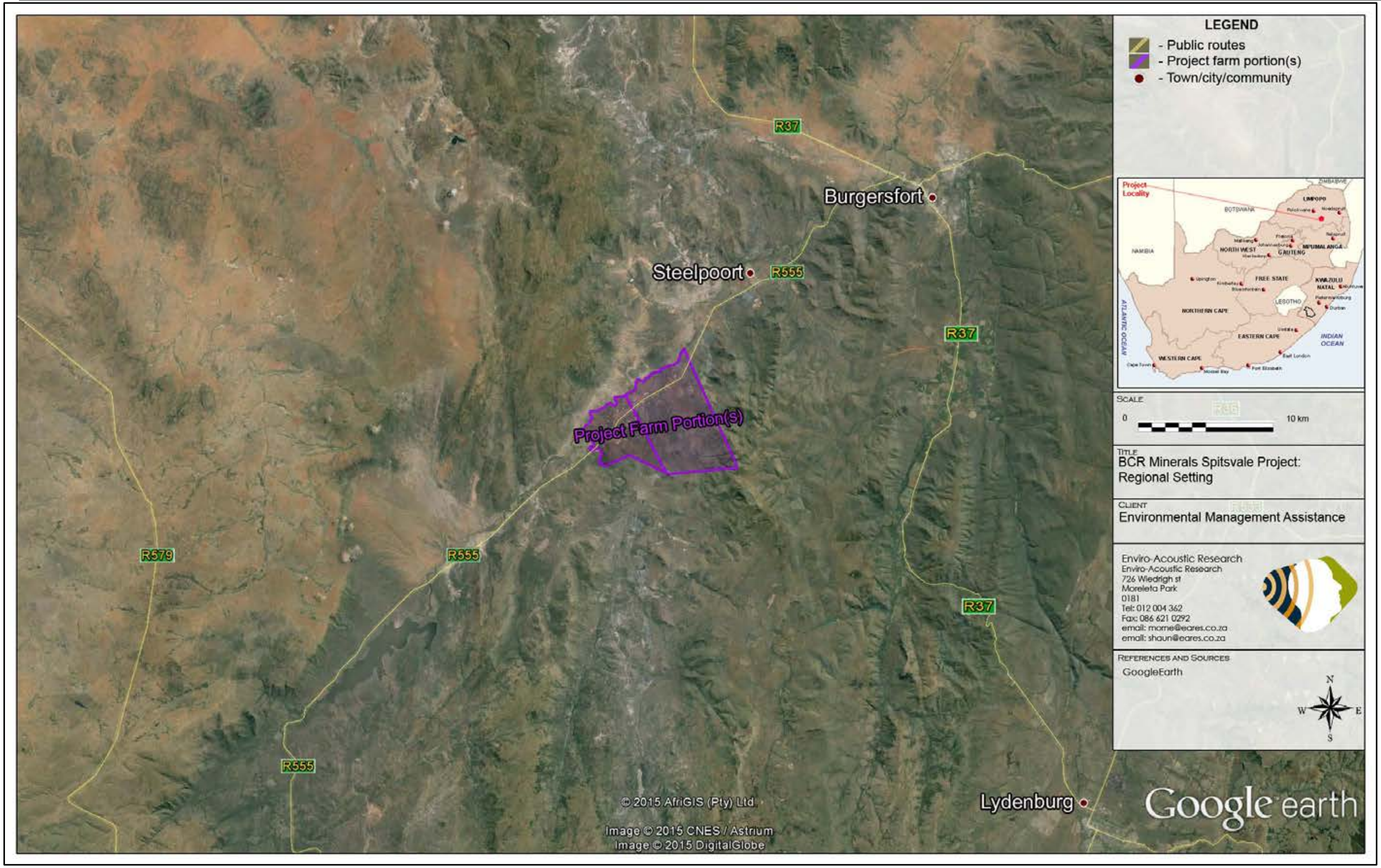

Figure 1-1: Site map indicating the farm / portions of the proposed development

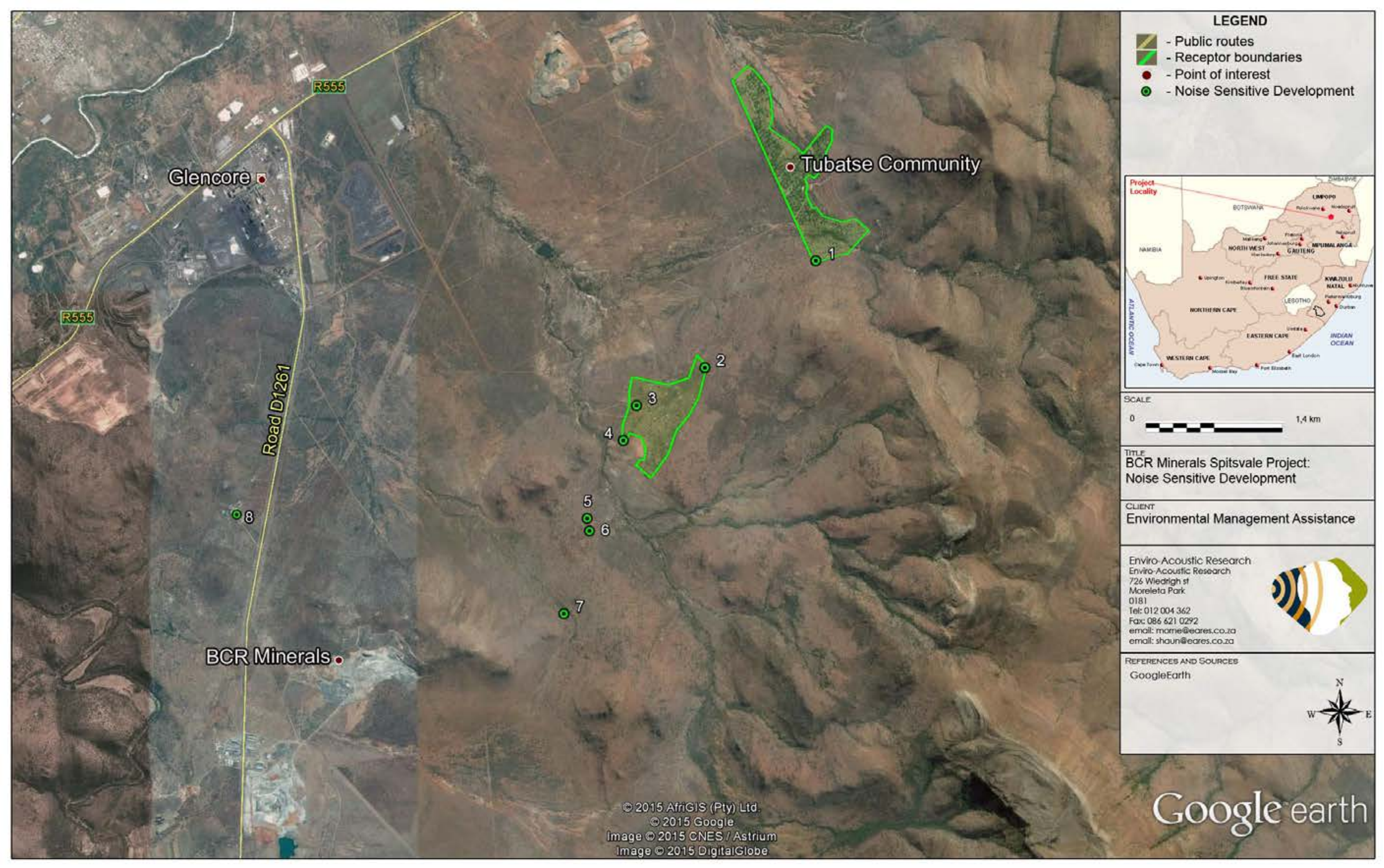

Figure 1-2: Study area potential noise-sensitive developments or receptors

2 LEGAL CONTEXT, POLICIES AND GUIDELINES

2.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION ACT ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see **Section 2.5**).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

2.2 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. See also **section 2.2.1**.

2.2.1 National Noise Control Regulations (GN R154 of 1992)

In terms of section 25 of the ECA, the national Noise Control Regulations (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exists in the Free State, Gauteng and Western Cape provinces.

The National Noise Control Regulations (GN R154 1992) defines:
"**controlled area**" as:

a piece of land designated by a local authority where, in the case of--

a) Road transport noise in the vicinity of a road-

i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65 dBA; or
ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period e, exceeds 65 dBA;

c) Industrial noise in the vicinity of an industry-
i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or
ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

"**disturbing noise**" as:
noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more.

"**zone sound level**" as:
a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is the same as the Rating Level as defined in SANS 10103.

In addition:
In terms of Regulation 2 -
"A local authority may –
(c):" if a noise emanating from a building, premises, vehicle, recreational vehicle or street is a disturbing noise or noise nuisance, or may in the opinion of the local authority concerned be a disturbing noise or noise nuisance, instruct in writing the person causing such noise or who is responsible therefor, or the owner or occupant of such building or premises from which or from where such noise emanates or may emanate, or all such persons, to discontinue or cause to be discontinued such noise, or to take steps to lower the lever of the noise to a level conforming to the requirements of these Regulations within the period stipulated in the instruction: Provided that the provisions of this paragraph shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles;
(d): before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests

are conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings or that, for the purposes of regulation 3(b) or (c), reports or certificates in relation to the noise impact to the satisfaction of that local authority are submitted by the owner, developer, tenant or occupant to the local authority on written demand";

In terms of Regulation 4 of the Noise Control Regulations:
"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof".

Clause 7.(1) however exempts noise of the following activities, namely -
"The provisions of these regulations shall not apply, if -
(a) the emission of sound is for the purposes of warning people of a dangerous situation;
(b) the emission of sound takes place during an emergency."

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include the following measures:

1. to investigate, assess and evaluate the impact on the environment
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed to avoid causing significant pollution or degradation of the environment
3. to cease, modify or control any act, activity or process causing the pollution or degradation
4. to contain or prevent the movement of the pollution or degradation
5. to eliminate any source of the pollution or degradation
6. to remedy the effects of the pollution or degradation

In addition, Appendix 6 of GN 982 of December 2014 (Gov. Gaz. 38282), issued in terms of this Act, have general requirements for EAPs and specialists. It also defines minimum information requirements for specialist reports.

2.3.1 Appendix 6 of GN 982 of December 2014 (Gov. Gaz. 38282)

These regulations define the required information to compile a specialist report. Chapter 4, Part 2 highlights this in section (8) *"A specialist report must contain all information set out in Appendix 6 to these Regulations".* These requirements are further defined as:

Appendix 6

"Specialist reports

1. (1) A specialist report prepared in terms of these Regulations must contain-

(a) details of-

(i) the specialist who prepared the report; and

(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;

(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;

(c) an indication of the scope of, and the purpose for which, the report was prepared;

(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;

(e) a description of the methodology adopted in preparing the report or carrying out them specialised process;

(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;

(g) an identification of any areas to be avoided, including buffers;

(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;

(i) a description of any assumptions made and any uncertainties or gaps in knowledge;

(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;

(k) any mitigation measures for inclusion in the EMPr;

(l) any conditions for inclusion in the environmental authorisation;

(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;

(n) a reasoned opinion-

(i) as to whether the proposed activity or portions thereof should be authorised; and

(ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;

(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;

(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and

(q) any other information requested by the competent authority.

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT ("AQA" – ACT 39 OF 2004)

Section 34 of the National Environmental Management: Air Quality Act (Act 39 of 2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise

(ii) the maximum levels of noise

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

This section of the Act is in force, but no such standards have yet been promulgated. Draft regulations have however, been promulgated for adoption by Local Authorities.

An atmospheric emission licence issued in terms of section 22 may contain conditions in respect of noise.

2.4.1 Model Air Quality Management By-law for adoption and adaptation by Municipalities (GN 579 of 2010)

Model Air Quality Management By-Laws for adoption and adaptation by municipalities was published by the Department of Water and Environmental Affairs in the Government Gazette of 2 July 2010 as Government Notice 579 of 2010. The main aim of the model air quality management by-law is to assist municipalities in the development of their air quality management by-law within their jurisdictions. It is also the aim of the model by-law to ensure uniformity across the country when dealing with air quality management challenges. Therefore, the model by-law is developed to be generic to deal with most of the air quality management challenges. With Noise Control being covered under the Air Quality Act (Act 39 of 2004), noise is also managed in a separate section under this Government Notice.

- **IT IS NOT** the aim of the model by-law to have legal force and effect on municipalities when published in the Gazette; and

- **IT IS NOT** the aim of the model by-law to impose the by-law on municipalities.

Therefore, a municipality will have to follow the legal process set out in the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000) when adopting and adapting the model by-law to its local jurisdictions.

2.5 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from developments, industry and roads. They are:

- SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
- SANS 10210:2004. 'Calculating and predicting road traffic noise'.
- SANS 10328:2008. 'Methods for environmental noise impact assessments'.
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method'.
- SANS 10181:2003. 'The Measurement of Noise Emitted by Road Vehicles when Stationary'.
- SANS 10205:2003. 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se.*

It must be noted that SANS 10103:2008 does stipulate *"for industries legitimately operating in an industrial district during the entire 24 h day/night cycle,* $L_{Req,d}$ = $L_{Req,n}$ *=70 dBA can be considered as typical and normal".*

2.5.1 Typical Attenuation of outside noises through building structure

Note 3 of Table 2 of SANS10103:2008 standard states that "*In districts where outdoor* $L_{R,dn}$ *exceeds 55 dBA, residential buildings (e.g. dormitories, hotel accommodation and residences) should preferably be treated acoustically to obtain indoor* $L_{Req,T}$ *values in line with those given in table 1.*"

When noise enters a building from the outside, it undergoes a reduction in level defined as the Noise Reduction (NR). The amount of NR obtained depends on the type of material used for the walls of the building, sizes and material used for windows and doors, the presence of noise leaks such as ventilation openings and the amount of acoustically-absorptive material inside the building. Noise Reduction can be measured directly or it may be calculated. The calculation of NR is however a complex process and need to consider all the elements where noise can enter a building and is a separate field from Environmental Acoustics (Architectural or Structural Acoustics).

Section 4.2.3 of SANS 10103:2008 states that a building with natural ventilation (open doors and windows) will provide sound insulation of approximately 10 dBA. This will increase if the wall facing the noise source does not have any openings, windows or doors, with 20 dBA being a conservative value for a double brick wall without any openings. For the purpose of this study a reduction of 20 dBA will be considered.

2.5.2 10103:2008 - Design and maximum rating levels for ambient noise for different areas of occupancy or activity indoors

SANS highlights limits for the design of facilities where indoor noise levels may be caused due to building services (e.g. ventilation systems, air-conditioning systems, lifts, plumbing and lighting. These maximum limits are presented in **Table 2-1** for reverence purpose only. These limits do not necessary apply to the calculated Rating Level as assessed in this document.

Table 2-1: Design and maximum rating levels for ambient noise for different areas of occupancy or activity indoors

Type of occupancy or activity - Residential	Design equivalent continuous rating level for ambient noise (dBA)	Maximum equivalent continuous rating level for ambient noise (dBA)
Living rooms	35	45
Kitchens and service areas	45	55
Bathrooms and toilets	40	55
Bedrooms	30	40
Classrooms	35	40
General office areas	40	45

2.6 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards exists, those selected below are used by numerous countries for environmental noise management.

2.6.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments. It discusses the specific effects of noise on communities including:

- Interference with communication, noise-induced hearing impairment, sleep disturbance effects, cardiovascular and psychophysiological effects, mental health effects, effects on performance, annoyance responses and effects on social behavior.

It further discusses how noise can impact (and propose guideline noise levels) on specific environments such as:

- Residential dwellings, schools and preschools, hospitals, ceremonies, festivals and entertainment events, sounds through headphones, impulsive sounds from toys, fireworks and firearms, and parklands and conservation areas.

To protect the majority of people from being affected by noise during the daytime, it propose that sound levels at outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB L_{Aeq}. At night, equivalent sound levels at the outside façades of the living spaces should not exceed 45 dBA and 60 dBA L_{Amax} so that people may sleep with bedroom windows open.

It is critical to note that this guideline requires the sound level measuring instrument to be set on the “fast” detection setting.

2.6.2 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the World Health Organization has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30 dB inside at night (which equals 45-50 dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40 db to avoid sleep disturbance and its related health effects. The report notes that only below 30 dB (outside annual average) are “*no significant biological effects observed*,” and that between 30 and 40 dB, several effects are observed, with the chronically ill and children being more susceptible; however, “*even in the worst cases the* *effects seem modest*." Elsewhere, the report states more definitively, "*There is no sufficient evidence that the biological effects observed at the level below 40 dB (night, outside) are harmful to health*." At levels over 40 dB "*Adverse health effects are observed*" and "*many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected*."

The 184-page report offers a comprehensive overview of research into the various effects of noise on sleep quality and health (including the health effects of non-waking sleep arousal), and is recommended reading for anyone working with noise issues. The use of an outdoor noise standard is in part designed to acknowledge that people do prefer to leave windows open when sleeping, though the year-long average may be difficult to obtain (it would require longer-term sound monitoring than is usually budgeted for by either industry or neighbourhood groups).

While recommending the use of the average level, the report notes that some instantaneous effects occur in relation to specific maximum noise levels, but that the health effects of these "cannot be easily established."

2.6.3 Equator Principles

The **Equator Principles** (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. Equator Principles Financial Institutions (EPFIs) commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs.

The Equator Principles were developed by private sector banks and were launched in June 2003. The banks chose to model the Equator Principles on the environmental standards of the World Bank (1999) and the social policies of the International Finance Corporation (IFC). Sixty-seven financial institutions (October 2009) have adopted the Equator Principles, which have become the de facto standard for banks and investors on how to assess major development projects around the world. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

2.6.4 IFC: General EHS Guidelines – Environmental Noise Management

These guidelines are applicable to noise created beyond the property boundaries of a development that conforms to the Equator Principle.

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from project facilities/operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling noise from stationary sources is to implement noise control measures at source.

It goes as far as to proposed methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas ;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 2-2**) as well as highlighting the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development.

It is therefore the considered opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

Table 2-2: IFC Table .7.1-Noise Level Guidelines

Receptor type	One hour L_{Aeq} (dBA)	
	Daytime 07:00 - 22:00	Night-time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The document uses the $L_{Aeq,1\ hr}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the IEC standards, which requires the fast detector setting on the Sound Level Meter during measurements in Europe.

2.6.5 National and International Guidelines - Appropriate limits for game parks and wilderness

The United States National Park Services identifies that "intrusive" un-natural sounds are concern for the National Park Services (United States[4]) as many visitors go to parks to enjoy the soundscape (interpreted as natural soundscape). Naturally quiet places will not mean (as per interpretation of the author and available information) that the noise levels in the area will be low but rather that the soundscape contributors are of a natural origin (faunal communication, wind shear, water etc.).

These natural events could include the dawn chorus when songbirds start to sing at the start of a new day or frogs croaking after a rainfall event. Although game park visitors, receptors in "natural" areas and hospitality industries may not seek intrusive un-natural sounds, the operation of the game park/hospitality industry or receptors dwelling itself is source of anthropogenic noise (vehicles, game park electrical and mechanical infrastructure etc.). National Parks do though implement their own guidelines/rules regarding noise created by park visitors.

Natural sounds can contribute a meaningful magnitude[5] to the ambient soundscape depending on season, time, faunal species, habitat and habitat fragmentation etc. Although the magnitude may be loud, natural sounds may contain harmonics[6] and other pleasant sounds that visitors seek when going to parks or wilderness areas.

Certain International states have tried implementing laws regarding external environmental "un-natural" noise sources into areas with natural sounds. In USA there exists numerous state and local laws to encourage industries near parks to keep within limits set out by the local authorities[7]. The United States National Park Service's efforts

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[4] National Park Services, "Soundscape Preservation and Noise Management", 2000, p. 1.
[5] Environ. We Int. Sci. Tech, "Ambient noise levels due to dawn chorus at different habitats in Delhi", 2001, p. 134.
[6] Panatcha Anusasananan, Suksan Suwanarat, Nipon Thangprasert, "Acoustic Characteristics of Zebra Dove in Thailand", p. 4.
[7] E.g. State of Oregon's Environmental Standards for Wilderness Areas

include attempts to reduce the flights over the Grand Canyon due to the introduction of non-natural impulsive noise events at the park.

2.6.6 Environmental Management Systems

Many organisations implement their own Environmental Management Systems tools to for planning, implementing and maintaining policy for environmental protection. The more popular International system is highlighted below.

2.6.6.1 ISO 14000

ISO 14000 is a family of standards related to environmental management that exists to help organizations:

a. minimize how their operations (processes etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land);
b. comply with applicable laws, regulations, and other environmentally oriented requirements, and
c. continually improve in the above.

The term continual improvement refers to an on-going process of performance enhancement. In the context of this environmental standard, it means that you need to enhance your organization's overall environmental performance by enhancing its environmental management system and by improving its ability to manage the environmental aspects of its activities, products, and services. Continual improvements can be achieved by carrying out internal audits, performing management reviews, analyzing data, and implementing corrective and preventive actions.

2.6.7 European Parliament Directive 200/14/EC

Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors was adopted by the European Parliament and the Council and first published in May 2000. The Directive was applied from January 3rd, 2002. The directive placed sound power limits on equipment to be used outdoors in a suburban or urban setting. Failure to comply with these regulations may result in products being prohibited from being placed on the EU market. Equipment list is vast and includes machinery such as compaction machineries, dozers, dumpers excavators etc. Manufacturers as a result started to consider noise emission levels from their products to ensure that their equipment will continue to have a market in most countries

3 CURRENT ENVIRONMENTAL SOUND CHARACTER

3.1 MEASUREMENT PROCEDURE

Ambient (background) noise levels were measured at appropriate times in accordance with the South African National Standard SANS 10103:2008 "***The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication***". The standard specifies the acceptable techniques for sound measurements including:

- type of equipment (Class 1);
- minimum duration of measurement;
- microphone positions and height above ground level;
- calibration procedures and instrument checks; and
- supplementary weather measurements and observations.

3.2 AMBIENT SOUND LEVEL MEASUREMENTS

Ambient sound levels were measured at two locations from the 22nd till 26th October 2015. One class-1 SLMs was used for measurements. The sound level meter would measure "average" sound levels over 10 minutes periods, save the data and start with a new 10 minute measurement till the instrument was stopped.

The measurement locations were numbered from BCR01 to BR02 (see **Appendix C** for measurement location in UTM, latitude and longitude). During site investigations three feasible localities were investigated for longer-term measurements. Where longer-term measurements were not feasible (e.g. 12 hours or longer), shorter term measurements were conducted.

Due to safety limitations of equipment it was selected to implement longer term measurement equipment at the more secure dwelling of Mr. Hendrik Mabelane (NSD05). This measured locality is illustrated as BCR01. The selected measurement localities property had only one singular dwelling adjacent to it. Two communities (illustrated by NSD01 (Tubatse) and NSD02 – NSD04 in this document) was app. 3km and 700m respectively from measurement locality. The measurement locality would likely be representative of the two communities Rating Level without extraneous noises (community sounds) impacting on measurements. BCR02 was a measured point conducted at the Tubatse community itself.

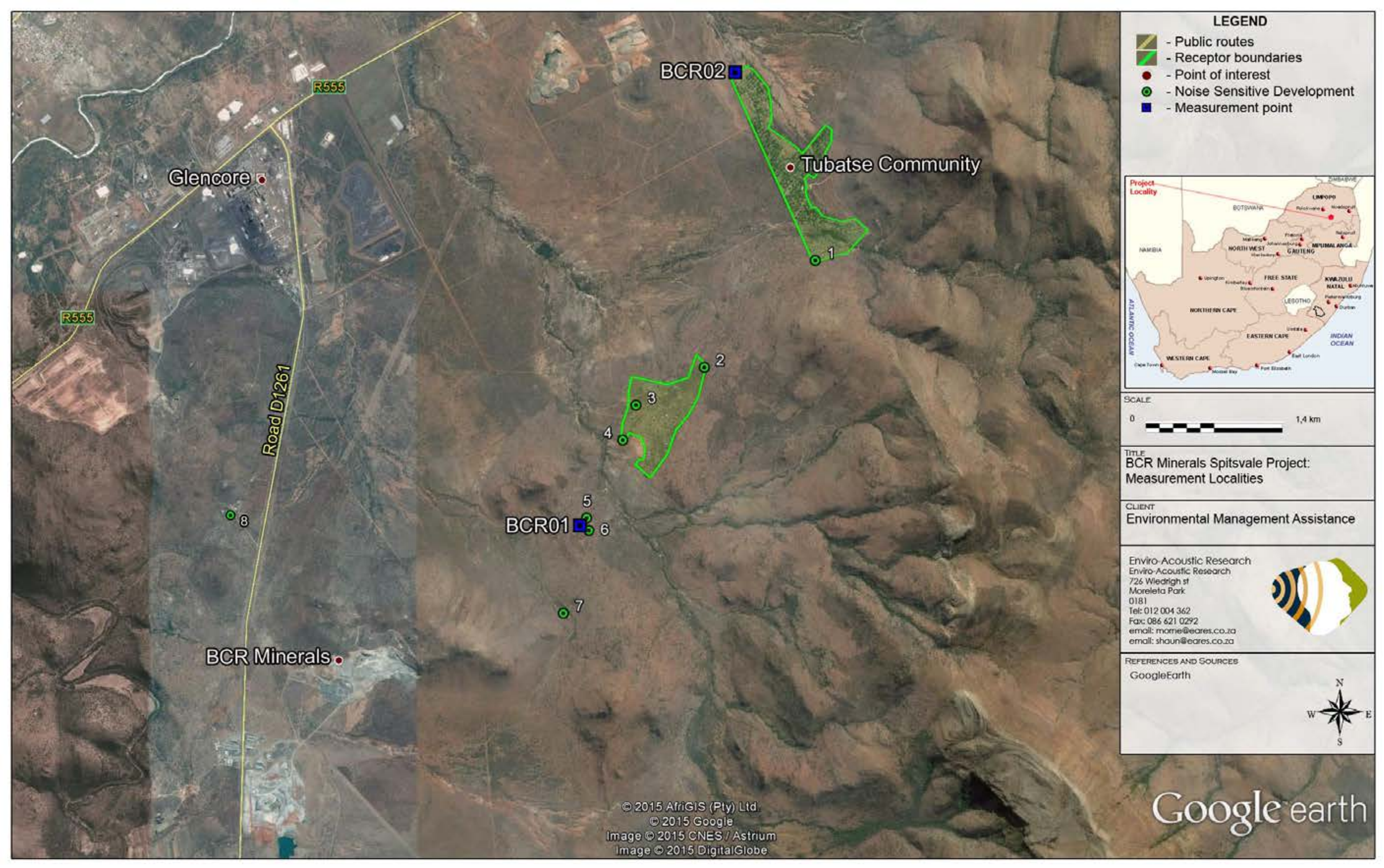

Figure 3-1: Localities of ambient sound level measurements

3.2.1 Measurement Point BCR01: Mabelane homestead (c/o Mr. Hendrik Mabelane)

A number of 10 minute measurements were taken over a day/night period from the 22nd till 26th October 2015. The equipment defined in **Table 3-1** was used for gathering data. Measured sound levels are presented in **Figure 3-2** - **Figure 3-4**.

Table 3-1: Equipment used to gather data (SVAN 977)

Equipment	Model	Serial no	Calibration Date
SLM	Svan 977	34160	May 2015
Microphone	ACO 7052E	54645	May 2015
Calibrator	B & K	1558840	January 2015

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The measurement location was selected to be reflective of the environmental ambient sound levels of the communities and dwellings at NSD01 – NSD06. Various localities on the property footprint were investigated. Selected locality was at the back of the property to minimise dwelling related noises. A cattle kraal was on the opposite side of the dwelling. Refer to **<u>Appendix B</u>** for a photo of this measurement location.

3.2.1.1 Impulse Setting

Impulse equivalent sound levels (South African legislation): Figure 3-2 illustrates the 10 minute equivalent values. During the daytime $L_{Aeq,10min}$ values ranged between 29.7 to 92.4 dBA. The night-time $L_{Aeq,10min}$ values ranged between 27.4 to 92.5 dBA. The average value of the 377 10-minute equivalent daytime sound level measurements were calculated at 48.7 dBA, while the average for the 192 night-time measurements were calculated at 39.8 dBA.

$L_{Aeq,16hr}$ day and $L_{Aeq,8hr}$ night: Figure 3-2 illustrates the calculated $L_{Aeq,8h/16hr}$ values (or equivalent). The daytime $L_{Aeq,16hr}$ values was calculated each day in chronological order as 54.1, 51.7, 51.7, 53.0 and 76.5 dBA (first and last not the entire 16 hr. periods). The night-time $L_{Aeq,8hr}$ values were calculated as 75.7, 51.5, 42.5 and 43.9 dBA.

The first night and last day's equivalent values were influenced by a noise event (described by the L_{Max} descriptor). The same first event influenced the $L_{Aeq,24hr}$ discussed further below. The source of these two events will be further investigated in the spectral section.

$L_{Aeq,24hr}$ (till 24:00) calculated values[8]: Figure 3-2 illustrates the calculated $L_{Aeq,24hr}$ value. The $L_{aeq,24h}$ level is for referenced purpose as per the Noise Control Regulations. The 24 hour periods were calculated in chronological order as 54.0, 70.9, 50.3 and 51.5 dBA.

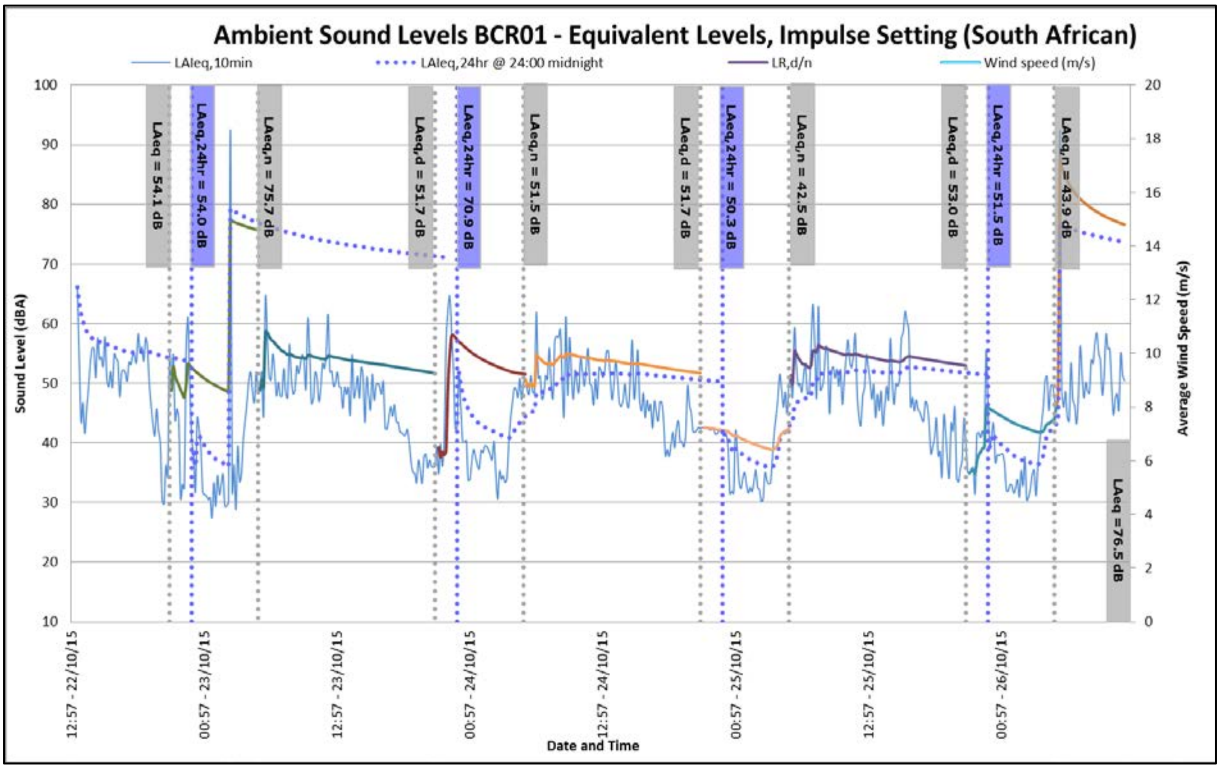

Figure 3-2: Ambient Sound Levels (Impulse) at AG01

3.2.1.2 Fast Setting

Fast equivalent sound levels (International guidelines): Equivalent (average) sound levels for the day, evening and night-time periods are shown in **Figure 3-3**. During the daytime $L_{Aeq,10min}$ values ranged between 34.1 to 59.8 dBA. The evening $L_{Aeq,10min}$ values ranged between 27.4 to 55.3 dBA. The night-time $L_{Aeq,10min}$ values ranged between 25.0 to 88.7dBA. The average value of the 281 10 min. equivalent daytime measurements were calculated at 44.4 dBA, the average for the 96 evening measurements were calculated at 37.0 dBA while the 192 10 min. equivalent night-time measurements were calculated at 36.3 dBA.

L_{day}, $L_{evening}$ and L_{night} (ISO/European Union and IFC: General EHS Guidelines): Figure 3-3 illustrates the calculated **L_{day}, $L_{evening}$** and **L_{night}:** European Union Noise Indices. The L_{day} value was calculated in chronological order as 48.9, 45.4, 46.3, 48.1, 42.4 and 45.0 dBA (first and last not entire 12 hr. periods). The $L_{evening}$ values were

[8] Noise Control Regulations (NCR)

calculated as 47.5, 36.4, 41.5 and 34.0 dBA. The L_{night} values were calculated as 71.9, 43.6, 40.8 and 71.2 dBA.

As is the case with the Impulse setting the Fast setting data was influenced by a maximum event, albeit during first and last night.

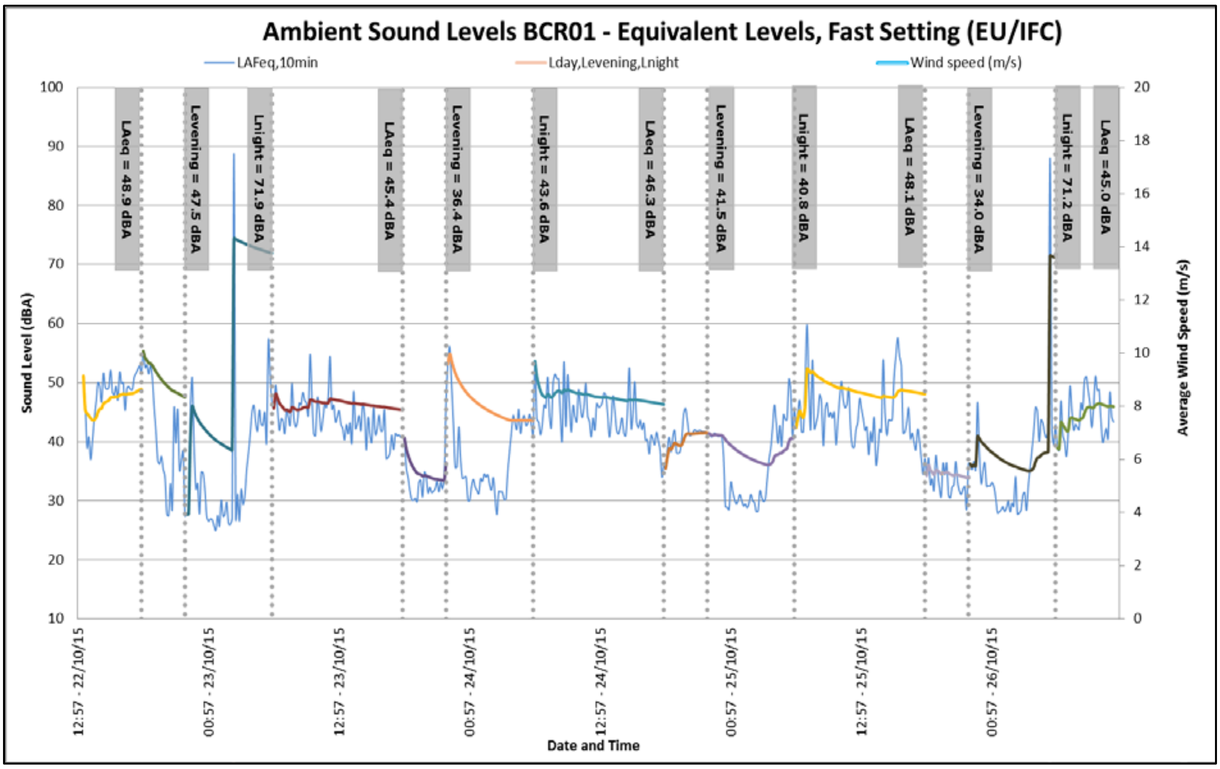

Figure 3-3: Ambient Sound Levels (Fast) at AG01

3.2.1.3 Statistical values, RMS and metrological data

Metrological conditions: Due to equipment malfunction metrological data was not measured.

Sounds heard during deployment and collection of equipment: Refer to **Table 3-2** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-2: Noises/sounds heard during site visits at receptors AG01

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible Audible Dominating	**Faunal and Natural:** Bird call and wind.
	Residential and other Anthropogenic: Dwelling comunication.
	Industries, Commercial and Road Traffic: None

Statistical sound levels ($L_{A90,10min}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-4**.

L_{A90} daytime values ranged from 24.3 to 50.7 dBA90. The night-time L_{A90} values ranged from 22.1 to 40.6 dBA90. The average value of the 377 10 min. equivalent daytime measurements was calculated at 32.7 dBA90, while the average for the 192 night-time measurements were calculated at 27.1 dBA90.

L_{A90} levels indicate that at times during the dead-off-night the background ambient soundscape would become moderately quiet with little consistent continuous sounds in the area.

Maximum noise levels ($L_{Amax,10min}$) RMS: Maximum sound levels are illustrated on **Figure 3-4** with the loudest day sound measured at 116.4 dBA (averaged 61.4 dBA), while night-time loudest sound measured at 115.7 dBA (averaged 50.5 dBA).

At times $L_{Aeq,10min}$ and levels were influenced by maximum noise events (both magnitude and number events). During the night-times L_{Amax} levels sometimes exceeded 65 dBA (during the 10 minute measurements) where amount of noise events and magnitude may become an annoyance when a peaceful time or rest is sought.[9]

Minimum noise levels ($L_{Amin,10min}$) RMS: Minimum noise levels are illustrated on **Figure 3-4** with the quietest sounds measured during the day at 23.3 dBA (averaged 29.2 dB), while night-time quietest was measured at 20.8 (averaged 25.2 dBA). It illustrates an area that can become quiet during the night.

[9] World Health Organization, 2009, '*Night Noise Guidelines for Europe.*

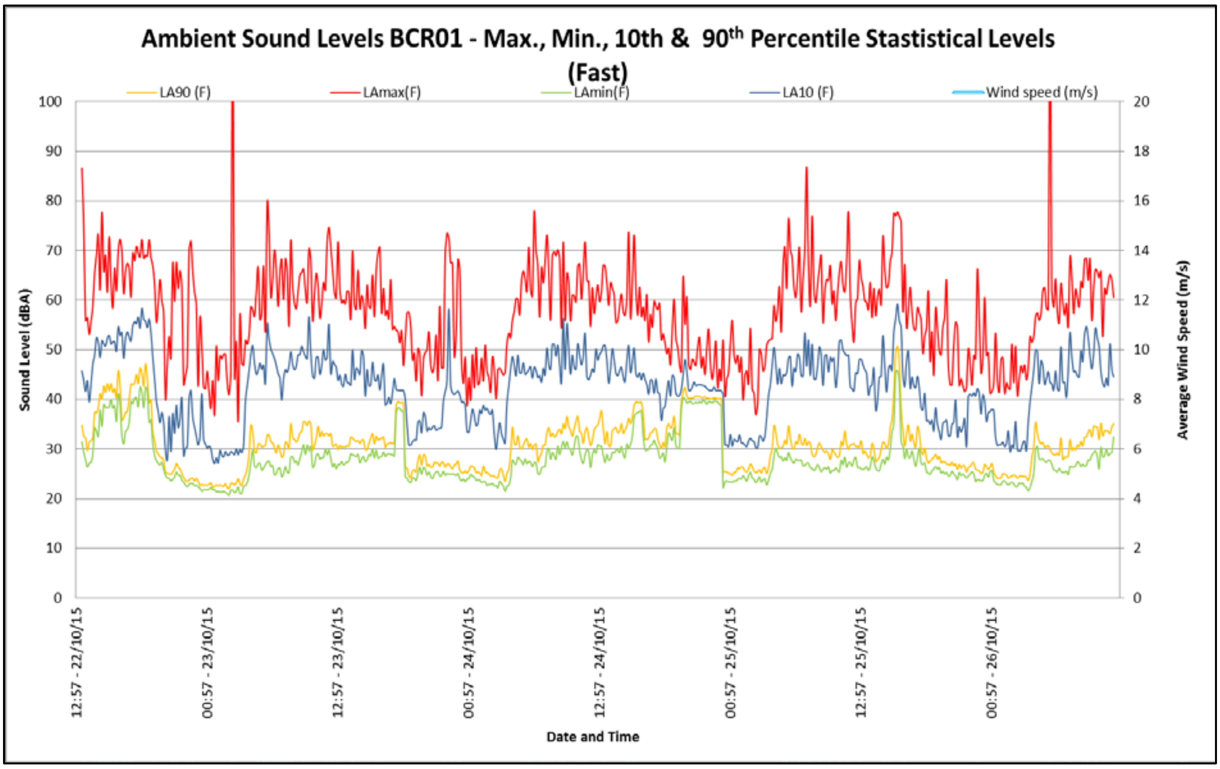

Figure 3-4: Maximum, minimum and statistical values at AG01

3.2.1.4 Third Octave Frequencies

Third octave frequencies (Figure 3-5 - Figure 3-6):

Lower frequencies (20 – 250 Hz, although low frequency is 100 Hz or below): This frequency band is generally dominated by noises originating from anthropogenic activities (vehicles idling and driving, pumps and motors, etc.) as well as certain natural phenomena (wind shear, ocean surf splash etc.). Motor vehicle engine revolutions per minute (1000 - 6000 rpm[10]) mostly convert to this range of frequency. Lower frequencies (above infrasound etc.) also have the potential to propagate much further than the higher frequencies due to atmospheric corrections.

The 10 min daytime measurement indicated some peaks and troughs in this range, at times elevated linear negative regression in fashion.

Third octave surrounding 1000 Hz: This range contains energy mostly associated with human speech (350 Hz – 2,000 Hz; mostly below 1,000 Hz) and dwelling noises (including sounds from larger animals such as cattle, dogs, goats and sheep). Road tyre interaction also contributes to this range.

During all hours consistent peaks and troughs was measured in this range, with no particular trend.

[10] Mechanical Engineering Conversion Factors, Dr. K. Clark Midkiff

Higher frequencies (2,000 Hz upwards until ultrasound range): Smaller faunal species, including animals, birds, frogs, crickets and cicada would use this range as the dominant frequency to communicate, hunt with etc. This could include male grasshoppers chirping at higher frequencies due to increased surrounding temperatures, mating season of a specific faunal species (and competition for territory - domination), insects near a wetland or before/during a drizzle/rain shower, cicada chirping or dawn chorus from birds during early morning hours etc. Natural faunal noise fluctuates depending on seasonal changes. Tones and harmonics (tone more than 5 dB adjacent third octave band sound pressure level difference above 500 Hz and from the central frequency)[11] is also likely to be measured in this range if faunal communication is prevalent.

At times there was some energy near the ultrasound range. During the day elevated energy was measured in the higher frequency with no real specific peak. During the nights, the 4,000 Hz had the dominant peak. This peak at times had a potential tone associated with it.

Summary: Spectral Analysis (Figure 3-5 - Figure 3-6):
Refer to the inserts in the mentioned figures illustrating a basic interpretation of data by removing certain measured data with potentially unwanted spectral signatures (e.g. a time when grass is cut at a homeowner's property, extraneous noises sources etc.). The criterion used to illustrate these spectral profiles was the frequency of occurrences and repetitiveness of certain frequencies. It is for representation purpose only, and is used to represent a likely spectral character of the area (natural, suburban, industrial etc.), identify concerns or potential acoustical traits.

The higher frequency at the 20,000 Hz is close to the ultrasound range and a frequency that is generally not observable by most humans. These high frequencies could be comparable to faunal echolocation such as that can be found from bats etc. Higher frequencies were from natural sounds including crepuscular birds, frogs or crickets.

The spectral contributors to the mid and low frequencies were a contribution from dwelling related sounds, domesticated animals and at times a vehicle passed by the unpaved route adjacent to the dwelling. From the data the traffic that did pass was infrequent and travelling at low speeds (no tyre interaction in the mid-range in 1,000 Hz). The smooth linear negative regression fashion was likely due to wind conditions.

[11] SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'. Pg. 34

The peaks at 4,000 Hz (and potential associated tone) could be from crepuscular birds, frogs or crickets or other faunal source (although no harmonics associated with the tone(s)). Many measurements were during evenings or night, or early morning hours (such as bird song during dawn chorus).

The first night and last day's Impulse (South African) equivalent values were influenced by a noise event (described by the L_{Max} descriptor), while the Fast setting European indices were effected during the first and last night. The same first event influenced the $L_{Aeq,24hr}$. Assessing the spectral data for these two events indicated no discernible trend. The octave data illustrated high data in all frequencies and therefore would require and immense amount of energy if it was from far away. Therefore the likely noise source was very loud and near the equipment such as someone talking into microphone etc.

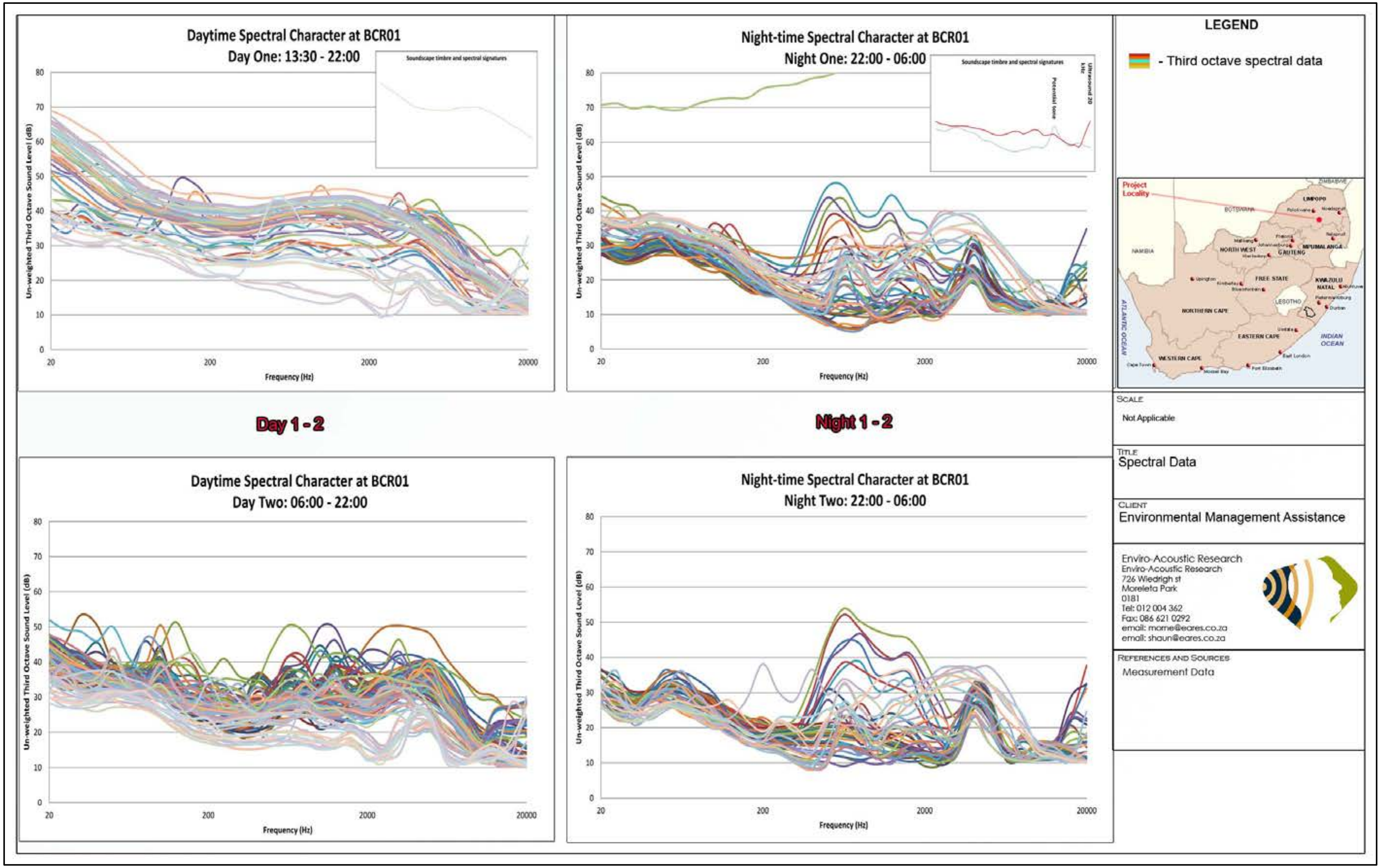

Figure 3-5: Spectral frequency distribution at BCR01 1st & 2nd day/night

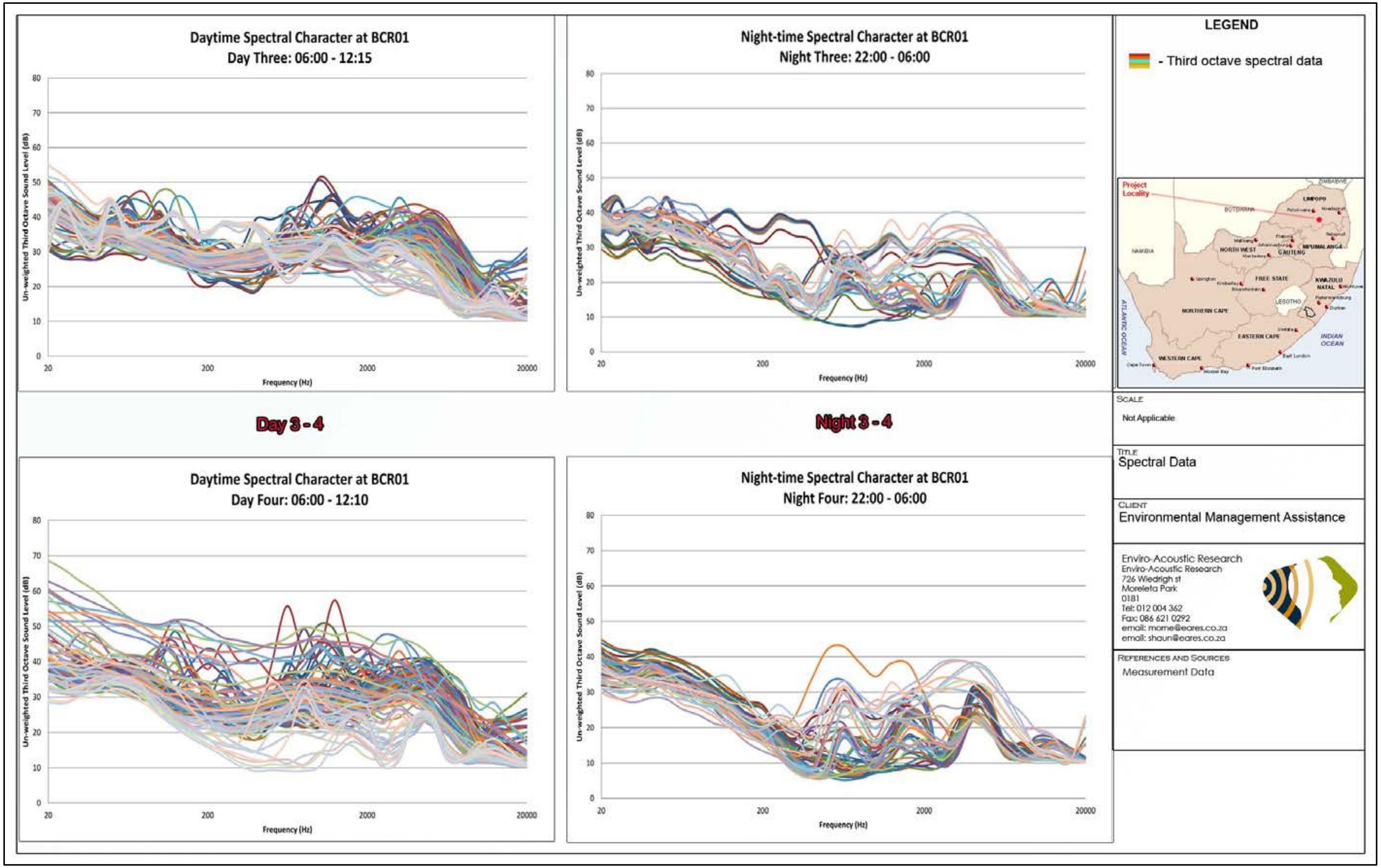

Figure 3-6: Spectral frequency distribution at BCR01 3rd & 4th day / night

3.2.2 Measurement Point BCR02: Single 10-minute measurements – Tubatse Community

Three 10 minute measurements were collected at the Tubatse Community during the day. The equipment defined in **Table 3-3** was used for gathering data. The measurement results are presented in in **Table 3-4**. A photo of the measurement locality is presented in Appendix B 2 .

Table 3-3: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Svan 977	34160	May 2015
Microphone	ACO 7052E	54645	May 2015
Calibrator	B & K	1558840	January 2015

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

Table 3-4: Results of ambient sound level monitoring (Datum type: WGS84, Decimal Degrees)

Name	Measurement Locality	$L_{AFeq,\ 10min}$ dBA	$L_{Aleq,10min}$ dBA	$L_{A90,10min}$ dB90	Comments
AG03	R542	50.2	53.8	34.6	Conditions were windy during measurement conditions. There was at least one vehicle passing through the community and hence the measurement locality.
		50.2	54.6	36.7	
		44.9	48.1	36.7	

3.3 Ambient Sound Levels – Summary

3.3.1 South Africa SANS 10103:2008 typical Rating Levels for noise districts

A summary of all L_{Req} based on $L_{Aleq,10\ min/16hr}$ measurements is presented in **Table 3-5**. It was selected not to make use of the data that was influenced by the higher L_{Max} descriptor (first night and last day's) as this data is not illustrative of the Rating Level.

BCR01 - Considering the L_{Aleq} measured daytime data ambient sound indicated many sound levels slightly higher than a typical suburban area, yet lower than urban area. Night-time data indicated Rating Level ranging between typical suburban, yet lower than a busy urban area.

BCR02 - Considering the L_{Aleq} measured daytime data ambient sound indicated a suburban to busy urban area.

Table 3-5: Rating Level profile

Point name	Noise district rating based on $L_{AIeq,16/8hr}$ measurement data (day/night)	Noise district rating based on all data and character of area	Existing ambient sound levels conforming to international recommended levels? (day/night)
BCR01	Suburban – urban/ suburban – busy urban	Suburban	Yes/yes
BCR02	Suburban – busy urban	Suburban (potential underestimation)	Yes

3.3.2 L_{day}, $L_{evening}$ and L_{night} (ISO/WHO and IFC: General EHS Guidelines)

A summary of all European indices based on $L_{AIeq,10\ min/12hr/16hr}$ measurements is presented in **Table 3-5** It was selected not to make use of the data that was influenced by the L_{Max} descriptor (first and last night).

BCR01 - $L_{Aeq,12hr}$/ $L_{Aeq,8hr}$ or similar levels measured during the day and night conformed to the recommendation of 55 and 45 dBA limits respectively set out by the World Health Organization (**Section 2.6.1** and **Section 2.6.2**), World Bank (**Section 2.6.3**) and International Finance Corporation (**Section 2.6.4**) for a residential area, with the equivalent levels being less than 55 dB.

BCR02 – The $L_{Aeq,10min}$ levels measured during the day conformed to the recommendation of 55 dBA limits set out by the World Health Organization and International Finance Corporation for a residential area.

4 INVESTIGATED EXISTING AND FUTURE NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction, as well as the operational phase of the activity. Noise emitted by proposed construction and operations can be associated with various types of noises and noise sources. These include mechanical sources due to operation of equipment, material impact noises (such as the noise made when materials are dropped at a height to ground level), electrical noise (reverse hooters from equipment) and aerodynamic noises such as from the ventilation fans.

Calculations in this section are based on a worst-case day/night-time scenarios and will not be relevant for all times of the envisaged scenario (not a moment in time, but the potential extent of noise rating levels during the operational phase i.e. $L_{Req,1hr}$). Equipment assessed is based off maximum capacity Sound Power Levels (SPL) allowable from the likely noisiest point on the equipment (exhaust, engine bay etc.). Equipment assessed is from large capacity equipment i.e. large bucket specifications on a FEL or large tonnage ADT. SPL is garnered from a host of online resources and available SPL conducted by manufacturers for their equipment.

Available information (see **Section 1.4**) indicated that the project may be constructed or operated within night-time limits set out by SANS10103:2008, night-time operations will therefore be investigated ($L_{Req,d/n}$). Modelled impact scenarios are a representation of the precautionary principles or over-engineering.

4.1 NOISE SOURCES – BASELINE SCENARIO

During onsite investigations no significant existing ambient sounds contributors were identified. The R555 class 3 regional route is the closest clearly identifiable noise source at app. 8 km however was not investigated due the significant distance to the study area.

4.2 POTENTIAL NOISE SOURCES - CONSTRUCTION PHASE

Potential maximum noise levels generated by construction equipment as well as the potential extent are presented in **Table 4-1**. The potential extent depends on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral character of the noise and the ambient surroundings.

Average or equivalent sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the receptor can experience. Typical sound power levels associated with various activities that may be found at a construction site is presented in **Table 4-2**.

4.2.1 Open cast pits

A scenario based on construction equipment operating on the surface as feasibly close to receptors while still remaining within the footprint area will be assessed.

Construction activities considered for the scenario will be topsoil, overburden removal and drilling. During this phase equipment on the open cast pits will have a direct line-of-sight from the project footprint to the receptors (not considering any berms, barriers or highwalls).

The basic construction functions of an acoustical nature during the construction phase are briefly discussed below:

- Excavation of undesired soils/topsoil/overburden etc.;
- Hauling of overburden to stockpiles;
- Dust suppression by means of water tanker dozers; and
- A drill for core drilling purposes if blasting is required.

For the designed scenario it was selected to model a front end loader (FEL) operating in conjunction with an articulated dump truck (ADT). Furthermore a water dozer and core drill operating alongside the FEL and ADT was considered.

4.2.2 Plant

Although various activities including foundation laying, concrete pouring and surface preparations will commence at the new plant section, it will not be investigated. This is due to the fact that receptors are well outside 1,000 m from the plant area as well as the lower sound power level capacity (SPL) of construction equipment required for general construction and in relation to heavy equipment used to strip open cast pits (higher noise generating capacity).

Many European, Western and Eastern countries have a set compliance noise emission level for heavy machinery (see **Section 2.6.7**). Constructions related equipment in use for general construction in South Africa would have complied with this.

4.2.3 Blasting

Rock blasting may be required to break down rock. However, blasting will not be considered during the Scoping or EIA phase for the following reasons:

- Blasting is highly regulated and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner;
- Blasting is a highly specialised field, and various management options are available to the blasting specialist. Options available to minimise the risk to equipment, people and infrastructure includes:
    - The use of different explosives that have a lower detonation speed, which reduces vibration, sound pressure levels as well as air blasts.
    - Blasting techniques such as blast direction and/or blast timings (both blasting intervals and sequence).
    - Reducing the total size of the blast.
    - Damping materials used to cover the explosives.
- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. This is normally associated with close proximity mining/quarrying.
- Blasts will be an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast result in a higher acceptance of the noise.

If blasting is required to take place near a receptors dwelling, it is recommended that the developer consult with a Blasting Specialist regarding the matter.

4.2.4 Vibrations

South African Standards available are limited to the SABS ISO 4866:1990 and SABS ISO 2631-1 1991. These documents are based on human and building infrastructure that is exposed to vibrations. It is a trend in African countries to refer to International Standards and guidelines in terms of vibration criteria.

Infrastructure vibrations predominately occur below 300 Hz, with many International guidelines highlighting the need to consider the measurement frequency weighting when assessing vibrations (relating more to railway bound vehicles). These include the international W_m/KB and British W_b/W_d standards, vibration decibel (VdB) measurements as well as the correlation between L_{Aeq} and L_{Ceq} for assessment of lower frequencies[12].

A ground-borne vibration is a system interlinking the noise source, vibration medium and receiver with one another. Several different mechanisms constitute this system including the distances, infrastructure specifications and noise source under investigation's *modus operandi*. There are many factors involved in the sophisticated estimation of vibration and ground-borne vibration, including[13]:

1. The medium - The surrounding geological strata, bedrock depth, soil type, bedrock contours, soil layering, depth of the water table etc.;
2. The source – The noise sources under investigation etc.; and
3. The receiver – Receptor's foundation design, building construction, interior acoustical absorption and location of building etc.

However blasting and vibration are interlinked. As such if blasting is required to take place near a receptors dwelling, it is recommended that the developer consult with a Vibration Specialist regarding the matter.

4.2.5 Delivery / Access Routes

See **Section 4.3.3** discussing delivery/access routes in more detail.

4.2.6 Impulse or tone corrections

See **Section 4.3.4** discussing these corrections in more detail.

[12] RIVAS. Review of existing standards, regulations and guidelines, as well as laboratory and field studies concerning human exposure to vibration. 2011.

[13] David A. Towers, P.E. Rail Transit Noise and Vibration; Sinan Al Suhairy. Prediction of Ground Vibration from Railways.2000

Table 4-1: Potential maximum noise levels generated by construction equipment

Equipment Description[14]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential **maximum** noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Auger Drill Rig	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Backhoe	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Chain Saw	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Compactor (ground)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	No	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Concrete Saw	No	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6
Crane	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dozer	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Generator (<25KVA, VMS Signs)	No	104.7	79.7	73.7	67.6	59.7	53.7	50.1	47.6	44.1	39.7	36.2	33.7	27.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Jackhammer	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Man Lift	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Mounted Impact Hammer	Yes	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6

[14] Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Paver	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Pickup Truck	No	89.7	64.7	58.7	52.6	44.7	38.7	35.1	32.6	29.1	24.7	21.2	18.7	12.6
Pumps	No	111.7	86.7	80.7	74.6	66.7	60.7	57.1	54.6	51.1	46.7	43.2	40.7	34.6
Rivit Buster/Chipping Gun	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Rock Drill	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Roller	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sand Blasting (single nozzle)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Scraper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sheers (on backhoe)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Slurry Plant	No	112.7	87.7	81.7	75.6	67.7	61.7	58.1	55.6	52.1	47.7	44.2	41.7	35.6
Slurry Trenching Machine	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Soil Mix Drill Rig	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Tractor	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Vacuum Excavator (Vac-Truck)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vacuum Street Sweeper	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Ventilation Fan	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibrating Hopper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibratory Concrete Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Vibratory Pile Driver	No	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Warning Horn	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Welder/Torch	No	107.7	82.7	76.7	70.6	62.7	56.7	53.1	50.6	47.1	42.7	39.2	36.7	30.6

4.3 POTENTIAL NOISE SOURCES - OPERATIONAL PHASE

Typical sound power levels associated with various activities that may be found at an opencast pit is presented in **Table 4-1** (maximum noises) and **Table 4-2** (average or equivalent noises). As can be seen from this table there are a range of equipment, frequently with different sound power emission levels and spectral characteristics.

During this phase pit highwalls and berms will have been implemented acting as a screen of noise from the pits to the receptors. However due to the height of certain surface elevations (mountainous ranges) some open cast equipment may be elevated above these noise screens. During the impact assessment investigations this will be considered.

4.3.1 Open Cast Pits

The basic *modus operandi* of the envisaged open cast scenario is briefly discussed below:

- Open cast truck and shovel mining in a typical grid by grid fashion; and
- A mobile crusher (primary crushing) operating on the open cast pits.

Run of mine (ROM) is garnered via means of graders, wheel loaders or any other required heavy equipment and loaded onto ADT's. A mobile crusher operation at maximum capacity is envisaged to operate simultaneously with above scenario.

4.3.2 Stockpile Management (ROM, softs, hards etc.) & New Plant Section

There are many designs and management options available when considering stockpiles. At some stage of the stockpile development and management equipment may work at an elevated height on the stockpile tip or at the edge of a stockpile footprint (near the bollards when the stockpiles are maintained at a gradient). This worst-case scenario will be investigated.

Therefore the following will be considered for stockpile management:

- Development and management of the topsoil/berm management making use of a FEL; and
- A general workshop and weight bridge section at the proposed plant section.

The existing operations will not be investigated as it is too far from any receptors, nor is it the scope of works.

4.3.3 Haul Road Design, Specifications & Information

Acoustics is not the only environmental and/or engineer discipline considered in the design and manufacturing of road paving. Other factors to play an important role in the prefeasibility stage of road construction include how well the road handles (i.e. skid resistance etc.) or how resistant it may be on tyre wear, costs involved in manufacturing and maintaining pavements etc. Although there are a host of noise generating mechanism in vehicle movement, the most important factor above 50 – 60 km/h is the road and tyre interaction between pavement and the vehicle (rolling noise).

The most important road noise/sound contributors include:

- Road traffic volume and speeds (most significant);
- Other road noise contributors (maintenance conditions, modifications etc.);
- Road vehicle type (trucks, busses, cars, motorbikes, etc.);
- Road/tyre interaction which includes:
  - Vehicle tyre design;
  - Stick-slip & stick-snap and air pumping ;[15] [16]
  - Horn Amplification;
  - Sub-grade, sub-base (or granular/cemented sub-base) and base course of road pavement material - Hot-mix, cold-mix, synthetic binder, resin modified etc. asphalt, Portland cement concrete (PCCP) [17], Unpaved Roads
  - Surface texture;[18] [19] [20]
  - Surface porosity[21][22]; and
- Single maximum noise events - magnitude and occurrences (L_{Amax}) (vehicles backfiring, maintenance issues, etc.).

From the information received from the Spitsvale Mine Works Plan (MWP, see **Section 1.4**) a maximum capacity scenario based on 30 000 tons per month (tpm) was assessed considering the use of 3x 30 ton ADT.

Construction vehicles to and from the project and on public routes were not considered as it does not fail within the scope of work.

[15] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed.
[16] Paul Sas. Structural Dynamic Behaviour of Tyres Noise & Vibration Engineering Research Group KU. Leuven. XIX CNIM 15-16/11 Castellon.
[17] Michael Maher, Chris Marshall, Frank Harrison, Kathy Baumgaertner. Context Sensitive Roadway Surfacing Selection Guide. Publication No. FHWA-CFL/TD-05-004. 2005.
[18] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed.
[19] Giuseppe Loprencipe & Giuseppe Cantisani. Unified Analysis of Road Pavement Profiles for Evaluation of Surface Characteristics. Modern Applied Science; Vol. 7, No. 8. 2013.
[20] PIARC. World Road Association: Report of the Committee on Surface Characteristics. 1987.
[21] A. Ongel, E. Kohler, J Nelson. Acoustical Absorption of Open-Graded, Gap Graded and Dense Graded Asphalt Pavements. Research Report: UCPRC-RR-2007-12.2007.
[22] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed.

4.3.4 Impulse or tone corrections[23][24]

A + 5 dBA correction can be implemented for a tone or impulsive noise source, with a highly impulsive event requiring a 12 dBA correction. The SANS 10103:2008 methodology indicates a + 5 dBA (tone, *C*t) in the calculation of the Rating level in the formulae $L_{Req,T} = L_{Aeq,T} + C\text{i} + C\text{t}$. The methodology to determine a tonal or impulsive content is stipulated in the mentioned standard. Tones and impulsive noises will not be considered for this report as tones are unlikely (engineered out) and there are no noise sources with a significant impulsive component (warning alarms are exempt, refer to **Section 2.2.1**).

4.4 Potential Noise Sources - Closure Phase

Closure activities will not be considered in this report. In general, closure activities have a significant lower noise impact than both the operational and closure phases. The closure phase will therefore not be considered during this document for the following reasons:

- Closure activities are generally less intense than construction and operational activities. Noise levels are lower and frequently limited to daylight hours. This reduces the significance of the noise impact;
- Most rehabilitation takes place con-currently with mining. It is therefore just another activity generating noise that could be considered as part of the operational phase; and
- A closure EMP must be developed by the mining operation at the end of the mining operation, which is more specific and accurate. If required, noise could be addressed in this document.

[23] SANS 10103:2008
[24] Brüel & Kjær. Investigation of Tonal Noise. 2007.

Table 4-2: Potential equivalent noise levels generated by various equipment

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Bulldozer CAT D10	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D11	113.3	88.4	82.3	76.3	68.4	62.3	58.8	56.3	52.8	48.4	44.8	42.3	36.3
Bulldozer CAT D9	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D6	108.2	83.3	77.3	71.2	63.3	57.3	53.7	51.2	47.7	43.3	39.8	37.3	31.2
Bulldozer CAT D5	107.4	82.4	76.4	70.4	62.4	56.4	52.9	50.4	46.9	42.4	38.9	36.4	30.4
Bulldozer Komatsu 375	114.0	89.0	83.0	77.0	69.0	63.0	59.5	57.0	53.4	49.0	45.5	43.0	37.0
Crusher/Screen (MTC Mobile)	109.6	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.0	44.6	41.1	38.6	32.6
Coal crushing plant (50 tons/h)	114.5	89.5	83.5	77.5	69.5	63.5	60.0	57.5	54.0	49.5	46.0	43.5	37.5
Coal beneficiation plant	107.5	82.5	76.5	70.5	62.5	56.5	53.0	50.5	46.9	42.5	39.0	36.5	30.5
Coal silo (Material Transfer)	103.2	78.3	72.2	66.2	58.3	52.2	48.7	46.2	42.7	38.3	34.7	32.2	26.2
Coal Yard Equipment	106.8	81.8	75.8	69.8	61.8	55.8	52.3	49.8	46.3	41.8	38.3	35.8	29.8
Coal Screen	105.1	80.1	74.1	68.1	60.1	54.1	50.6	48.1	44.6	40.1	36.6	34.1	28.1
Diesel loco moving	108.7	83.7	77.7	71.7	63.7	57.7	54.2	51.7	48.2	43.7	40.2	37.7	31.7
Diesel loco idling	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7
Drilling Machine	109.6	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.1	44.6	41.1	38.6	32.6
Dumper/Haul truck - CAT 700	115.9	91.0	85.0	78.9	71.0	65.0	61.4	58.9	55.4	51.0	47.5	45.0	38.9
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.2	57.7	55.2	51.7	47.2	43.7	41.2	35.2
Excavator - Hitachi EX1200	113.1	88.1	82.1	76.1	68.1	62.1	58.6	56.1	52.6	48.1	44.6	42.1	36.1
Excavator - Hitachi 870 (80 t)	108.1	83.1	77.1	71.1	63.1	57.1	53.6	51.1	47.5	43.1	39.6	37.1	31.1
FEL - Bell L1806C	102.7	77.7	71.7	65.7	57.7	51.7	48.2	45.7	42.1	37.7	34.2	31.7	25.7
FEL - CAT 950G	102.1	77.2	71.2	65.1	57.2	51.2	47.6	45.1	41.6	37.2	33.7	31.2	25.1
FEL - Komatsu WA380	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7
General noise	108.8	83.8	77.8	71.8	63.8	57.8	54.2	51.8	48.2	43.8	40.3	37.8	31.8
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.9	54.4	51.9	48.4	43.9	40.4	37.9	31.9
Grader	110.9	85.9	79.9	73.9	65.9	59.9	56.4	53.9	50.3	45.9	42.4	39.9	33.9
Screening plant	105.5	80.6	74.6	68.5	60.6	54.6	51.0	48.5	45.0	40.6	37.0	34.6	28.5
Water Dozer, CAT	113.8	88.8	82.8	76.8	68.8	62.8	59.3	56.8	53.3	48.8	45.3	42.8	36.8

5 METHODS: NOISE IMPACT ASSESSMENT

5.1 POTENTIAL NOISE IMPACTS ON ANIMALS[25][26]

A great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on animals. While aircraft noise have a specific characteristic that might not be comparable with industrial noise, the findings should be relevant to most noise sources.

Overall, the research suggests that species differ in their response to:

- Various types of noise, durations of noise, magnitude of the noise, characteristic of the noise and sources of noise.

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:

- Which species is exposed (difference in hearing sensitivity, susceptibility to noise-induce hearing loss etc.);
- Whether there is one animal or a group; and
- Whether there have been some previous exposures.

There are numerous other factors in the environment of animals that also influence the effects of noise. These include predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic. This hinders the ability to define the real impact of noise on animals.

From these and other studies the following can be concluded:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate. This is not relevant to wind energy facilities because the turbines do not generate impulsive noises close to these sound levels;
- Animals of most species exhibit adaptation with noise, including aircraft noise and sonic booms;
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate; and
- Noises associated with helicopters, motor- and quad bikes significantly impact on animals.

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[25] USEPA, 1971: *"Effects of Noise on Wildlife and other animals"*.
[26] Autumn, Lyn Radle. The effect of noise on Wildlife: A literature review. 2007.

As such various South African/International guidelines existing very briefly mentioning potential noise impacts on wildlife from industrial and commercial industries, it has the issue where no acoustical criteria is defined[27]. Faunal guidelines exists regarding the protection of an animal's surrounding environment, with "physical" impacts such as water, vegetation etc. a far more critical impact than that of acoustics.

With the available information in mind, this documents intent remains a determination of the existing rating level and the potential increase of magnitude above (in dB, with applicable corrections) at a receptors dwelling as per legislation/guidelines, and due to a proposed noise source of significance (see **Section** 2).

5.1.1 Effects of Noise on Wildlife

Potential noise impacts on wildlife are very highly species dependent. Studies showed that most animals adapt to noises and would even return to a site after an initial disturbance, even if the noise continues. The more sensitive animals that might be impacted by noise would most likely relocate to a quieter area.

There are a few specific studies discussing the potential impacts of noise on wildlife associated with construction, transportation and industrial facilities. Available information indicates that noises from transportation and industrial may mask the sounds of a predator approaching; similarly predators depending on hearing would not be able to locate their prey.

Many natural based acoustics themselves may be loud or impulsive. Examples include thunder, wind induced noises that could easily exceed 35 dBA ($L_{A90,fast}$) above wind speeds averaging 6 m/s (wind conditions of a moderate breeze on the Beaufort Scale[28]), noise levels during early morning dawn chorus or loud cicada noises during late evening or early morning.

5.1.2 Effects of Noise on Domesticated Animals

It may be that domesticated animals are more accustomed to noise sources of an industrial, commercial or other anthropogenic nature, although exposure to high noise levels may affect domestic animals well-being. Sound levels in animal shelters can exceed 100 dB, much more than what can be expected at a domestic dwelling from an industrial, commercial or transportation noise source (10 minute equivalent)[29 & 30]. The high noise

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[27] E.g. International council of Mining & Metals. "Good Practice Guidance for Mining and Biodiversity". P.g. 63.
[28] Met Office, "National Meteorological Library and Archive Fact sheet 6 – The Beaufort Scale", Version 1, Crown copyright 2010, p.4.
[29] Crista L. Coppola. Noise in the Animal Shelter Environment: Building Design and the Effects of Daily Noise Exposure.
[30] David Key, Essential Kennel Designs.

levels may see negative influences on animals cardiovascular systems and behaviour, and may damaging to the hearing of dogs in the kennel facility[31].

Domesticated animals may also respond differently to noises than animals in the wild. Domesticated dogs are pack animals and may respond excitedly or vocally to other noises, smells, visual and other stimulants, in contrast to wild animals that may flee at the slight sound of a noise or visual disturbances. Animals that are transported at least once in their life (such as pigs to an abattoir) would endure high noise levels for the duration of the delivery period[32]. A change in the heart rate, renal blood flow and blood pressure of study subjects were noted in the above studies.

5.1.3 Laboratory Animal Studies

Although many laboratory animals have wild counterparts (rats, mice) the laboratory test subjects differ in many aspects (genetics, behaviour etc.). Also noise levels of studies are conducted at generally very high levels at over 100 dB, much more than what would be experienced in environmental settings around industrial, commercial or transportation activities.[33] Other dissimilarities to laboratory tests and a natural environment include the time exposure (duration of noise), the spectral and noise character (impulsive noise vs. constant noise) etc. Although there exists dissimilarities in tests conducted and noise levels around commercial and industrial environments, laboratory rodents exposed to high noise levels did indicated physiological, behavioural changes, hearing loss and other such effects[34].

5.2 WHY NOISE CONCERNS COMMUNITIES[35]

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping); and
- Presents a health risk due to hearing damage.

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[31] Wei, B. L. (1969). Physiological effects of audible sound. AAAS Symposium Science, 166(3904), 533-535.
[32] D B Stephens and R d Rader. J R Soc Med. 1983.
[33] USEPA, 1971: *“Effects of Noise on Wildlife and other animals”.*
[34] Ann Linda Baldwin. *“Effect of Noise on Rodent Physiology”*. 2007.
[35] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases, annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered “disturbing”. One can refer to a dripping tap in the quiet of the night, or the irritating “thump-thump” of the music from a neighbouring house at night when one would prefer to sleep.

Severity of the annoyance depends on factors such as:

- Background sound levels as well as the background sound levels the receptor is used to;
- The manner in which the receptor can control the noise (helplessness);
- The time, unpredictability, frequency distribution, duration, and intensity of the noise;
- The physiological state of the receptor; and
- The attitude of the receptor about the emitter (noise source).

5.2.1 Annoyance associated with Industrial Processes

Annoyance is the most widely acknowledged effect of environmental noise exposure, and is considered to be the most widespread. It is estimated that less than a third of the individual noise annoyance is accounted for by acoustic parameters, and that the non-acoustic factors plays a major role. Non-acoustic factors that have been identified include age, economic dependence on the noise source, attitude towards the noise source and self-reported noise sensitivity.

On the basis of a number of studies into noise annoyance, exposure-response relationships were derived for high annoyance from different noise sources. These relationships, illustrated in **Figure 5-1**, are recommended in a European Union position paper published in 2002, stipulating policy regarding the quantification of annoyance. This can be used in Environmental Health Impact Assessment and cost-benefit analysis to translate noise maps into overviews of the numbers of persons that may be annoyed, thereby giving insight into the situation expected in the long term. It is not applicable to local complaint-type situations or to an assessment of the short-term effects of a change in noise climate.

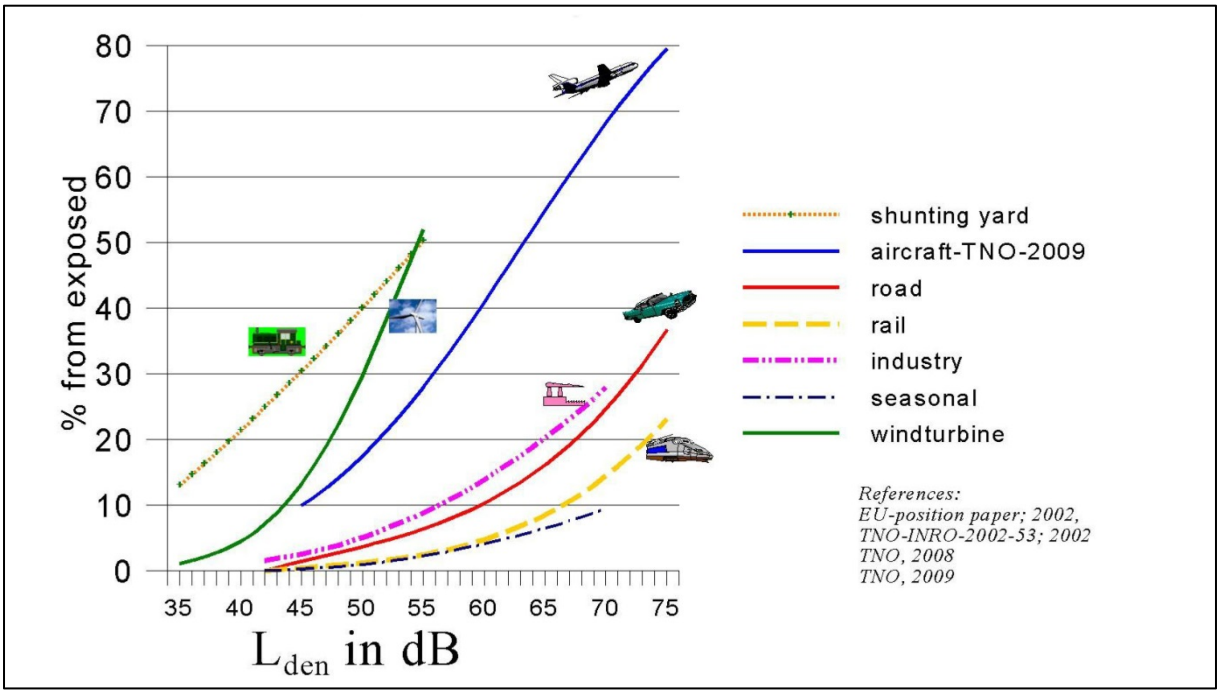

Figure 5-1: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling

As shown in **Figure 5-1**, there is significant potential of annoyance associated with noise from shunting operations, mainly due to the highly impulsive character of the noises created.

5.3 IMPACT ASSESSMENT CRITERIA

5.3.1 Overview: The Common Characteristics

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are:

- Intensity;
- Loudness;
- Annoyance; and
- Offensiveness.

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated, but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

5.3.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Regulations, published by the Department of Environmental Affairs (June 2006) in terms of the NEMA, SANS 10103:2008 as well as guidelines from the World Health Organization.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations, an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 5-2**.
- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 5-1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 5-1**). It provides the equivalent ambient noise levels (referred to as Rating Levels), $L_{Req,D}$ and $L_{Req,N}$, during the day and night respectively to which different types of developments may be exposed.

Due to the variance in ambient sound measurements it is recommended that the project consider the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas as well as the South African SANS10103:2008 guidelines.

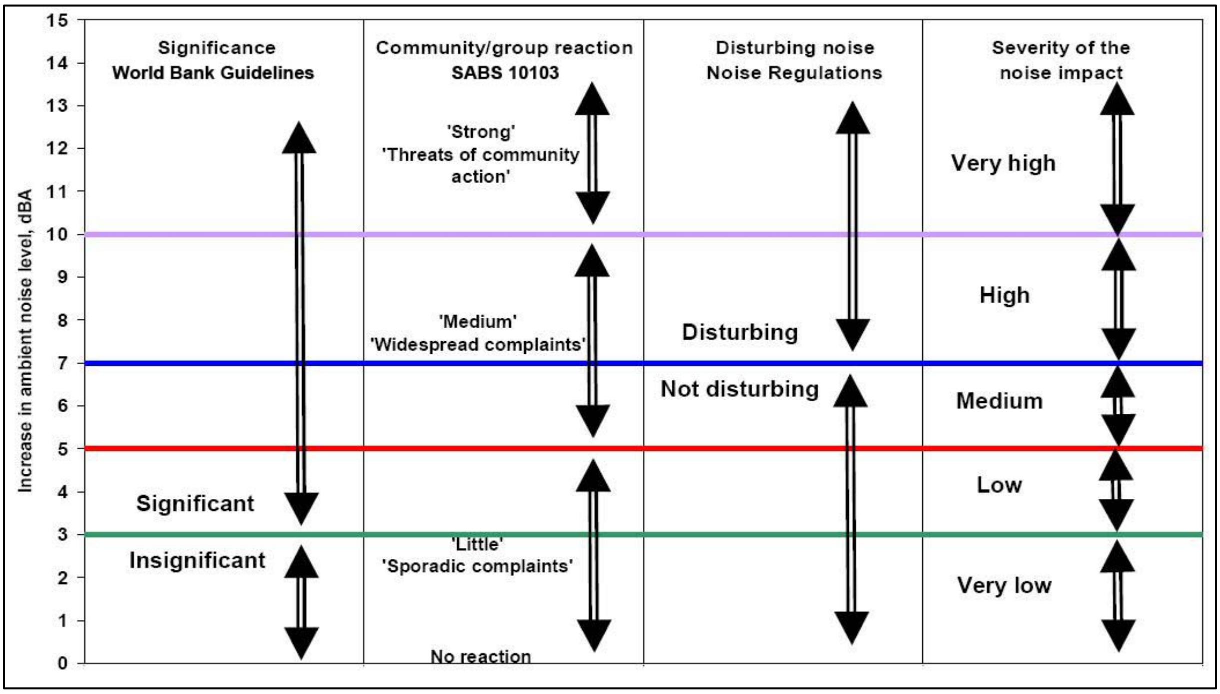

Figure 5-2: Criteria to assess the significance of impacts stemming from noise

During site measurements (**Section 3.2**) $L_{Aleq,16/8hr}$ ranged between suburban to busy urban. By considering other measured variables and by taking a precautious stance (due to seasonal faunal sounds, unwanted noises from dwellings etc.) the following SANS 10103:2008 rating levels (zone sound levels for a quieter area than measured during the site visit, particularly during the night-times, based on the character of the area) will be considered:

- Suburban district $L_{Req,d}$ of 50 dBA; and
- Suburban district $L_{Req,n}$ of 40 dBA.

International guidelines should also be considered. The International IFC (Equator Principle) Residential; institutional and educational referenced areas includes ratings of:

- Use of L_{day} of 55 dBA during the daytimes; and
- Use of L_{night} of 45 dBA during the night-times.

SANS 10103:2008 also 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 sound level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.

- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.
- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

Note that an increase of more than 7 dBA is defined as a disturbing noise and prohibited (National and Provincial Noise Control Regulations).

Table 5-1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req.T}$) for noise** dBA					
	Outdoors			**Indoors, with open windows**		
	Day/night $L_{R,dn}$ [a]	**Daytime** $L_{Req,d}$ [b]	**Night-time** $L_{Req,n}$ [b]	**Day/night** $L_{R,dn}$ [a]	**Daytime** $L_{Req,d}$ [b]	**Night-time** $L_{Req,n}$ [b]
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

5.3.3 Other noise sources of significance

In addition, other noise sources that may be present should also be considered. During the day, people are generally bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc). This excludes activities that may generate additional noise associated with normal work.

At night, sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from a variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

Figure 5-3 illustrates the sound levels associated with some equipment or in certain rooms. This is however more for illustrative purposes, as there are many manufacturers with different equipment, each with a different noise emission character.

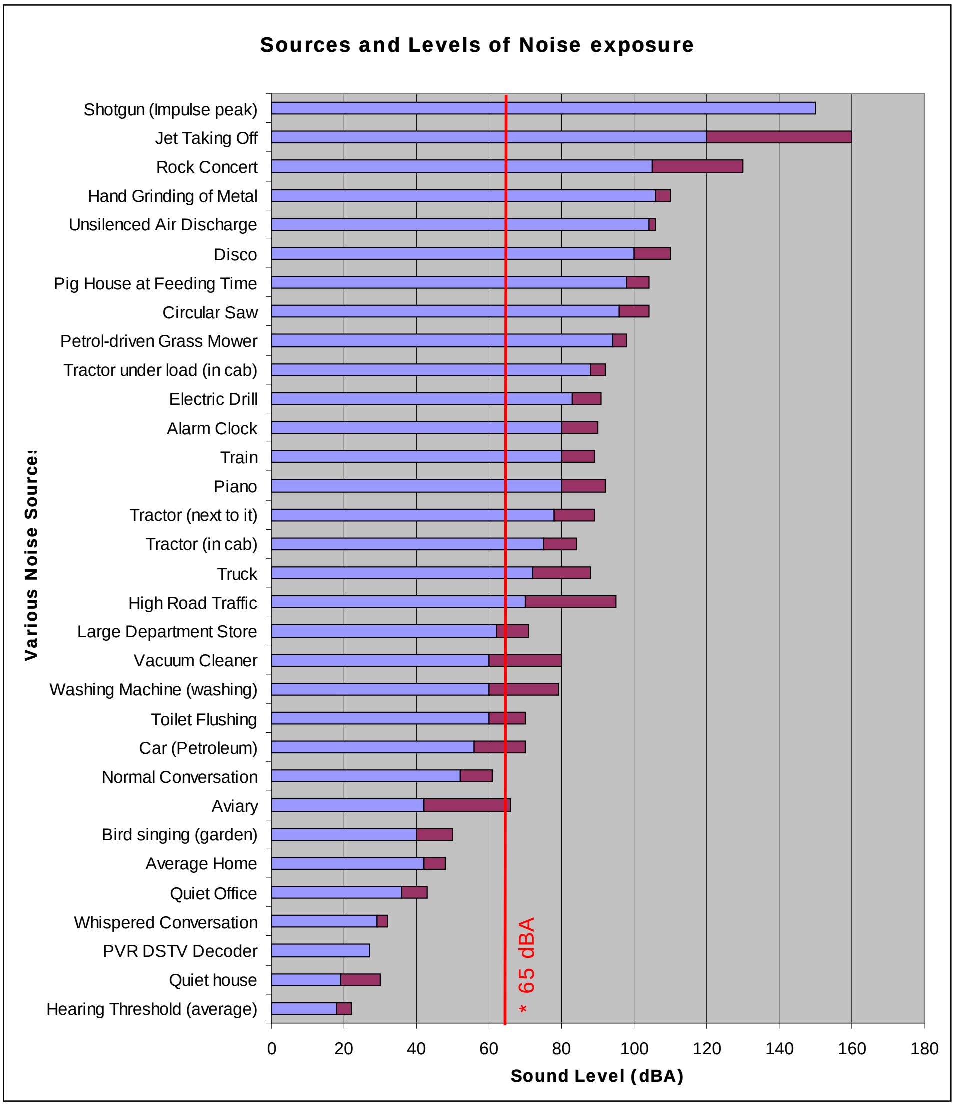

Figure 5-3: Typical Noise Sources and associated Sound Pressure Level

5.3.4 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value as defined in the third column in the tables below.

The impact consequence is determined by the summing the scores of Magnitude **Table 5-2**), Duration (**Table 5-3**) and Spatial Extent (**Table 5-4**). The impact significance (see **Sections 5.3.5** and **Section 5.3.6**) is determined by multiplying the Consequence result with the Probability score (**Table 5-5**).

An explanation of the impact assessment criteria is defined in the following tables.

Table 5-2: Impact Assessment Criteria - Magnitude

This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species.		
Rating	**Description**	**Score**
Low	Increase in average sound pressure levels between 0 < 3 dB from the expected ambient sound levels. The ambient sound levels will be defined by the Rating Level. Total projected outdoor noise level is less than the Rating Level and/or Equator Principle in wind-still conditions.	2
Low Medium	Total projected outdoor noise levels between 3 < 5 above the Rating Level and/or Equator Principle (wind-less conditions).	4
Medium	Increase in outdoor sound pressure levels between 5 < 7 above the Rating Level and/or Equator Principle (wind less conditions). Sporadic complaints expected.	6
High	Total projected outdoor noise levels between 7 < 10 dBA above the Rating Level and/or Equator Principle (wind-less condition). Medium to widespread complaints expected.	8
Very High	Total projected outdoor noise levels higher than 10 dB above the Rating Level and/or Equator Principle (wind less-conditions). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action. Any point at a receptor where 24 hr. measured or calculated value exceeds 61 dBA for certain controlled areas (roads and or industrial). These areas require demarcation by relevant authorities (see also Noise Control Regulations in **Section 2.2.1**). The magnitude of nose inside a building is more than the maximum design or activities indoor (discussed further below in **Section 2.5.2**	10

Table 5-3: Impact Assessment Criteria - Duration

The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently.		
Rating	**Description**	**Score**
Temporary	Impacts are predicted to be of short duration (portion of construction period) and intermittent/occasional.	1
Short term	Impacts that are predicted to last only for the duration of the construction period.	2
Long term	Impacts that will continue for the life of the Project, but ceases when the Project stops operating.	4
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.	5

Table 5-4: Impact Assessment Criteria – Spatial extent

Classification of the physical and spatial scale of the impact		
Rating	**Description**	**Score**
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1
Local	The impact could affect the local area (within 1,000 m from site).	2
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.	3
National	The impact could have an effect that expands throughout the country (South Africa).	4
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.	5

Table 5-5: Impact Assessment Criteria - Probability

This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:		
Rating	**Description**	**Score**
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).	1
Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25 %.	2
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50 %.	3
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined between 50 % to 75 %.	4
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100 %.	5

In order to assess each of these factors for each impact, the following ranking scales as contained in **Table 5-6** will be used.

Table 5-6: Assessment Criteria: Ranking Scales

PROBABILITY		MAGNITUDE	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
Definite/don't know	5	Very high/don't know	10
Highly likely	4	High	8
Likely	3	Medium	6
Possible	2	Low Medium	4
Improbable	1	Low	2
DURATION		**SPATIAL SCALE**	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
		International	5
Permanent	5	National	4
Long Term	4	Regional	3
Short term	2	Local	2
Temporary	1	Footprint	1

5.3.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a Significance Rating (SR) value for each impact (prior to the implementation of mitigation measures).

Significance without mitigation is rated on the following scale:

SR<30	Low (L)	Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required.
30<**SR** <60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR>60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. Animpact which could influence the decision about whether or not to proceed with the project.

5.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale:

SR<30	Low (L)	The impact is mitigated to the point where it is of limited importance.
30<**SR** <60	Medium (M)	Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
SR>60	High (H)	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded of high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

5.4 REPRESENTATION OF NOISE LEVELS

Noise rating levels will be calculated in this report using the appropriate sound propagation models as defined. It is therefore important to understand the difference between sound or noise level as well as the noise rating level (also see Glossary of Terms, **Appendix A**).

Sound or noise levels generally refers to a level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections and adjustments was added. These noise rating levels are further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In this project it illustrate the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time.

6 METHODS: CALCULATION OF NOISE CLIMATE

6.1 NOISE CLIMATE ON THE SURROUNDING ENVIRONMENT

6.1.1 Point Sources – Infrastructure

The noise emissions from various sources, as defined by the project, were calculated in detail for the operation of the construction and operational activities by using the sound propagation models described by SANS 10357 and ISO 9613-2 models.

The following were considered:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receivers from the noise sources;
- The impact of atmospheric absorption;
- The meteorological conditions in terms of Pascal stability;
- The operational details of the proposed project, such as projected areas where activities will be taking place;
- Screening corrections where applicable;
- Topographical layout; and
- Acoustical characteristics of the ground.

6.1.2 Linear Sources – Road Traffic

- Distance of receptor from the road;
- Road construction material;
- Average speeds of travel;
- Types of vehicles used;
- Road gradient; and
- Ground acoustical conditions.

Although the SANS 10210 model is the South African guideline on road noise propagation, there exists International various models including:

- VBUS – Germany model;
- NMPB - Roads 2008 - French model;
- Calculation of Road Traffic Noise (CoRTN) – British model; and
- FHWA 1998 TNM – United States model.

Each model in itself has its own advantages and issues. This report uses the CoRTN (British) L_{A10} values to check the modelling accuracy.

7 ASSUMPTIONS AND LIMITATIONS

7.1 LIMITATIONS - ACOUSTICAL MEASUREMENTS

Limitations due to environmental acoustical measurements include the following:

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. A high measurement may not necessarily mean that the area is always noisy. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of day, dependant on faunal characteristics (mating season, dawn chorus[36] early hours of the morning, temperature etc.), vegetation in the area and meteorological conditions (especially wind). This excludes the potential effect of sounds from anthropogenic origin;
- As mentioned above seasonal changes in the surrounding environment can change the measured soundscape. Many faunal species are more active during warmer periods than colder periods. Cicada (crickets) is usually only active during warmer periods. Certain cicada species can generate noise levels up to 120 dB for mating or distress purposes, sometimes singing in synchronisation magnifying noise levels they produce from their tymbals[37];
- Defining ambient sound levels using the result of one 10-minute measurement may be very inaccurate (very low confidence level in the results) relating to the reasons mentioned above;
- Determination of noise sources of environmental significance are an important factor to consider when compiling an environmental acoustical report;
- Measurements over wind speeds of 3 -5 m/s could provide data influenced by wind-induced noises;
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high due to faunal activity which can dominate the sound levels around the measurement point (specifically during summertime, rainfall event or during dawn chorus of bird songs). This generally is still considered naturally quiet and accepted as features of the natural soundscape, and in various cases sought after and pleasing;
- Considering one or more sound descriptor or equivalent can improve an acoustical assessment. Parameters such as L_{AMin}, L_{Aeq}, L_{AMax}, L_{A10}, L_{A90} and spectral analysis forms part of the many variables that can be considered. The South African Legislation however is the L_{AIeq} setting, and must at all times be considered;
- It is technically difficult and time consuming to improve the measurement of spectral distribution of large equipment in an industrial setting. This is due to the many

[36] Environ. We Int. Sci. Tech. *Ambient noise levels due to dawn chorus at different habitats in Delhi*. 2001. Pg. 134.
[37] Clyne, D. *"Cicadas: Sound of the Australian Summer, Australian Geographic"* Oct/Dec Vol 56. 1999.

correction factors that need to be considered (e.g. other noise sources active in the area, adequacy of average time setting, surrounding field non-uniformity etc. [38] as per SANS 9614-3:2005);

- Exact location of a sound level meter in an area in relation to structures, infrastructure, vegetation, wetlands and external noise sources will influence measurements. It may determine whether you are measuring anthropogenic sounds from a receptors dwelling, or measuring environmental ambient soundscape contributors of significance (faunal, roads traffic, railway traffic movement etc.); and
- As a residential area develops, the presence of people will result in increased dwelling related sounds. These are generally a combination of traffic noise, voices, animals and equipment (including TV's and Radios). The result is that ambient sound levels will increase as an area matures.

7.2 Calculating noise emissions – Adequacy of predictive methods

Limitations due to the calculations of the noise emissions into the environment include the following:

- Many sound propagation models do not consider sound characteristics as calculations are based on an equivalent level (with the appropriate correction implemented e.g. tone or impulse). These other characteristics include intrusive sounds or amplitude modulation;
- Many sound propagation models do not accurately (or at all) calculate the increase of the ambient soundscape due to wind shear (masking noise);
- Most sound propagation models do not consider refraction through the various temperature layers (specifically relevant during the night-times);
- Most sound propagation models do not consider the low frequency range (third octave 16 Hz – 31.5 Hz). This would be relevant to facilities with a potentially low frequency issues;
- Many environmental models consider sound to propagate in hemi-spherical way. Certain noise sources (e.g. a speakers, exhausts, fans) emit sound power levels in a directional manner;
- The octave sound power levels selected for processes and equipment accurately represents the sound character and power levels of processes/equipment. The determination of these levels in itself is subject to errors, limitations and assumptions with any potential errors carried over to any model making use of these results;
- Sound power emission levels from processes and equipment may change depending on the load the process and equipment is subject too. While the octave sound power

[38] SANS 9614-3:2005. "Determination of sound power levels of noise sources using sound intensity – Part 3: Precision method for measurement by scanning".

level is the average (equivalent) result of a number of measurements, this measurement relates to a period that the process or equipment was subject to a certain load. Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worst-case scenario;

- As it is unknown which processes and equipment will be operational, modelling considers a scenario where all processes and equipment are under full load 100% of the time. The result is that projected noise levels would likely over-estimate or over-engineered sound levels;
- The impact of atmospheric absorption is simplified and very uniform meteorological conditions are considered. This is an over-simplification and the effect of this in terms of sound propagation modelling is difficult to quantify;
- Many environmental models are not highly suited for close proximity calculations; and
- Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform. Ground conditions will not be considered in this assessment.

Due to these assumptions modelling generally could be out with as much as +10 dBA although realistic values ranging from 3 dBA to less than 5 dBA is more common in practice.

7.3 ADEQUACY OF UNDERLYING ASSUMPTIONS

Noise experienced at a certain location is the cumulative result of innumerable sounds emitted and generated both far and close, each in a different time domain, each having a different spectral character at a different sound level. Each of these sounds are also impacted differently by surrounding vegetation, structures and meteorological conditions that result in a total cumulative noise level represented by a few numbers on a sound level meter. As previously mentioned, it is not the purpose of noise modelling to accurately determine a likely noise level at a certain receptor, but to calculate a noise rating level that is used to identify potential issues of concern.

7.3.1 Haul route during operations and onsite measurements

- Haul route alignments were not available and a linear conceptual scenario was investigated;
- The safety of measurement equipment used to conduct longer-term measurements (24 hours or more) was a concern. Where longer-term measurements could not be conducted 3x 10 minute measurements were collected.

8 SCENARIO: FUTURE NOISE CLIMATE

8.1 INVESTIGATED SCENARIOS

Two scenarios are applicable namely the future construction and operational phases. No acoustical baseline scenario was investigated as not important attributed was identified. The two phases are discussed in more detail in **Section** 4. Daytime (06:00 – 22:00) and night-time (22:00 – 06:00) operations will be assessed. It should be noted that night-time operations may not occur frequently (see available information **Section 1.4**).

Calculations in this section are based on a worst-case scenario and will not be relevant for all times of the construction or operation phases (not a moment in time, but the potential extent of noise rating levels during the relevant phase i.e. $L_{Req,1hr/dn}$). Modelled impact scenarios are a representation of the precautionary principle or over-engineering.

8.1.1 Investigated Construction Scenario

This section investigates the construction phase of the project in terms of acoustics. The resulting primary and secondary corrections are presented in **Table 8-1** with the construction scenario layout presented in **Figure 8-1**. Due to the lack of information available on haul route layouts, a generic conceptual linear scenario was investigated.

Table 8-1: $L_{R,dn}$ construction scenarios investigated

Intervening environmental factors	
Receiver(s)	See layout in **Figure 1-2** & **Figure 8-1**.
Indoor correction (screening)	-20 dB.
Intervening ground correction	Medium-hard nature (25% soft).
Façade correction	No.
Metrological	Activities assessed functioned during wind-still conditions during good sound propagation conditions (20°C and 80% humidity).
Elevations	Yes.
Spitsvale open cast stripping and site preparations	
Screening corrections	No. A direct line of sight from noise source to receiver will be achieved as this phase will see development of berms and highwalls.
Grasvally construction noise sources	See **Section 4.2.**
Haul routes	
Traffic: Conceptual haul route	Vehicles considered at 6 per hour (50 % heavy and light - a conceptual scenario).
Average speed (km/h)	An estimated 60 km/h (maximum allowable speeds on a typical mine due to health & safety legislation).
Road Surface	Unpaved
Aggregate, binder & texture	N/a
Sand Patch Test Texture Depth	N/a
Stop junction	None assessed. Traffic calculated at constant speed.
Lanes	Single lane, although the route will likely be alternative directions.

8.1.2 Investigated Operational Soundscape

This section investigates the operational phase of the project in terms of acoustics. The resulting corrections are presented in **Table 8-2** with the operational scenario layout presented in **Figure 8-1**. Due to the lack of information available on haul route layouts, a generic conceptual linear scenario was investigated.

Table 8-2: $L_{R,dn}$ operational scenarios investigated

Intervening environmental factors	
Receiver(s)	See layout in **Figure 1-2** & **Figure 8-1**.
Indoor correction (screening)	-20 dB.
Intervening ground correction	Medium-hard nature.
Façade correction	No.
Metrological	Activities assessed functioned during wind-still conditions, in good sound propagation conditions (20°C and 80% humidity).
Elevations	Yes.
Spitsvale open cast mining and plan operations	
Screening corrections	No. As noted berms and barriers may not act as acoustical screens due to heights of operations on mountains and hills.
Grasvally construction noise sources	See **Section 4.2.**
Haul routes	
Traffic: Conceptual haul route	Vehicles considered at 6 per hour (50 % heavy and light - a conceptual scenario).
Average speed (km/h)	An estimated 60 km/h (maximum allowable speeds on a typical mine due to health & safety legislation).
Road Surface	Unpaved
Aggregate, binder & texture	N/a
Sand Patch Test Texture Depth	N/a
Stop junction	None assessed. Traffic calculated at constant speed.
Lanes	Single lane, although the route will likely be alternative directions.

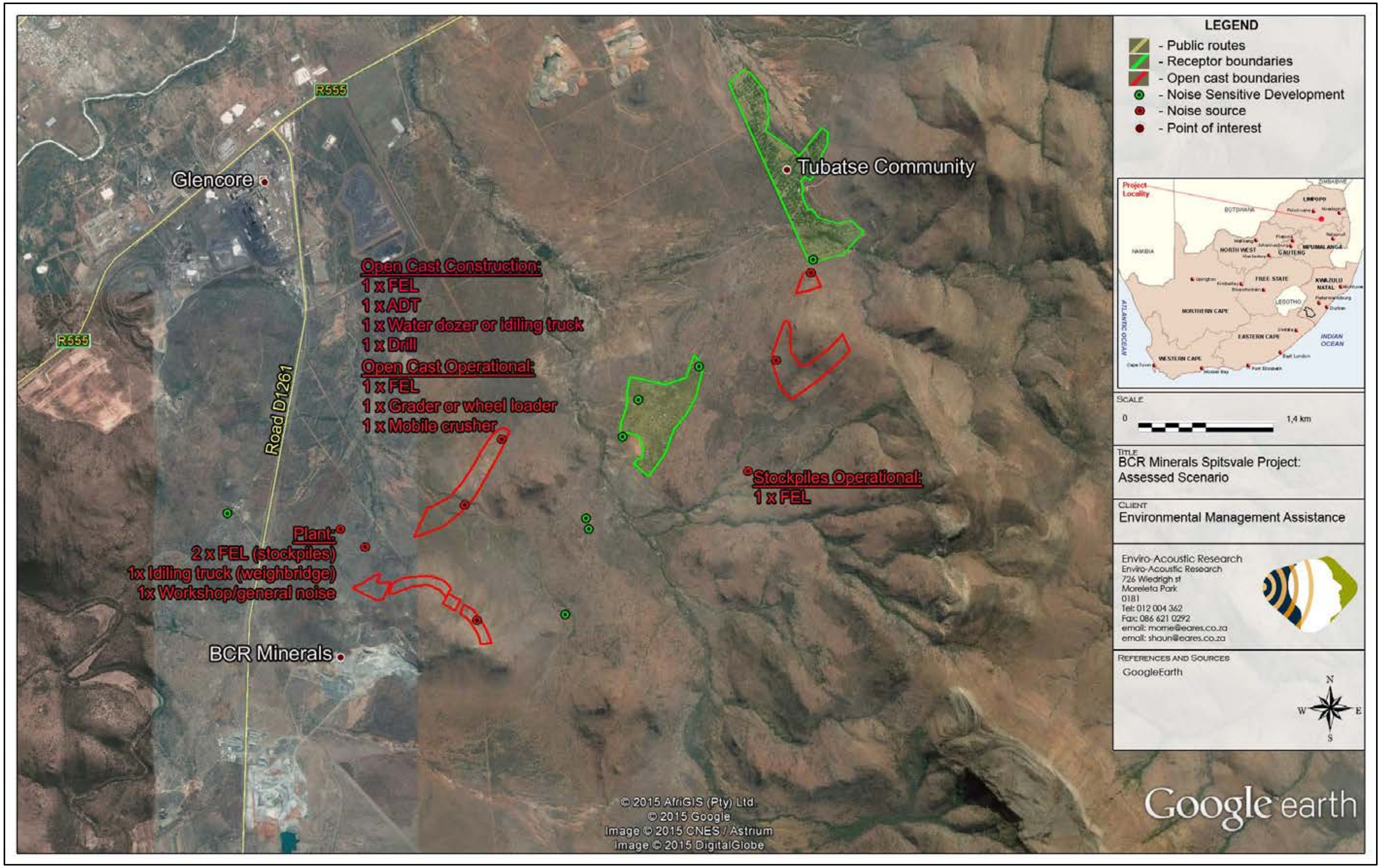

Figure 8-1: Investigated scenarios

9 MODELLING RESULTS AND IMPACT ASSESSMENT

9.1 MODELLED SCENARIOS

Most critical investigational times would be the night-time hours when a quiet environment is desired (at night for sleeping, weekends etc.) and when other masking sounds/noises may subside (local road traffic etc.).

It should be noted that the projected noise levels represent a potential worse-case sound levels at a specific point in time, considering all the various activities simultaneously, operating at full load levels (maximum noise levels).

9.1.1 Haul Routes $L_{Req,1hr}$ – Worst-case Maximum Noise Levels

The outcome of the day-night linear haul route scenario investigated (see **Section 4.3.3** - **Section 7.3.1**) is presented in **Figure 9-1 - Figure 9-2**.

9.1.2 Construction $L_{Req,1hr}$ – Worst-case Maximum Noise Levels

The resulting outcome of the daytime and night-time construction impact assessment is presented in **Table 9-1** and **Table 9-2** respectively specifically on the receptors within the study area. It is further represented in **Figure 9-3** using contours of constant noise levels.

The resulting future noise projections indicated that the construction of the further most open cast pits activities as modelled for representation at times may not comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and International Finance Corporation. Mitigation options are further presented in preceding **Section 10**.

9.1.3 Operational $L_{Req,1hr}$ – Worst-case Maximum Noise Levels

The resulting outcome of the daytime and night-time construction impact assessment is presented in **Table 9-3** and **Table 9-4** respectively specifically on the receptors within the study area. It is further represented **Figure 9-4** using contours of constant noise levels.

The resulting future noise projections indicated that the operation of the further most open cast pits activities as modelled for representation at times may not comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and International Finance Corporation. Mitigation options are further presented in preceding **Section 10**.

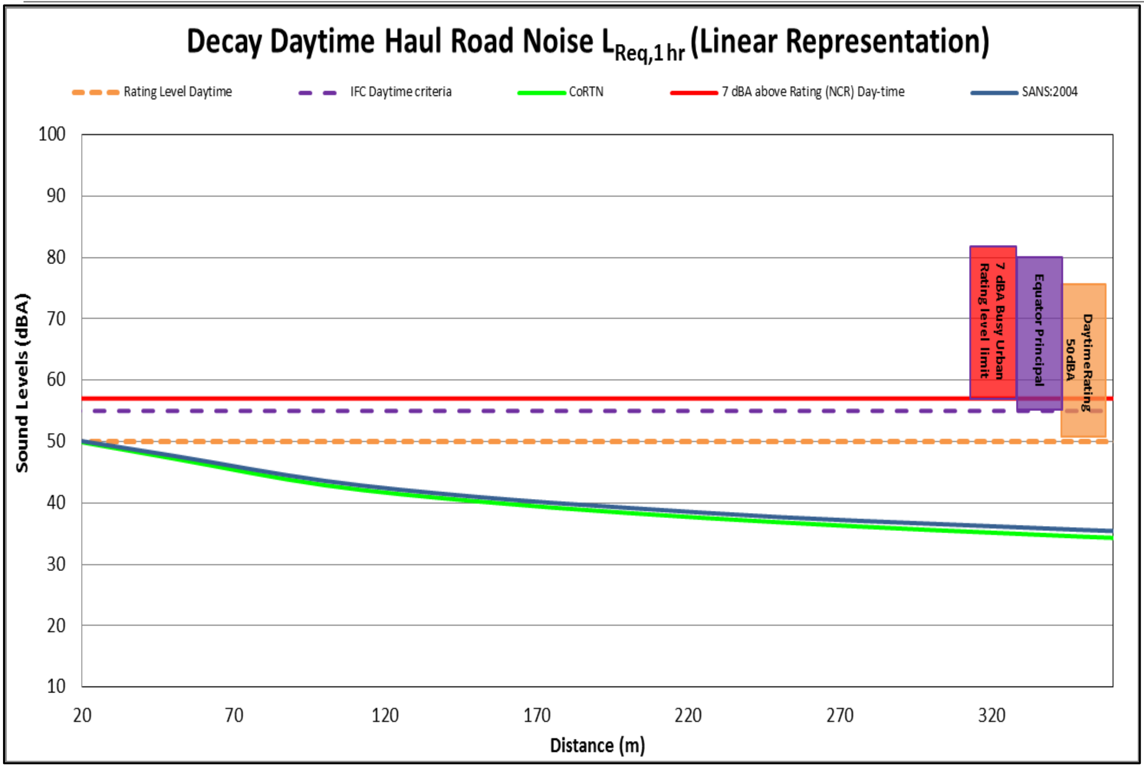

Figure 9-1: $L_{R,d}$ projected noise levels vs. distance – daytimes

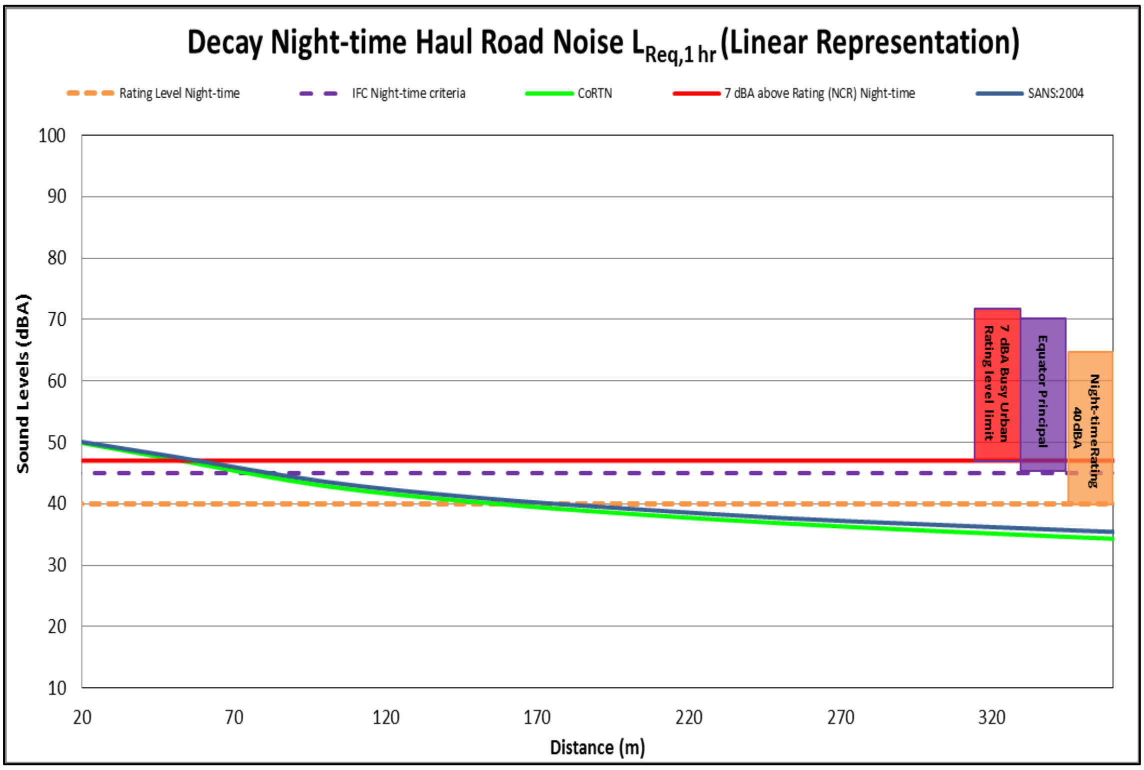

Figure 9-2: $L_{R,n}$ projected noise levels vs. distance - night-times

Table 9-1: Impact Assessment: Daytime construction activities

Receiver no	Projected Construction noise level - $L_{Aeq,1hr}$ (dBA)	Daytime Rating Level ($L_{Req,d}$) (dBA)	Magnitude (compared to daytime rating level) 50 dBA	Duration	Extent	Probability (considering range of measures ambient sound levels)	Significance
1	62.0	50 dBA Suburban Rating (or 55 dBA IFC limits)	10	2	2	3	**42**
2	44.0		2	2	2	2	**12**
3	43.0		2	2	2	2	**12**
4	38.0		2	2	2	2	**12**
5	41.0		2	2	2	2	**12**
6	42.0		2	2	2	2	**12**
7	44.0		2	2	2	2	**12**
8	30.0		2	2	2	2	**12**

Comments: The furthermost open cast pit borders the Tubatse Community (NSD01). Due to the close proximity of receptors to noisy activities the probability of a noise impact increases. Receptors may not be present during daytime hours.

Probability of impact	Moderate
Confidence in finding	High
Mitigation measures	Mitigation is required, see preceding **Section 10**
Cumulative impacts	Construction noises will cumulatively add to any other noises in the area. The construction activities will be the dominant source at receptors NSD01 when operating adjacent to community
Residual Impacts:	This impact will continue with the construction phase, although the levels and character may be different.

Table 9-2: Impact Assessment: Night-time construction activities

Receiver no	Projected Construction noise level - $L_{Aeq,1hr}$ (dBA)	Night-time Rating Level ($L_{Req,n}$) (dBA)	Magnitude (compared to night-time rating level) - 40 dBA	Duration	Extent	Probability (considering range of measures ambient sound levels)	Significance
1	62.0	40 dBA Suburban Rating (or IFC limits)	10	2	2	4	56
2	44.0		4	2	2	2	16
3	43.0		2	2	2	2	12
4	38.0		2	2	2	2	12
5	41.0		2	2	2	2	12
6	42.0		2	2	2	2	12
7	44.0		4	2	2	2	16
8	30.0		2	2	2	2	12
Comments: The furthermost open cast pit borders the Tubatse Community (NSD01). Due to the close proximity of receptors to noisy activities the probability of a noise impact increases. There are other night noise characteristics/factors that will increase the likelihood of an impact occurring at NSD01 during the night-time (and due to proximity of noise source to receivers). These include the use of reverse alarms on equipment (however exempt from legislation, see Noise Control Regulations) impulsive events (only International World Health Organisation recommendations) etc.							
Probability of impact	Moderate-high						
Confidence in finding	High						
Mitigation measures	Mitigation is required, see preceding **Section 10**						
Cumulative impacts	Construction noises will cumulatively add to any other noises in the area. The construction activities will be the dominant source at receptors NSD01 when operating adjacent to community						
Residual Impacts:	This impact will continue with the construction phase, although the levels and character may be different.						

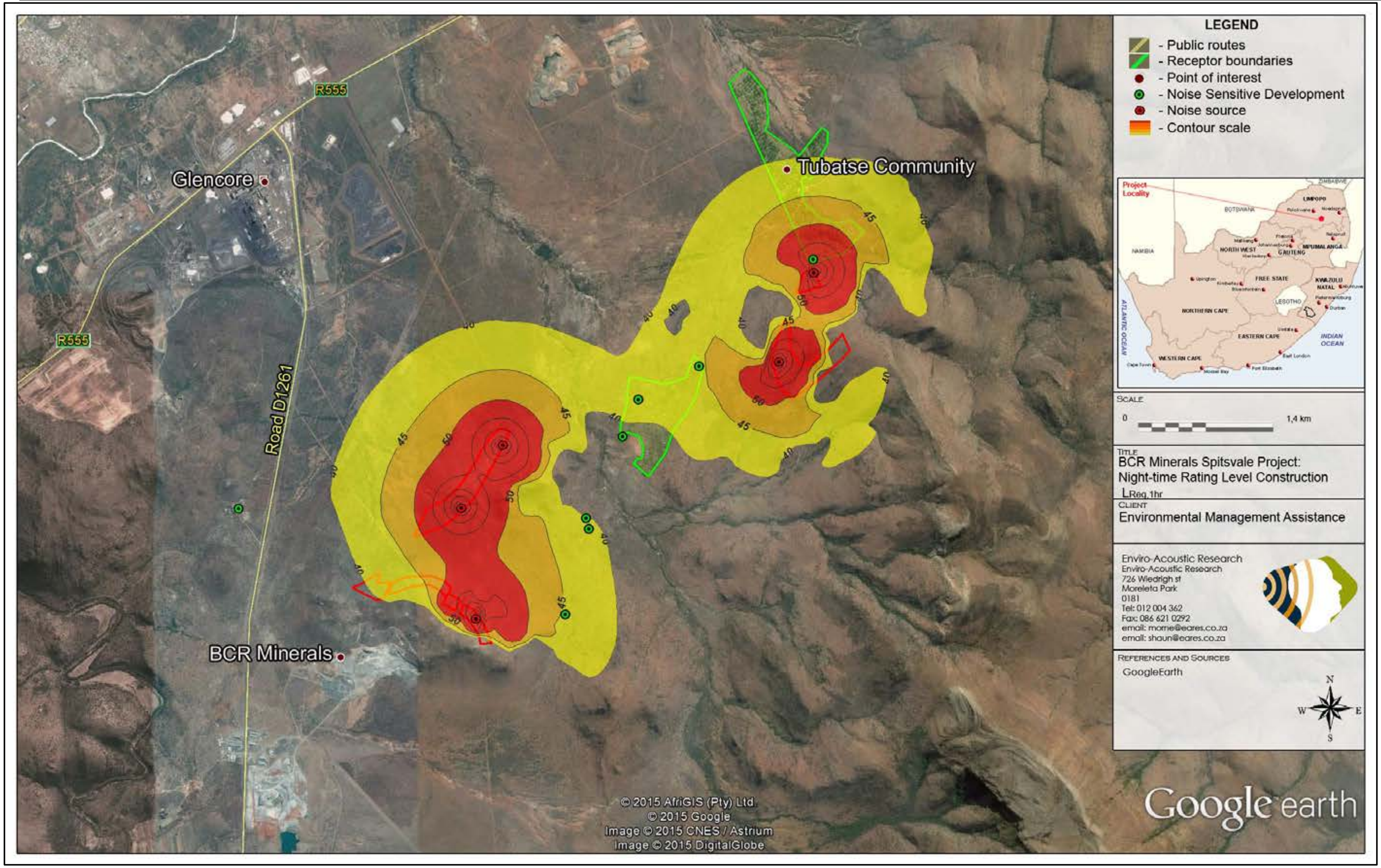

Figure 9-3: Projected night-time construction noise Rating Levels

Table 9-3: Impact Assessment: Daytime operational activities

Receiver no	Projected Operational noise level - $L_{Aeq,1hr}$ (dBA)	Daytime Rating Level ($L_{Req,d}$) (dBA)	Magnitude (compared to daytime rating level) - 50 dBA	Duration	Extent	Probability (considering range of measures ambient sound levels)	Significance
1	63.00	50 dBA Suburban Rating (or IFC limits)	10	4	2	3	**48**
2	45.60		2	4	2	2	**16**
3	41.30		2	4	2	2	**16**
4	39.60		2	4	2	2	**16**
5	40.40		2	4	2	2	**16**
6	40.60		2	4	2	2	**16**
7	45.00		2	4	2	2	**16**
8	N/a		2	4	2	2	**16**

Comments: The furthermost open cast pit borders the Tubatse Community (NSD01). Due to the close proximity of receptors to noisy activities the probability of a noise impact increases. Receptors may not be present during daytime hours.

Probability of impact	Moderate
Confidence in finding	High
Mitigation measures	Mitigation is required, see preceding **Section 10**
Cumulative impacts	Operational noises will cumulatively add to any other noises in the area. The construction activities will be the dominant source at receptors NSD01 when operating adjacent to community
Residual Impacts:	This impact will continue with the operational phase, although the levels and character may be different

Table 9-4: Impact Assessment: Night-time operational activities

Receiver no	Projected Operational noise level - $L_{Aeq,1hr}$ (dBA)	Night-time Rating Level ($L_{Req,n}$) (dBA)	Magnitude (compared to night-time rating level) - 40 dBA	Duration	Extent	Probability (considering range of measures ambient sound levels)	Significance
1	63.00	40 dBA Suburban Rating (or IFC limits)	10	4	2	4	64
2	45.60		2	4	2	2	16
3	41.30		2	4	2	2	16
4	39.60		2	4	2	2	16
5	40.40		2	4	2	2	16
6	40.60		2	4	2	2	16
7	45.00		2	4	2	2	16
8	N/a		2	4	2	2	16

Comments: The furthermost open cast pit borders the Tubatse Community (NSD01). Due to the close proximity of receptors to noisy activities the probability of a noise impact increases. There are other night noise characteristics/factors that will increase the likelihood of an impact occurring at NSD01 during the night-time (and due to proximity of noise source to receivers). These include the use of reverse alarms on equipment (however exempt from legislation, see Noise Control Regulations) impulsive events (only International World Health Organisation recommendations) etc.	
Probability of impact	Moderate-high
Confidence in finding	High
Mitigation measures	Mitigation is required, see preceding **Section 10**
Cumulative impacts	Operational noises will cumulatively add to any other noises in the area. The construction activities will be the dominant source at receptors NSD01 when operating adjacent to community
Residual Impacts:	This impact will continue with the operational phase, although the levels and character may be different

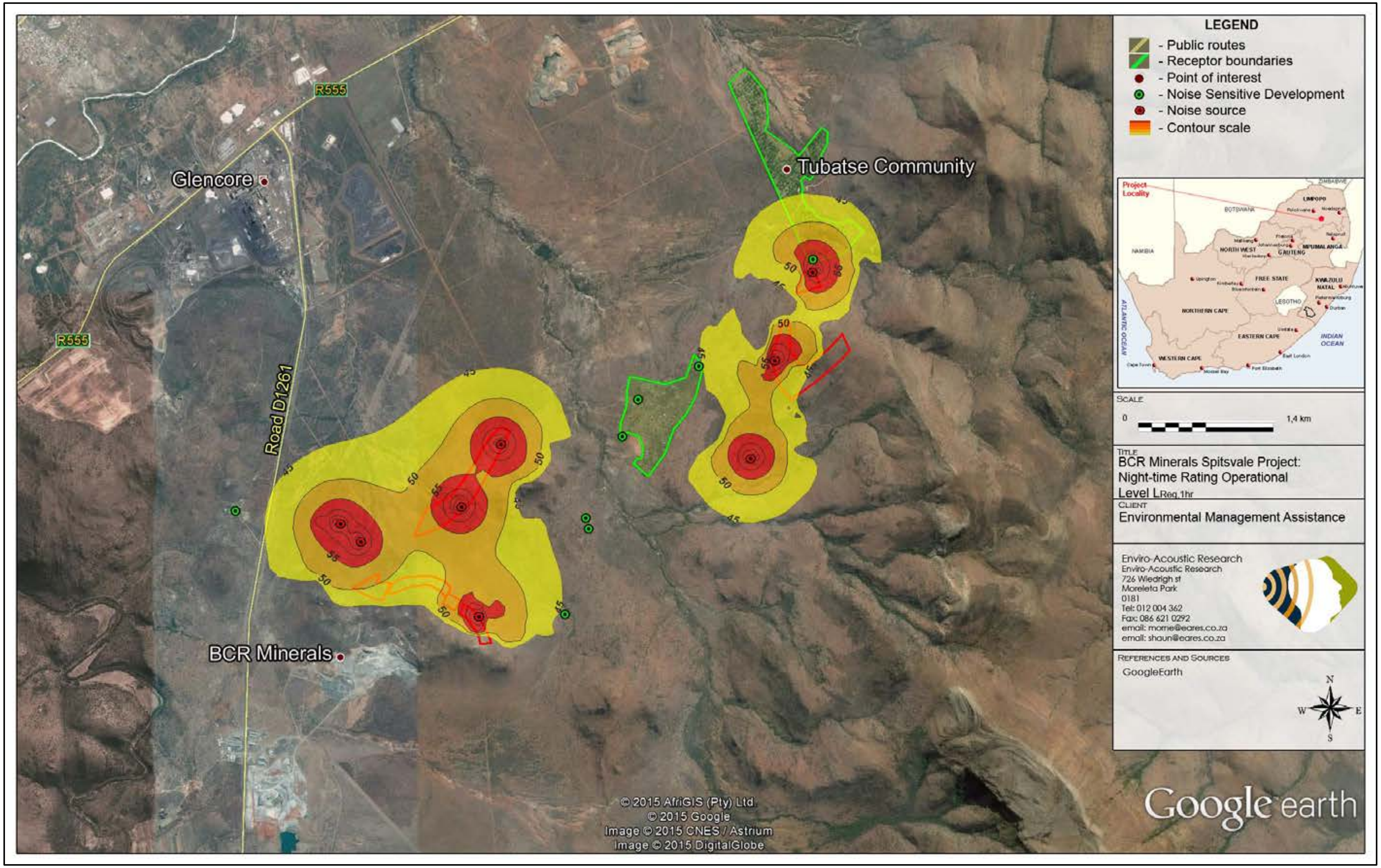

Figure 9-4: Projected night-time operational noise Rating Levels

10 MITIGATION OPTIONS

The two most relevant primary mitigation corrections that can be considered for the project is berms/barriers (acoustical screen) and distance between noise source and receiver (a buffer). These primary corrections will get the best reduction of noise levels at receptors e.g. doubling of distance will be app. -6dBA (reduction).

Other technical and management options are also discussed further below. Engineering out a large portion of the noise from large equipment to be used on the open cast is not a financially feasible option (mechanical component design etc.), as equipment could generate in excess of 115 dBA. Only technically financially feasible options such as exhaust mufflers or engine bay covers will be considered (an option that can result in a much small reduction). Relocation of receptors (many houses) within a community is not deemed a viable option either and was no considered.

The only potential area where a noise impact could occur is from the operations of the northern most open cast pit (impacting on NSD01 - refer to Figure 10-1) on the closest receptors of the Tubatse community. Most mitigation options will focus on this specific potentially noise-sensitive area.

10.1 PRE-PLANNING STAGE

During the planning phase the developer and project design team can consider implementing various acoustical related specifications and management related options to reduce noise levels as defined below:

- The developer must implement an Acoustical Measurement & Audit Programme for receptors **NSD01** during the construction and operational phase. Refer to **Section 11** which outlines the proposed acoustical measurement plan in the Environmental Management Plan (EMP).
- Haul road designs could consider the below design elements that would be applicable during all phases of the project:
    - o Limit the maximum speed on the haul roads to 50 - 70 km/h when operating close to potential noise-sensitive receptors (within 100 m). Road speeds should be kept as consistent as is feasibly possible (i.e. no speed bumps to reduce noise or stop junctions). This would help in keeping road traffic noise more “linear” (i.e. no ADT air brakes on long stretches of roads, no acceleration of vehicles from a stop junction

using maximum capacity of engine in lower gears for pulling power etc.);
    - If feasible, roads should be planned so as to reduce heavy vehicles reversing when collecting or dumping at stockpiles/tips etc. This will minimise the use of reverse alarms on vehicles. An example is to design a road loop around a stockpile dump, thus ensuring that once an ADT has released its load it will move forward around the loop and back onto the haul road (i.e. no reversing at stockpile to get back to haul road); and
    - If feasible the road should be paved or asphalted (e.g. continuous graded asphalt). From an acoustical perspective paver bricks should not be considered. It is likely that routes will be unpaved. The developer should then consider maintain these unpaved routes regularly smoothing out irregularities on the routes.
- Stockpiles of hards or softs (such as the topsoil) could be implemented between the Tubatse community and the further most norther open cast pit. This may however impact on other environmental factors such as visual, soils, water etc. and should be discussed with relevant specialists. If implemented the stockpiles bisecting the Tubatse community and open cast pit should be designed sloping away from the community towards the pit with access routes well concealed on opposite façade of the community (i.e. facing pits and not community). No night-time work should occur on these stockpiles, including bollard implementation (or safety barriers) and stockpile compaction or management;
- The developer could consider alternative layouts or moving open cast pits further back from receptors NSD01 (Tubatse community); and
- If the layout of the mine changes significantly (or assumptions change) used in this report, that this Environmental Noise Impact Assessment be reviewed with the appropriate information supplied by the developer, including:
    - Locality of the noise source;
    - Operational time of the noise source; and
    - If possible specifications regarding the noise source.

10.2 CONSTRUCTION PHASE

Due to the moderate significance for a potential for a noise impact to occur, mitigation options are recommended during the construction of open cast pits.

10.2.1 Open cast pits

Mitigation options include:

- The developer should minimize **night-time** operations when removing topsoil and overburden from open cast pits directly bordering NSD01 (Tubatse Community). For the developer to ensure a 45 dBA contour at receptors (and based on a worst-case scenario) equipment would require a buffer of 750m from the closest dwelling in the community (night-time operation);
- It is recommended that the barrier be built as close as feasibly possible to the mining operations or receptor. Berm/barriers are required either at the community or at the open cast pit. Due to the elevation of the pit going uphill (onto a mountainous section) implementing a barrier on the open cast boundary (i.e. on the outskirts of the footprint, see red line **Figure 10-1**) will not suffice as raising a noise source or receive above a barrier reduces the effect of the acoustical screens shadow zone (see insert **Figure 10-1**). To negate this one would require a berm/barrier directly adjacent to the closest dwellings to the open cast footprint or a berm as feasibly close to the noise source at all times (i.e. directly adjacent such as developing berm per open cast grid);
- The developer should consider the introduction of berms/highwalls (and during the daytime only) before any site clearance/stripping or construction activities commences. This will minimise the amount of equipment operating simultaneously (i.e., construction of pits and berm development). Topsoil/Overburden/interburden acquired from open cast development could be sourced as berm material. The following factors/specifications should be considered when implementing as berm as an acoustical screen:
  - It is recommended that the height of the berms/barriers be at least 2 - 3 m higher than the line of sight to the highest noise source from open cast pits and stockpile areas, although the higher the berm/barrier the better acoustical screen tool it will be[39]. Certain heavy vehicles have their exhaust ports above the cabin of the vehicle and needs to be considered as the noise source point. Barriers must also be sufficiently dense (at least 10 kg/m^2) [40] and sufficient in thickness. A brick wall provides a surface density of 244 kg/m^2 at thickness of 150 mm[41] and is considered as a typically good acoustical

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[39] Norton, M.P. and Karczub, D.G, *"Fundamentals of Noise and Vibration Analysis for Engineers",* Second Edition, 2003, p.600.
[40] International Finance Corporation. General EHS Guidelines – Environmental Noise Management.
[41] Everest and Pohlmann, "Master Handbook of Acoustics", Fifth Edition, 2009, p. 121.

barrier. Certain metrological conditions (particularly during night-times) can see refraction of noise over the barriers due to the various temperature inversion layers. This means that noise levels from a mine may propagate back down to the ground at a receptors dwelling due to the curvature of sound in the warmer upper night-time atmosphere. Barrier height cannot effect this propagation[42];
    - The barrier should be sufficiently long to block the line of sight from receptors to the sides of the mining operations; and
- No apertures (gaps, entrances) should be implemented at berms/highwalls and facing a receptors dwelling. If an open cast pit entrance is implemented it should be designed facing away from receptors. This is due to security points and berm entrances where haul trucks need to stop and make use of air brakes and reverse alarms, which may cause a noise annoyance at a receptors property; and
- Communication between the Tubatse community and the developer need to be implemented and maintained, highlighting the outcome of this study. The developer should consider co-ordinate the working time with periods when the receptors are likely not at home. An example would be to work within the 8 am to 2 pm time-slot to minimise the significance of the impact due to:
    - Potentially receptors are most likely at school or at work, minimizing the probability of an impact happening; and
    - Normal daily activities will generate other noises that would most likely mask construction noises, minimizing the probability of an impact happening.
- The use the smaller/quieter equipment when operating near receptors. An example could be the use of equipment that can haul less tonnage (and less engine capacity). A 64 ton dump truck could be replaced by a 32 ton, while one FEL with a small bucket capacity (e.g. 1.9m^3 at net power of 92 kW[43]) could be used instead of a larger capacity FEL;
- Ensuring that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. Acoustical mufflers (or silencers) should be considered on equipment exhausts on open cast pits and stockpile areas. A noise absorption braid could be mounted on the front of heavy equipment radiators (ADT's, FEL's etc.) to prevent excess mechanical fan noise into the surrounding environment. Engine bay covers over heavy equipment could be pre-fitted with sound absorbing material.

[42] Norton, M.P. and Karczub, D.G, *"Fundamentals of Noise and Vibration Analysis for Engineers"*, Second Edition, 2003, p.600.
[43] BELL E-series FEL catalogue

Heavy equipment that fully encloses the engine bay should be considered, ensuring that the seam gap between the hood and vehicle body is minimised;

- The developer should investigate the use of white-noise generators instead of tonal reverse alarms on heavy vehicles operating on roads, in mine pits and at stockpile areas[44]. This option is highly recommended although it must be noted that reverse alarms is exempt from an acoustical assessment due to Government Notice R154 of 1992 (Noise Control Regulations) – Clause 7.(1) – *"the emission of sound is for the purposes of warning people of a dangerous situation";* and
- Ensure a good working relationship between the mining environmental representative and all potentially sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them. Information that should be provided to the potentially sensitive receptor(s) include:
  - Proposed working times;
  - How long the activity is anticipated to take place;
  - What is being done, or why the activity is taking place;
  - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.

10.2.2 Road design, specifications & information

Refer to previous section (Pre-planning phase **Section 10.2**) highlighting design specifications for the developer to consider.

10.2.3 Blasting & Vibrations

It must be also noted that if blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist.

[44] White Noise Reverse Alarms: http://www.brigade-electronics.com/products.

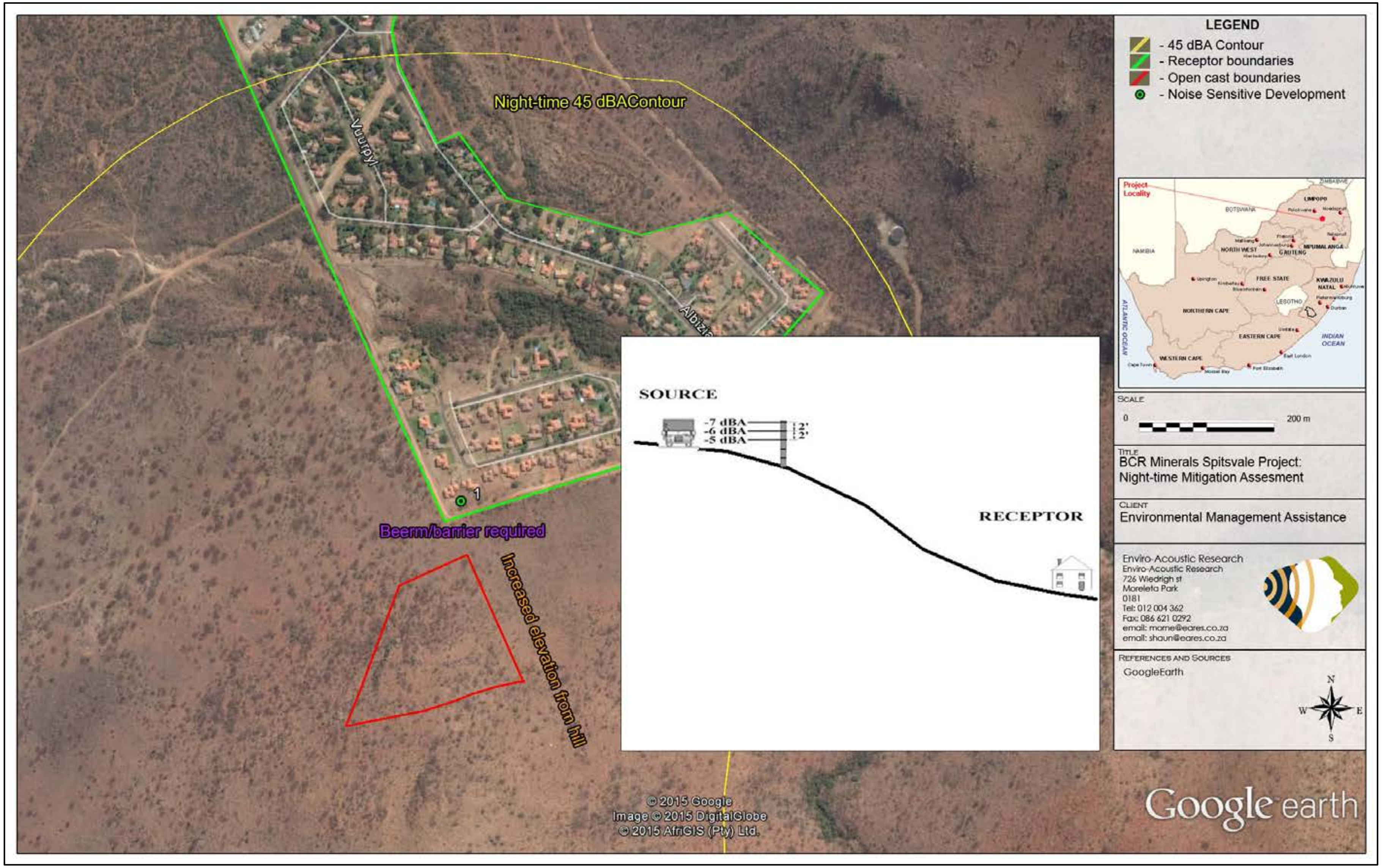

Figure 10-1: Night-time 45 dBA contour and mitigation options

10.3 OPERATIONAL PHASE

Due to the moderate to high significance for a potential for a noise impact to occur, mitigation options are recommended during the operational phase.

10.3.1 Open cast pits

Mitigation options include:

- The developer should minimize **night-time** operations at open cast pits directly bordering NSD01 (Tubatse Community);
- Ensure that berms/barriers as highlighted in the construction phase (**Section 10.2.1**) has been implemented and maintained; and
- At all times communication between the receptors at Tubatse community and the developer must be maintained. See also previous **Section 10.2.1**.

Refer to previous section (Construction phase **Section 10.2**) highlighting design specifications for the developer to consider.

10.3.2 Road design, specifications & information

Refer to previous section (Pre-planning phase **Section 10.2**) highlighting design specifications for the developer to consider.

10.3.3 Plant

No mitigation options are highlighted for the plant as no receptor is within 1,000m of this area.

10.4 MITIGATION OPTIONS SUMMARY – ALL PHASES

10.4.1 Important Environmental Authorisation Mitigation

The most important mitigation options to consider and could be implemented in the Environmental Authorisation include:

- To minimize night-time operations on the open cast pits proposed adjacent to the Tubatse community;
- Berms/barriers need to be developed between the northern-most mining area and the residential area just north of this mining site. The following factors/specifications should be considered when implementing as berm as an acoustical screen:
  - It is recommended that the barrier be built as close as feasibly possible to the mining operations or receptor. Due to the elevation of the pit going uphill (onto a mountainous section) implementing a

barrier on the open cast boundary (i.e. on the outskirts of the footprint, see red line **Figure 10-1**) will not suffice as raising a noise source or receive above a barrier reduces the effect of the acoustical screens shadow zone (see insert **Figure 10-1**). To negate this one would require a berm/barrier directly adjacent to the closest dwellings to the open cast footprint or a berm as feasibly close to the noise source at all times (i.e. directly adjacent such as developing berm per open cast grid);

- It is recommended that the height of the berms/barriers be at least 2 - 3 m higher than the line of sight to the highest noise source from open cast pits and stockpile areas, although the higher the berm/barrier the better acoustical screen tool it will be. Certain heavy vehicles have their exhaust ports above the cabin of the vehicle and needs to be considered as the noise source point. Barriers must also be sufficiently dense (at least 10 kg/m^2) and sufficient in thickness. A brick wall provides a surface density of 244 kg/m^2 at thickness of 150 mm and is considered as a typically good acoustical barrier. Certain metrological conditions (particularly during night-times) can see refraction of noise over the barriers due to the various temperature inversion layers. This means that noise levels from a mine may propagate back down to the ground at a receptors dwelling due to the curvature of sound in the warmer upper night-time atmosphere. Barrier height cannot effect this propagation;
- The barrier should be sufficiently long to block the line of sight from receptors to the sides of the mining operations;
- No apertures (gaps, entrances) should be implemented at berms/highwalls and facing a receptors dwelling;

- Communication between the Tubatse community and the developer need to be implemented and maintained, highlighting the outcome of this study;
- An Acoustical Measurement & Audit Programme must be developed and implemented before the construction of the northern-most pits. Noise measurements should continue as long as mining activities take place within 1,000m from the closest NSD;
- If blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist; and
- If new mining areas are proposed with 1,000 m of any NSD, this report, this Environmental Noise Impact Assessment must be reviewed.

10.4.2 Environmental Management Programme (EMP) Mitigation

The aspects that could be included in the EMP to ensure compliance with the Noise Control Regulations include the following:

- An Acoustical Measurement & Audit Programme must be developed and implemented before the construction of the northern-most pits. Noise measurements should continue as long as mining activities take place within 1,000m from the closest NSD;
- The developer must investigate any reasonable and valid noise complaint if registered by a receptor staying within 1,000 m from location where construction or operational activities are taking place;
- Berms/barriers need to be developed between the northern-most mining area and the residential area just north of this mining site;
- The use the smaller/quieter equipment when operating near receptors (i.e. equipment with less capacity);
- Acoustical mufflers (or silencers) and noise absorption braid should be considered on equipment exhaust and engines, especially equipment operating closer to the Tubatse community; and
- If blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist.

11 ENVIRONMENTAL MANAGEMENT PLAN

11.1 CONSTRUCTION PHASE

Projected rating levels used to illustrate the construction phase of the project were modelled using the methodology as proposed by SANS 10357:2004. Construction phase entails the stripping of topsoil and overburden at open cast pits.

The resulting future noise projections indicated that the construction of the further most open cast pits activities as modelled for representation at times may not comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and International Finance Corporation. However with mitigation options implemented the compliance or criteria targets will be achieved.

The following objectives and targets are recommended to define the performance of the project in mitigating the projected noise impacts and reducing the significance of any noise impacts. Objectives and targets are relevant for Receptor **NSD01** where a moderate day and night-time noise impact has been identified (without mitigation options).

Objective	**Control potential noise pollution stemming from the construction of the project**
Project Component(s)	Construction of open cast pits.
Potential Impact	• Increased noise levels at potentially sensitive receptors exceeding criteria of the Noise Control Regulations legislation (NCR) and SANS guidelines; • Changing ambient sound levels could change the acceptable land use capability; • Changing ambient sound levels could increase annoyance and potential complaints; and • Disturbing character of sound.
Activity/Risk source	• Construction of open cast pits.
Mitigation Target/Objective	• Ensure equivalent A-weighted noise levels below 55 dBA at potentially noise-sensitive receptors (daytime). • Ensure equivalent A-weighted noise levels below 45 dBA at potentially noise-sensitive receptors (night-time). • Define the noisy areas with a set boundary ensuring that equivalent A-weighted noise levels at this boundary does not exceed 61 dB $L_{Aleq,24hr}$. It should be noted that the area would have to be demarcated as a “controlled zone” in terms of the NCR; • Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 5 - 7 dBA; • Ensuring compliance with the National Noise Control Regulations and SANS10103:2008 guidelines. The referencing of the International Finance Corporation (World Bank) guidelines for an acceptable sound level in a residential area was also considered.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Measurement and Audit Programme		
Design an Acoustical Measurement & Audit Programme. Note: If there are no noise-sensitive receptors within 1,000m from any mining activities no routine noise monitoring will be required.	- Acoustical Consultant	Before and during all phases. See below for proposed Acoustical

See the following **Section 12** for the proposed noise monitoring programme.		Measurement & Audit Programme
Haul Roads		
Limit the maximum speed on the haul roads to 60 km/h or less. Road speeds should be kept as consistent as is feasibly possible (i.e. no speed bumps to reduce noise or stop junctions). This will help minimise the use of air brakes as well as reduce required maximum capacity of heavy vehicles during pull off.	- Project engineers	During pre-panning phase
Roads should be planned so as to reduce heavy vehicles reversing when collecting or dumping at stockpiles/tips etc. (E.g. use of a loop instead of a dead-end road). This will minimise the use of reverse alarms on vehicles.	- Project engineers	During pre-panning phase
If feasible the road should be paved or asphalted (e.g. continuous graded asphalt). From an acoustical perspective paver bricks should not be considered. It is likely that routes will be unpaved. The developer should consider maintain these unpaved routes regularly smoothing out irregularities on the routes.	- Project engineers	During pre-panning phase
Open cast pits		
The developer could consider alternative layouts or moving open cast pits further back from receptors NSD01 (Tubatse community).	- Project engineers - Project management	During pre-panning phase
Stockpiles of hards or softs could be implemented between the Tubatse community and the further most norther open cast pit. This may however impact on other environmental factors such as visual, soils, water etc. The stockpile bisecting the Tubatse community and open cast pit should be designed sloping away from the community towards and towards the pit with access routes well concealed on opposite façade of the community (i.e. facing pits and not community). No night-time work should occur on these stockpiles, including bollard implementation (or safety barriers) and stockpile compaction or management.	- Project engineers - Project management - Environmental management	During pre-panning phase
If blasting is required to take place near a receptors dwelling (within 500m), it is recommended that the developer consult with a Vibration & Blasting Specialist regarding the matter.	- Project management - Environmental management	During all phases
The developer should minimize night-time operations when removing topsoils and overburden from open cast pits directly bordering NSD01 (Tubatse Community). For the developer to ensure a 45 dBA contour at receptors (and based on a worst-case scenario) equipment would require a buffer of 750m from the closest dwelling in the community.	- Project management - Environmental management - Contractors	During construction phase
Berm/barriers are required either at the community or at the open cast pit. Due to the elevation of the pit going uphill (onto a mountainous section) implementing a barrier on the open cast boundary (i.e. on the outskirts of the footprint) will not suffice as raising a noise source or receive above a barrier reduces the effect of the acoustical screens shadow zone. To negate this you would require a berm/barrier directly adjacent to the closest dwellings to the open cast footprint or a berm as feasibly close to the noise source at all times (i.e. directly adjacent such as developing berm per open cast grid). The developer should consider the introduction of berms/highwalls (and during the daytime only) before any site clearance/stripping or construction activities commences. This will minimise the amount of equipment operating simultaneously (i.e., construction of pits and berm development). Overburden/interburden acquired from open cast pits further than 750m from receptors could also be sourced as berm constituent. The following factors/specifications should be considered when implementing as berm as an acoustical screen:	- Project management - Environmental management - Contractors	During construction phase

o It is recommended that the barrier be built as close as feasibly possible to the mining operations or receptor; o It is recommended that the height of the berms/barriers be at least 2 - 3 m higher than the line of sight to the highest noise source from open cast pits and stockpile areas, although the higher the berm/barrier the better acoustical screen tool it will be. Certain heavy vehicles have their exhaust ports above the cabin of the vehicle and needs to be considered as the noise source point. Barriers must also be sufficiently dense (at least 10 kg/m^2) and sufficient in thickness. A brick wall provides a surface density of 244 kg/m^2 at thickness of 150 mm and is considered as a typically good acoustical barrier. Certain metrological conditions (particularly during night-times) can see refraction of noise over the barriers due to the various temperature inversion layers. This means that noise levels from a mine may propagate back down to the ground at a receptors dwelling due to the curvature of sound in the warmer upper night-time atmosphere. Barrier height cannot effect this propagation; and o The barrier should be sufficiently long to block the line of sight from receptors to the sides of the mining operations. No apertures (gaps, entrances) should be implemented at berms/highwalls and facing a receptors dwelling. If an open cast pit entrance is implemented it should be designed facing away from receptors. This is due to security points and berm entrances where haul trucks need to stop and make use of air brakes and reverse alarms, which may cause a noise annoyance at a receptors property.		
Communication between the Tubatse community and the developer need to be implemented and maintained, highlighting the outcome of this study. The developer should also consider co-ordinate the working time with periods when the receptors are likely not at home. An example would be to work within the 8 am to 2 pm time-slot to minimise the significance of the impact due to: o Potentially receptors are most likely at school or at work, minimizing the probability of an impact happening; and o Normal daily activities will generate other noises that would most likely mask construction noises, minimizing the probability of an impact happening.	- Project management - Environmental management	Pre planning phase
The use the smaller/quieter equipment when operating near receptors. An example could be the use of equipment that can haul less tonnage (and less engine capacity). A 64 ton dump truck could be replaced by a 32 ton, while one FEL with a small bucket capacity (e.g. 1.9m^3 at net power of 92 kW) could be used instead of a larger capacity FEL.	- Contractors	During all phases
Ensuring that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. Acoustical mufflers (or silencers) should be considered on equipment exhausts on open cast pits and stockpile areas. A noise absorption braid could be mounted on the front of heavy equipment radiators (ADT's, FEL's etc.) to prevent excess mechanical fan noise into the surrounding environment. Engine bay covers over heavy equipment could be pre-fitted with sound absorbing material. Heavy equipment that fully encloses the engine bay should be considered, ensuring that the seam gap between the hood and vehicle body is minimised	- Contractors	During all phases
The developer should investigate the use of white-noise generators instead of tonal reverse alarms on heavy vehicles operating on roads, in mine pits and at stockpile areas. This option is highly recommended although it must be noted that reverse alarms is exempt from an acoustical assessment due	- Project management - Environmental management	Pre planning phase

to Government Notice R154 of 1992 (Noise Control Regulations) – Clause 7.(1) – *"the emission of sound is for the purposes of warning people of a dangerous situation".*		
Ensure a good working relationship between the mining environmental representative and all potentially sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them. Information that should be provided to the potentially sensitive receptor(s) include: o Proposed working times; o How long the activity is anticipated to take place; o What is being done, or why the activity is taking place; and o Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.	- Project management - Environmental management	During all phases

11.2 OPERATIONAL PHASE

Projected rating levels used to illustrate the operational phase of the project were modelled using the methodology as proposed by SANS 10357:2004. Operational phase entails the truck and shovel open cast mining, maintaining stockpiles as well as plant operations.

The resulting future noise projections indicated that the operation of the further most open cast pits activities as modelled for representation at times may not comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and International Finance Corporation. However with mitigation options implemented the compliance or criteria targets will be achieved.

The following objectives and targets are recommended to define the performance of the project in mitigating the projected noise impacts and reducing the significance of any noise impacts. Objectives and targets are relevant for Receptor **NSD01** where a moderate - high noise impact during day and night-time operations have been identified (without mitigation options).

Objective	Control potential noise pollution stemming from the operational of the project
Project Component(s)	Operations of open cast pits, stockpiles and plant.
Potential Impact	• Increased noise levels at potentially sensitive receptors exceeding criteria of the Noise Control Regulations legislation (NCR) and SANS guidelines; • Changing ambient sound levels could change the acceptable land use capability; • Changing ambient sound levels could increase annoyance and potential complaints; • Disturbing character of sound.
Activity/Risk source	• Operations of open cast pits, stockpiles and plant.
Mitigation Target/Objective	• Ensure equivalent A-weighted noise levels below 55 dBA at potentially noise-sensitive receptors (daytime). • Ensure equivalent A-weighted noise levels below 45 dBA at potentially noise-sensitive receptors (night-time). • Define the noisy areas with a set boundary ensuring that equivalent A-weighted noise levels at this boundary does not exceed 61 dB $L_{Aleq,24hr}$. It

	should be noted that the area would have to be demarcated as a "controlled zone" in terms of the NCR; • Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 5 - 7 dBA; • Ensuring compliance with the National Noise Control Regulations and SANS10103:2008 guidelines. The referencing of the International Finance Corporation (World Bank) guidelines for an acceptable sound level in a residential area was also considered.

Mitigation: Action / Control	Responsibility	Timeframe
Measurement and Audit Programme		
Design an Acoustical Measurement & Audit Programme. Note: If there are no noise-sensitive receptors within 2 000 meters from any mining activities no routine noise monitoring will be required. See the following **Section 12** for the proposed noise monitoring programme.	- Acoustical Consultant	Before and during all phases. See below for proposed Acoustical Measurement & Audit Programme
Haul Roads		
Refer to previous section (construction phase **Section 11.1**) highlighting design specifications for the developer to consider.	- Project management - Environmental management	Operational phase
Open cast pits		
The developer should minimize **night-time** operations at open cast pits directly bordering NSD01 (Tubatse Community).	- Project management - Environmental management	Operational phase
Ensure that berms/barriers as highlighted in the construction phase (**Section 11.1**) has been implemented and maintained.	- Project management - Environmental management	Operational phase
Communication between the Tubatse community and the developer need to be implemented and maintained, highlighting the outcome of this study. See also previous **Section 11.1**.	- Project management - Environmental management	Operational phase
Plant		
No mitigation options are highlighted for the plant as no receptor is within 1,000m of this area.	N/a	N/a

12 ENVIRONMENTAL MONITORING PLAN

Environmental Noise Monitoring can be divided into two distinct categories, namely:

- Passive monitoring – the registering of any complaints (reasonable and valid) regarding noise; and
- Active monitoring – the measurement of noise levels at identified locations.

Active environmental noise monitoring is recommended due to the medium (after the implementation of appropriate mitigation measures) significance for a noise impact to develop. In addition, should a valid complaint be registered, the mine must investigate this complaint as per the following sections. It is recommended that the noise investigation be done by an independent acoustic consultant.

While this section recommends a noise monitoring programme, it should be used as a guideline as site specific conditions may require that the monitoring locations, frequency or procedure be adapted.

12.1 MEASUREMENT LOCALITIES AND PROCEDURES

12.1.1 Measurement Localities

Annual noise measurements are recommended at **NSD01** the Tubatse community.

If any of these receptors are relocated the measurement locations should be replaced with a similar location. If there are no potential noise-sensitive receptors living within 1,000m from any noise sources (associated with the mine) no noise measurements is required.

In addition, noise measurements must be conducted at the location of the person that registered a valid and reasonable noise complaint. The measurement location should consider the direct surroundings to ensure that other sound sources cannot influence the reading. A second instrument can be deployed at the mine (close to the source of noise) during the measurement.

12.1.2 Measurement Frequencies

Noise measurements should be conducted on a quarterly basis at the measurement locations identified in **section 12.1.1** (or any additional measurement locations that can be motivated) using a defined measurement procedure (see **section 12.1.3**). Noise measurements should continue during the construction and operational phase (quarterly) for the first two years of operation when the noise monitoring plan can be reviewed (measurements increased, continued, reduced or stopped).

12.1.3 Measurement Procedures

Ambient sound measurements should be collected as defined in SANS 10103:2008. Due to the variability that naturally occurs in sound levels at most locations, it is recommended that semi-continuous measurements are conducted over a period of at least 24 hours, covering at least a full day- (06:00 – 22:00) and night-time (22:00 – 06:00) period. Measurements should be collected in 10-minute bins defining the 10-minute descriptors such as $L_{AIeq,10min}$ (National Noise Control Regulation requirement), $L_{A90,f}$ (background noise level as used internationally) and $L_{AFeq,10min}$ (Noise level used to compare with IFC noise limit). Spectral frequencies should also be measured to define the potential origin of noise. When a noise complaint is being investigated, measurements should be collected during a period or in conditions similar to when the receptor experienced the disturbing noise event.

12.2 RELEVANT STANDARD FOR NOISE MEASUREMENTS

Noise measurements must be conducted as required by the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008. It should be noted that the SANS standard also refers to a number of other standards.

12.3 DATA CAPTURE PROTOCOLS

12.3.1 Measurement Technique

Noise measurements must be conducted as required by the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008.

12.3.2 Variables to be analysed

Measurements should be collected in 10-minute bins defining the 10-minute descriptors such as L_{AIeq} (National Noise Control Regulation requirement), L_{AF90} (background noise level as used internationally) and L_{AFeq} (Noise level used to compare with IFC noise limit). Spectral frequencies should also be measured to define the potential origin of noise.

12.3.3 Database Entry and Backup

Data must be stored unmodified in the electronic file saved from the instrument. This file can be opened to extract the data to a spread sheet system to allow the processing of the data and to illustrate the data graphically. Data and information should be safeguarded from accidental deletion or corruption.

12.3.4 Feedback to Receptor

A monitoring report must be compiled considering the requirements of the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008. The mine must provide feedback to the potential noise-sensitive receptors using the channels and forums established in the area to allow interaction with stakeholders, alternatively in a written report.

12.4 STANDARD OPERATING PROCEDURES FOR REGISTERING A COMPLAINT

When a noise complaint is registered, the following information must be obtained:

- Full details (names, contact numbers, location) of the complainant;
- Date and approximate time when this non-compliance occurred;
- Description of the noise or event;
- Description of the conditions prevalent during the event (if possible).

13 CONCLUSIONS AND RECOMMENDATIONS

Assessments done in this document are as recommended by the National/International guidelines and regulations SANS 10103, SANS 10328 and GN R154. The report considers a worst-case scenario, evaluating the potential noise impact during peak hours.

Two phases were investigated and modelled. The construction phase, which entails the stripping of topsoil and overburden at open cast pits. The second phase is the operational, which entails the truck and shovel open cast mining, stockpile maintenance as well as the new plant operations.

Considering this approach, there is a risk of a noise impact of medium-high significance during peak construction and operational noise levels and at the Tubatse community (**NSD01**) directly adjacent to the proposed furthermost northern pit. The assessment made use of the SANS 10103:2008 guideline and International Finance Corporation noise limits for residential areas. With proposed mitigation options implemented (see EMP) an acceptable low significance can be achieved.

The most important mitigation options recommended would be to minimize night-time operations on the open cast pits proposed adjacent to the Tubatese community. Berms/barriers need to be constructed along either the noise sources or the Tubatse receivers. In order for the berms/barriers to successfully act as an acoustical screen specifications indicated in this document mitigation section must be adhered to. Communication between the Tubatse community and the developer need to be implemented and maintained, highlighting the outcome of this study.

An annual Acoustical Measurement & Audit Programme is recommended to be conducted during the construction and operational phase. Measurements should be collected in 10-minute bins over a 48 hour measurement period. Variables and measurement recommended settings to be analysed include L_{AMin}, L_{Aeq}, L_{AMax}, L_{AMin} L_{A10}, L_{A90} and spectral analysis. Noise measurements must be continued as long as there are potential receptors living within 1,000m of the boundaries of the mining operation, or as long as a valid noise complaint is registered.

Feedback regarding noise measurements should be presented to all stakeholders and other Interested and Affected parties in the area. The feedback platform and interval periods should be defined by the developer, with an annual feedback period recommended.

It should be noted that this does not suggest that the sound from the mining activities should not be inaudible under all circumstances - this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source, but rather that the sound due to the mining activities should be at a reasonable level in relation to the ambient sound levels as per regulations.

If the layout of the mine changes significantly (or assumptions change) used in this report, that this Environmental Noise Impact Assessment be reviewed with the appropriate information supplied by the developer, including:

- Locality of the noise source;
- Operational time of the noise source; and
- If possible specifications regarding the noise source.

14 THE AUTHOR

The author of this report, M. de Jager (B. Ing (Chem), UP) graduated in 1998 from the University of Pretoria. He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker enclosure design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control.

The co-author of this report, Shaun Weinberg, has from May 2009 worked as an Environmental Consultant at the firm M^2 Environmental Connections (MENCO), and then at Enviro-Acoustics Research from 2012. His environmental background includes being involved in acoustical measurements (including ETSU-R97 methodology), Baseline, Environmental Noise Impact Assessments, Recommended Longer Term Measurement Plans, Monitoring and Auditing Reports.

As from 2007 they have been involved with the following projects:

Wind Energy Facilities	*Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinzee (SE), iNCa Gouda (Aurecon SA), Kangnas (Aurecon), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Happy Valley (SE), Deep River (SE), Saldanha WEF (Terramanzi), Loeriesfontein (SiVEST), Noupoort (SiVEST), Prieska (SiVEST), Plateau East and West (Aurecon), Saldanha (Aurecon), Veldrift (Aurecon), Tsitsikamma (SE), AB (SE), West Coast One (SE), Namakwa Sands (SE), Dorper (SE), VentuSA Gouda (SE), Amakhala Emoyeni (SE), Klipheuwel (SE), Cookhouse (SE), Cookhouse II (SE), Canyon Springs (Canyon Springs), Rheboksfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Outeniqwa (Aurecon), Koningaas (SE), Eskom Aberdene (SE), Spitskop (SE), Rhenosterberg (SiVEST), Bannf (Vidigenix), Wolf WEF (Aurecon)*
Mining and Industry	*BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon Environmental), SASOL Borrow Pits Project (JMA Consulting), Lesego Platinum (AGES), Tweefontein Colliery (Cleanstream), Evraz Vametco Mine and Plant (JMA), Goedehoop Colliery (Geovicon), Hacra Project (Prescali Environmental), Der Brochen Platinum Project (J9 Environment), Delft Sand (AGES), Brandbach Sand (AGES), Verkeerdepan Extension (CleanStream), Dwaalboom Limestone (AGES), Jagdlust Chrome (MENCO), WPB Coal (MENCO), Landau Expansion (CleanStream), Otjikoto Gold (AurexGold), Klipfontein Colliery (MENCO), Imbabala Coal (MENCO), ATCOM East Expansion (Jones and Wagner), IPP Waterberg Power Station (SE), Kangra Coal (ERM), Schoongesicht (CleanStream), EastPlats (CleanStream), Chapudi Coal (Jacana Environmental), Generaal Coal (JE), Mopane Coal (JE), Boshoek Chrome (JMA), Langpan Chrome (PE), Vlakpoort Chrome (PE), Sekoko Coal (SE), Frankford Power (REMIG), Strahrae Coal (Ferret Mining), Transalloys Power Station (Savannah), Pan Palladum Smelter, Iron and PGM Complex (Prescali), Extensions of the Rietspruit Crushers (Gudani Consulting), Proposed Colenso Coal Fired Power Station and Coal Mine (SiVEST), Development of the proposed Fumani Mine(AGES)*

Road and Railway	*K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane), Swaziland Rail Link – Assessment of 4 Schools in Swaziland (Aurecon), Extension of Atterbury Road, City of Tshwane (Bokomoso)*
Airport	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping*
Noise monitoring	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional, Sephaku Delmas (AGES), Amakhala Emoyeni WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF (Cennergi and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon), Unica Iron and Steels's Babelgi Plant Operations (Unica), Sephaku Cement Aganang Quarterly Monitoring Report (Exigo), Sephaku Cement Delmas Quarterly Monitoring Report (Exigo)*
Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (Noman Shaikh), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangalethu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Ladium (AGES), Safika Cement Isando (AGES), Natref (NEMAI), RareCo (SE), Struisbaai WEF (SE), uMzimkhulu Landfill Site (Nzingwe Consultancy), Proposed Linksfield Residential Development (Bokomoso)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma (Cennergi), Amakhala Emoyeni (Windlab), Spreeukloof (Savannah), Spinning Head (Savannah), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy)*

15 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2010, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all interested and affected parties that participated in a public participation process; and
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- all the particulars furnished by me in this form are true and correct;
- will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010.

____
Signature of the environmental practitioner:

Enviro-Acoustic Research cc
Name of company:

____
Date:

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APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Anthropogenic	Human impact on the environment or anthropogenic impact on the environment includes impacts on biophysical environments, biodiversity and other resources
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Axle	Shaft connecting two wheels on either side of the vehicle. The wheels are forced to rotate at the same speed. Vehicles with independent wheels have 'stub axles' that do not connect the two wheels on either side of the vehicle.
Ballast	A layer of coarse stones supporting the sleepers.
Baseplate	A track component designed to hold the rail in place, usually with resilience to provide improved vibration isolation.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.

Echolocation	Echo locating animals emit calls out to the environment and listen to the echoes of those calls that return from various objects near them. They use these echoes to locate and identify the objects. Echolocation is used for navigation and for foraging (or hunting) in various environments.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time weighting	(1) Averaging detection time used in sound level meters. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.
Footprint area	Area to be used for the construction of the proposed development, which does not include the total study area.
Free Field Condition	An environment where there is no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.
Green field	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exist.
Grinding	A process for removing a thin layer of metal from the top of the rail head in order to remove roughness and/or to restore the correct profile. Special grinding trains are used for this.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
I (impulse) time weighting	(1) Averaging detection time used in sound level meters as per South African standards and Regulations. (2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.
Impulsive sound	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be

	about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Interburden	Material of any nature that lies between two or more bedded ore zones or coal seams. Term is primarily used in surface mining
Joint rail	A connection between two lengths of rail, often held together by an arrangement of bolts and fishplates.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
Locomotive	A powered vehicle used to draw or propel a train of carriages or wagons (as opposed to a multiple unit).
L_{AMin} *and* L_{AMax}	Is the RMS (root mean squared) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Mitigation	To cause to become less harsh or hostile.
Natural Sounds	Are sounds produced by natural sources in their normal soundscape.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Overburden	In mining and in archaeology, overburden (also called waste or spoil) is the material that lies above an area of economic or scientific interest. In mining, it is most commonly the rock, soil, and ecosystem that lies above a coal seam or ore body
Positive impact	A change that improves the quality of life of affected people or the quality of the

	environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Rail head	The bulbous part at the top of the rail.
Rolling Stock	Rolling stock comprises all the vehicles that move on a railway. It usually includes both powered and unpowered vehicles, for example locomotives, railroad cars, coaches, and wagons.
ROM	The coal delivered from the mine that reports to the coal preparation plant is called run-of-mine, or ROM, coal. This is the raw material for the CPP, and consists of coal, rocks, middlings, minerals and contamination
Shunting	Shunting, in railway operations, is the process of sorting items of rolling stock into complete train sets.
Railway Sidings	A siding, in rail terminology, is a low-speed track section distinct from a running line or through route such as a main line or branch line or spur. It may connect to through track or to other sidings at either end.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Timbre	Timbre (also known as tone colour or tone quality) is the quality of the sound made by a particular voice or musical instrument.
Tread braked	The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.
Tone	Noise can be described as tonal if it contains a noticeable or discrete, continuous note. This includes noises such as hums, hisses, screeches, drones, etc. and any such subjective description is open to discussion and contradiction when reported.

Wagon	A freight-carrying vehicle.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.

APPENDIX B

Site Investigation – Photos of monitoring locations

Photo B 1: Measurement location BCR01

Photo B 2: Measurement location BCR02

APPENDIX C

Potential Noise-Sensitive Developments and Measurement Locations

Table C.1: Locations of identified noise-sensitive receptors (Datum type: WGS84, UTM)

Noise-sensitive development	Status	Location Latitude (m E)	Location Longitude (m S)
1	Tubatse Community	214598	7251604
2	Community	213483	7250490
3	Dithamaga Primary School	212790	7250089
4	Community	212662	7249730
5	Mr. Hendrik Mabelane	212308	7248928
6	Mr. Hendrik Mabelane	212334	7248801
7	Commercial (office)	212089	7247951
8	Residential	208705	7248893

TableC.2: Locations of Measurement Locations (Datum type: WGS84, UTM)

Point name	Location Latitude (m E)	Location Longitude (m S)
BCR01	212292	7248844
BCR02	213750	7253441