Exigo Sustainability (Pty) Ltd

NOISE STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

Doornhoek Fluorspar Project, near Zeerust, North-West Province

Study done for:

SA Fluorite (Pty) Limited

Exigo

Prepared by:

EAR Enviro Acoustic Research

P.O. Box 2047, Garsfontein East, 0060
Tel: 012 – 004 0362, Fax: 086 – 621 0292, E-mail: info@eares.co.za

EXECUTIVE SUMMARY

INTRODUCTION

Enviro-Acoustic Research cc (EARES) was commissioned by Exigo Sustainability (Pty) Ltd (also referred to as the main consultant) to determine the potential noise impact on the surrounding environment due to the Doornhoek Fluorspar Mine. SA Fluorite Pty Ltd and Southern Palace Pty Ltd (the mine) propose to mine fluorspar deposits, south of Zeerust in the North-West Province. The mines proposes a fluorspar open cast truck and shovel open cast pits and associated processing plant.

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

The Terms of Reference (ToR) for this study is in the guidelines and regulations of SANS 10103:2008, 10328:2008, Appendix 6 of GN R 982 of 2014 in terms of NEMA and GN R154 of 1992 (Noise Control Regulations) in terms of Section 25 of the Environment Conservation Act, 1989.

BASELINE

Receptors

Ten receptors in the study area were numbered from NSD01 to NSD10, with their status confirmed during onsite investigations.

Measurements

Ambient sound levels were measured at five localities from the 2nd till 6th April 2016. Two class-1 SLMs was used for measurements. The sound level meter would measure "average" sound levels over 10 minute periods, save the data and start with a new 10 minute measurement till the instrument was stopped.

Acceptable rating levels considering site measurements

The resulting rating level selected for all receptors based in the study area (and taking a precautious stance) is the rural rating level of 45 dBA 35 dBA (day and night SANS 10103:2008 $L_{Req,d/n}$).

FINDINGS

Five phases were evaluated as per main consultant's criteria, namely the planning, construction, operational, closure/ decommissioning and post closure phases. The most important times for an assessment for an assessment are night-time hours (22:00 – 06:00). The night scenarios were then further separated into the relevant years of operations. These are the yearly periods of the first 1 -5 years, 5 - 10 years, 10 – 20 and finally 20 – 30 year periods of mining.

The resulting future noise projections indicate that the operations will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards.

MANAGEMENT & MITIGATION OF NOISE IMPACT

Communication channels between the identified receptors and the mine needs to be implemented during all phases, highlighting the outcome of this study. Berms/barriers are required at certain sections of open cast footprint areas (refer to document highlighting specifications). A bi-annual measurement programme is recommended during all phases up to the end of the operational phase.

RECOMMENDATIONS

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. From a noise impact perspective it is recommended that the project be authorised subject to the implementation of the mitigation measures contained in this report.

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014

PROJECT TITLE

PROPOSED DOORNHOEK FLUORSPAR MINE ON VARIOUS PORTIONS OF FARMS DOORNHOEK 305 JP, FARM 306 JP, KNOFLOOKFONTEIN 310 JP, STRYDFONTEIN 326 JP, RHENOSTERFONTEIN 304 JP, KWAGGAFONTEIN 297 JP, PAARDEPLAATS 296 JP, SAAMGEVOEG 320 JP AND WITRAND 325 JP, ZEERUST DISTRICT, NORTH WEST PROVINCE

Specialist:	Noise		
Contact person:	Morné de Jager		
Postal address:	PO Box 2047, Garsfontein East		
Postal code:	0060	Cell:	082 565 4059
Telephone:	012 004 0362	Fax:	086 621 0292
E-mail:	morne@eares.co.za		
Professional affiliation(s) (if any)	ASA, SAAI		

Project Consultant:			
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

The specialist appointed in terms of the Regulations

I, **Morné de Jager**, declare that –

General declaration

- I act as the independent specialist 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 the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- 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;
- all the particulars furnished by me in this form are true and correct; 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.

Signature of the specialist:

Enviro-Acoustic Research cc
Name of company (if applicable):

17 October 2017
Date:

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 13**
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	See above
(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;	**Section 1.3.5** & **Section 4**
(g) an identification of any areas to be avoided, including buffers;	**Section 1.3.5** & **Section 9**
(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 9** & **Figure 8-1**
(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;	**Section 9**
(k) any mitigation measures for inclusion in the EMPr;	**Section 10**
(l) any conditions for inclusion in the environmental authorisation;	**Section 10** & **Section 11**
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	**Section 11**
(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. **Section12** ii. **Section 10** & **Section 11**
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None received
(p) any other information requested by the competent authority	Nothing requested

Report should be sited as:

De Jager, M. (2016). "*Doornhoek Fluorspar Project, near Zeerust, North-West Province*", Enviro-Acoustic Research cc, Pretoria

Client:

Exigo Sustainability (Pty) Ltd on behalf of Southern Palace & SA Fluorite (Pty) Limited

Pretoria

Report no:

EXIGO-NFM/ENIA/201605-Rev 1

Authors:

M. de Jager *(B. Ing (Chem))*

Review:

Shaun Weinberg *(B.Sc. Applied Mathematics in Physics Stream – in process)*

Date:

November 2016

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APPENDICES

Appendix A Glossary of Acoustic Terms, Definitions and General Information
Appendix B Measurement Location Photos
Appendix C Potential Noise-Sensitive Developments and Measurement Locations

GLOSSARY OF ABBREVIATIONS

AZSL	Acceptable Zone Sound Level (Rating Level)
dB	Decibel
EARES	Enviro-Acoustic Research cc

ECA	Environment Conservation Act, 1989 (Act No. 78 of 1989)
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
EMS	Environmental Management System
ENIA	Environmental Noise Impact Assessment
ENPAT	Environmental Potential Atlas
EP	Equator Principle
EPFI	Equator Principle Financial Institutions
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
IFC	International Finance Corporation
km/h	kilometres per hour
m	Meters
mamsl	Meters above mean sea level
NCR	Noise Control Regulations (under Section 25 of the ECA)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NSD	Noise-Sensitive Development
p/d	per day
SABS	South African Bureau of Standards
SANS	South African National Standard
SPL	Sound Power Levels
t	Time
ToR	Terms of Reference
UTM	Universal Transverse Mercator
WHO	World Health Organisation

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research cc (EARES) was commissioned by Exigo Sustainability (Pty) Ltd (also referred to as the main consultant) to determine the potential noise impact on the surrounding environment due to the Doornhoek Fluorspar Mine. Southern Palace & SA Fluorite (Pty) Limited, the mine) proposes to mine fluorspar deposits, south of Zeerust in the North-West Province.

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

The Terms of Reference (ToR) for this study is in the guidelines and regulations of SANS 10103:2008, 10328:2008, Appendix 6 of GN R 982 of 2014 and GN R 154 of 1992 (Noise Control Regulations) in terms of Section 25 of the Environment Conservation Act, 1989.

1.2 BRIEF PROJECT DESCRIPTION

1.2.1 Project Overview

The mine proposes an opencast truck and shovel operation with associated processing plant. The proposed project footprints are illustrated in **Figure 1-1**.

1.3 STUDY AREA

The study area (refer to **Figure 1-2**) includes a number of dwellings or potential noise-sensitive receptors in the vicinity of the proposed development. The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

1.3.1 Topography

ENPAT[1] (1998) describes the topography as *"hills and lowlands"*. Hills and mountainous areas may help assist in buffering of noise from project infrastructure to study area receptors. This is particularly relevant for the open cast activities from year 5 – 10 whereby

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

a mountain region bisects receptors NSD01 and NSD05 from eastern open cast activities. Refer to **Figure 1-3** roughly illustrating the elevation contours of this study section.

1.3.2 Surrounding Land Use

The surrounding land uses consist of farming (grazing) land, residential, transportation routes and mining.

1.3.3 Roads and Railway lines

Many small 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 baseline.

1.3.4 Ground conditions and vegetation

Vegetation cover within the study area mainly consists of low growing grass, flora and shrubs and trees.

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 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 study areas up to a distance of 1,000[2]m from the closest project boundary (as illustrated in **Figure 1-2**). This was supported by a site visit to confirm the status of the identified dwellings.

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 buildings (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 (UTM WGS84).

[2] SANS 10328:2008. *Methods for environmental noise impact assessments*. Pg. 13, occasionally receptors are outside these criteria and are only identified for reference purposes.

Ten receptors in the study area were numbered from NSD01 to NSD10. Receptors NSD04 are the dwelling of Mrs. Mang Josef while NSD05 is that of Mr. Hennie Grobler. The dwellings from NSD01 to NSD03 were derelict during site visits (2016). NSD07 is the site office of the developer while NSD10 is a business. During site investigations, discussions with the workers at NSD10 indicated that at times employees may make use of the facility to sleep.

1.4 AVAILABLE INFORMATION

The available information 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.

Table 1-1: Available Reports/information

Date	Report/source
2012	Delta Minerals Limited. *"Doornhoek Fluorspar Mine: Process Summary and Conceptual Process Flowsheet"*
2013 - 2016	De Jager M. *"Quarterly Acoustical Measurement Report: Dangote Cement Aganang's Operations, North-West Province".* Enviro-Acoustic Research cc, Pretoria

No specific comments on noise-related issues have been received for this report during public participation for the EIA process.

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);
- if any noise source is to be situated in the proximity of noise-sensitive developments (SANS 10328:2008);
- It is a controlled activity in terms of the NEMA regulations and an ENIA is required, because:
  - 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 authorisation or planning approval in terms of Regulation 2(d) of GN R154 of 1992.

In addition, Appendix 6 of GN R 982 of 2014, 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 authorisation, 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 authorisation if the approval is obtained from the relevant authority.

Furthermore the SANS 10328:2008 and Noise Control Regulations defines a noise-sensitive development to include any of the following:

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'.*

Both the construction/rehabilitation of the project and the operations there of were investigated in terms of acoustics (SANS 10328:2008 recommendation).

Figure 1-1: Site map indicating the proposed project footprint

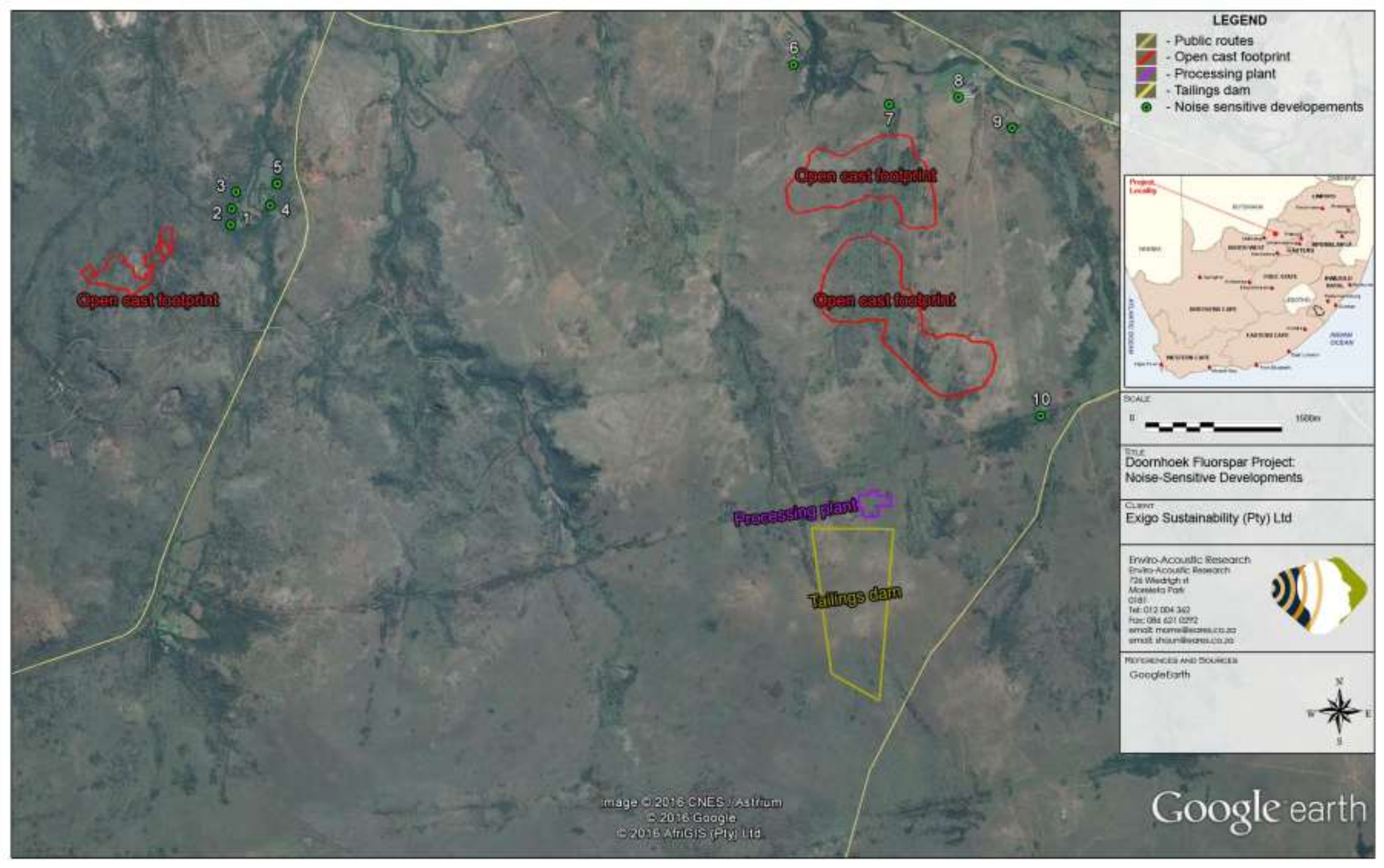

Figure 1-2: Study area potential noise-sensitive developments or receptors

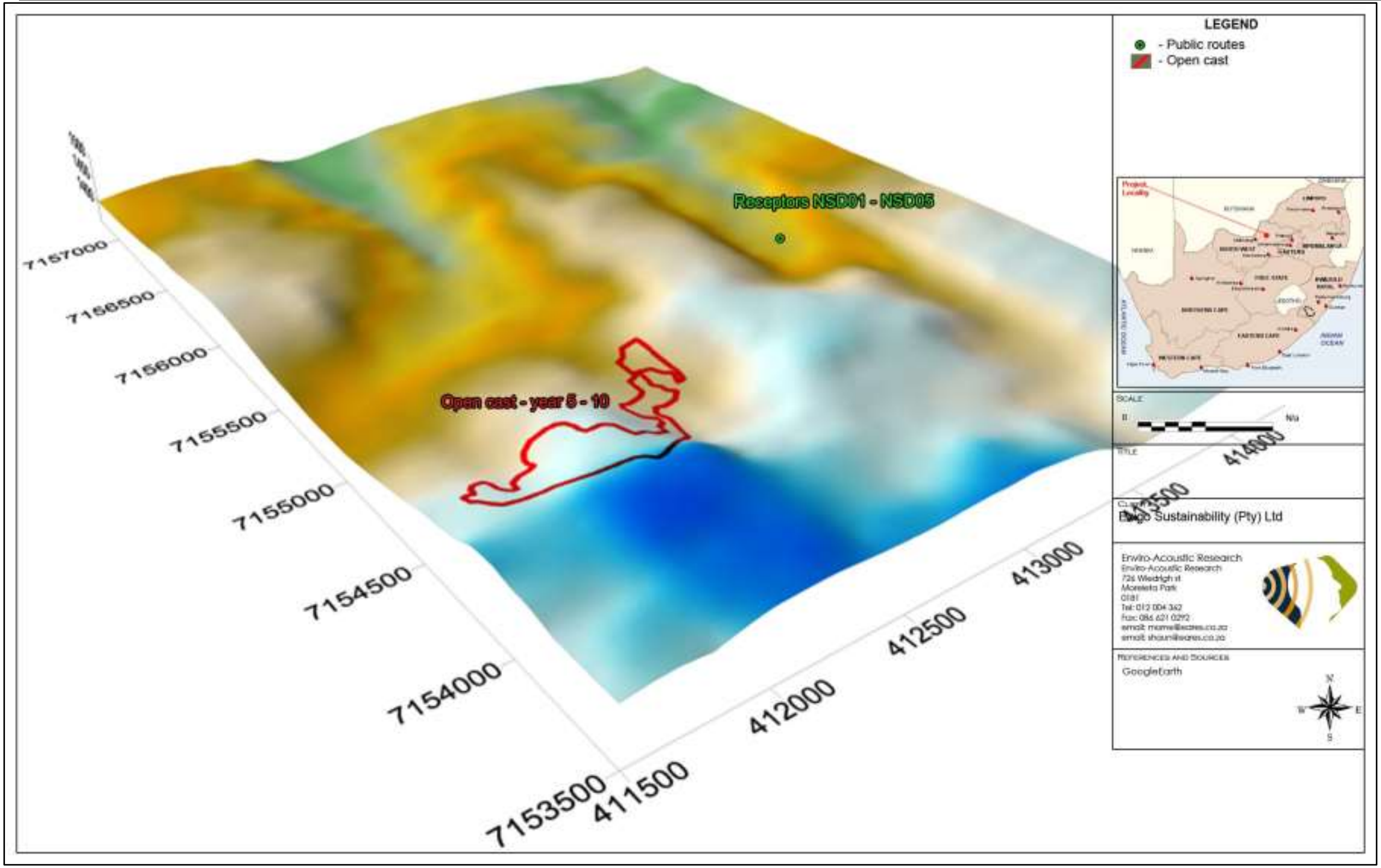

Figure 1-3: 3D Elevations map - Open cast years 5 - 10

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 R 154 of 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 exist 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--

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 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 e, 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
(f) designate a controlled area in its area of jurisdiction or amend or cancel an existing controlled area by notice in the Official Gazette concerned.

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".

General prohibition

3. No person shall -

(c) make changes to existing facilities or existing uses of land or buildings or erect new buildings, if it shall in the opinion of a local authority house or cause activities which shall, after such change or erection, cause a disturbing noise, unless precautionary measures to prevent the disturbing noise have been taken to the satisfaction of the local authority;

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 R 982 of 2014, issued in terms of this Act, has general requirements for EAPs and specialists. It also defines minimum information requirements for specialist reports.

2.3.1 Appendix 6 of GN R 982 of 2014

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. However, draft regulations have 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 were published in 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".*

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 $L_{Req,T} = L_{Aeq,T} + C_i + C_t$. 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**).

2.6 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards exist, 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 affect (and propose guideline noise levels) specific environments such as residential dwellings, schools, 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 proposes 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 day, 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. Revision III of the EPs has been in place since June 2013. The participating 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). Eighty-three financial institutions (2016) 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.

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 Principles. 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.

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 2-1**) and highlights 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. Therefore, it is EARE’s 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 2-1: 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 $L_{Aeq,1hr}$ 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 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.

2.6.5.1 ISO 14001

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

a. minimise 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, analysing data, and implementing corrective and preventive actions.

2.6.6 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 and applied from 3 January 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.

2.6.7 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[3]) 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[4] 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[5] 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[6]. The United States National Park Service's efforts include attempts to reduce the flights over the Grand Canyon due to the introduction of non-natural impulsive noise events at the park.

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

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 five localities from the 2nd till 6th April 2016. Two class-1 SLMs was used for measurements. The sound level meter would measure "average" sound levels over 10 minute periods, save the data and start with a new 10 minute measurement till the instrument was stopped.

The longer-term measurement locations were numbered from FMLT01 to FMLT02, while shorter term measurements were numbered FMST01 – FMST04 (see **Appendix C** for measurement location in UTM, latitude and longitude). Measurement localities are presented in **Figure 3-1**. Refer to **Appendix B** for photos of measurement locations.

In this measurement section if the fast setting is exceeded by the IFC criteria it will be highlighted in **bold red** for better referencing. The SANS 10103:2008 Rating levels will be illustrated using colour coding (developed by EARES) as described in **Table 5-1**.

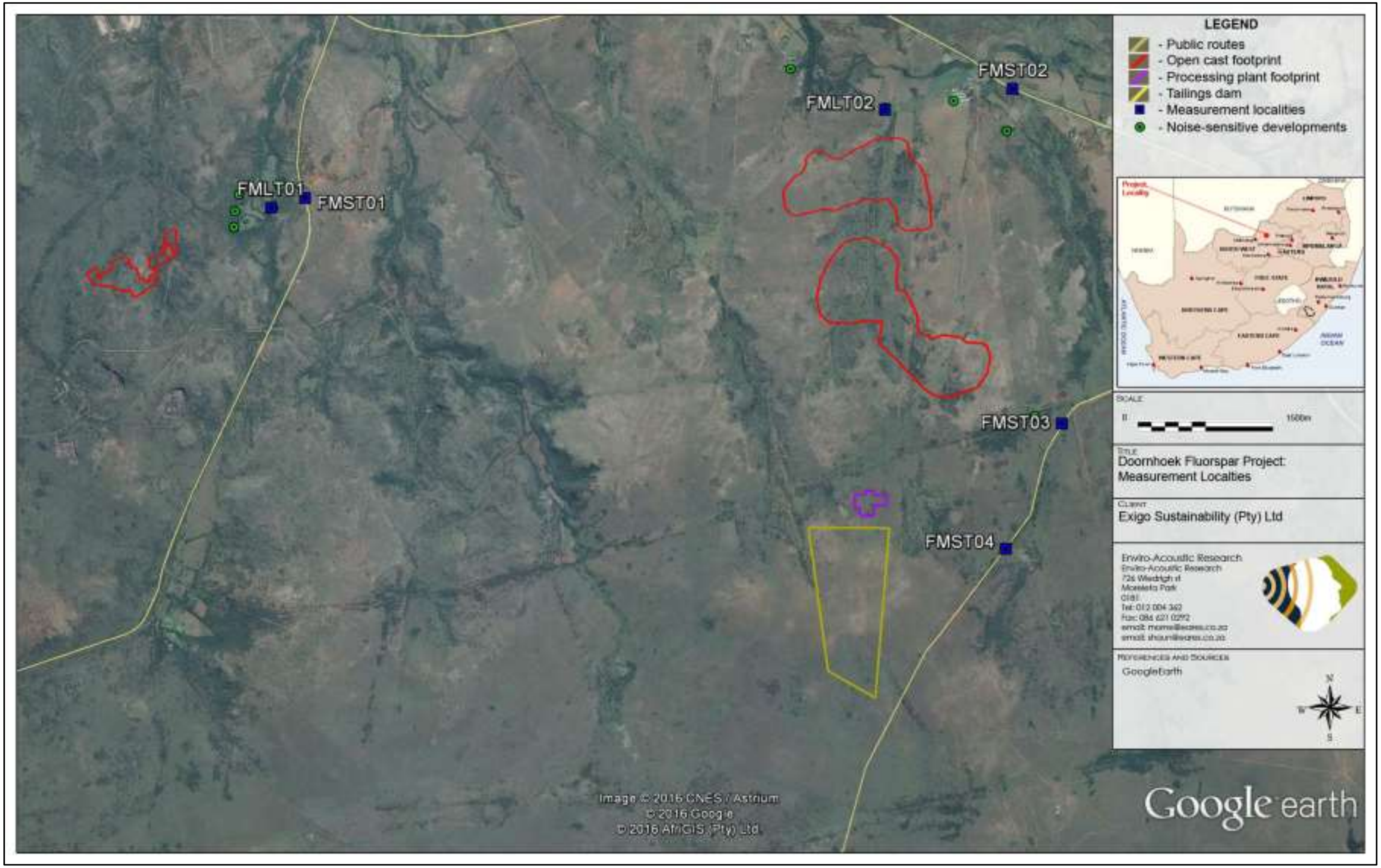

Figure 3-1: Localities of ambient sound level measurements

3.2.1 Longer-term Measurement Point FMLT01: Josef Homestead

The equipment defined in **Table 3-1** was used for gathering data.

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	Quest CA-22	J 2080094	June 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 in the vicinity of NSD01 to NSD05. As a result the sound level meter was implemented on the property of Mrs. Mang Josef (NSD04).

Refer to **Table 3-2** highlighting sounds heard during equipment setup, collection and days it was calibrated/inspected. It also provides information on intervening environmental factors as well as investigation of alternative measurement localities.

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

Selected measurement locality - intervening environmental factors		
Josef homestead	Measurement equipment was implemented in the back garden of Mrs. Mang Josef (NSD04).	
Alterative measurement localities - intervening environmental factors		
Mr. Hennie Grobler	The property of Mr Grobler (NSD05) was investigated. Selected locality was deemed ideal to measure the potential noise levels from the project at receptors NSD01 – NSD05.	
Noises/sounds heard during onsite investigations		
Magnitude Scale Code: • **Barely Audible** • **Audible** • **Dominating**	**Faunal and Natural**	Bird call/communication.
	Residential	Dwelling related sounds (radio, daily activities etc.).
	Industrial & transportation	Traffic on local roads (during event).

3.2.1.1 Impulse (SA Legislation), Fast (IFC Criteria) & Statically Values

Impulse equivalent sound levels $L_{AIeq,10min}$ (South African legislation in 10 min. bins) and fast equivalent sound levels $L_{AFeq,10min}$ (International guidelines in 10 min. bins) are presented **Figure 3-2** and **Table 3-3** below. Also presented in the table/figure below are the maximum (L_{Amax}), minimum (L_{Amin}) and 90th percentile (L_{A90}) values. The L_{A90} level is presented in this report 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 average sound level. Refer to section **2** discussing these National and International criteria in more detail.

L_{A90} and L_{Amin} (minimum levels) indicated the background sound character levels (not considering the impulsive events i.e. L_{AMax}) had the potential to become very quiet. During the night-times L_{AMax} levels rarely exceeded the amount of events and magnitude of 65 dBA (during the 10 minute measurements) where it may become an annoyance during a peaceful time or when rest is sought.[(7)]

Table 3-3: Impulse (SA), fast (IFC) and satistical values

Period	$L_{AIeq,10min}$ (SA)	$L_{AFeq,10min}$ (IFC)	L_{Amax}	L_{Amin}	L_{A90}
Day Ave.	42.4	37.9	54.7	23.9	26.7
Night Ave.	28.0	29.0	37.4	23.4	24.6
Evening Ave.	x	25.7	x	x	x
Day minimum - maximum					
Day Min.	21.9	21.2	x	18.2	19.1
Day Max.	61.4	54.0	80.4	x	39.9
Night minimum - maximum					
Night Min.	20.8	21.2	x	18.3	19.2
Night Max.	34.0	30.5	52.4	x	29.7
Evening minimum - maximum					
Evening Min.	x	20.5	x	x	x
Evening Max.	x	55.5	x	x	x

$L_{Aeq,16hr}$ day and $L_{Aeq,8hr}$ night (South African Rating level $L_{Rd/n}$, 16 & 8 hr. equivalent) and L_{day}, $L_{evening}$ and L_{night} (ISO/European Union and IFC: General EHS Guidelines, 12, 4 & 8 hr. equivalent values) are presented in **Figure 3-2** and **Table 3-4** below.

Table 3-4:$L_{R.d/n}$, L_{day}, Levening & L_{night}

Period	$L_{R,d}$ Day (SA)	$L_{R,n}$ Night (SA)	L_{day} Day (IFC)	$L_{evening}$ Evening (IFC)	L_{night} Night (IFC)
1st day/night	47.1	29.1	41.3	27.7	40.8
2nd day/night	49.0	30.3	41.6	27.6	37.5
3rd day/night	47.9	28.1	41.4	24.1	39.0
4th day/night	47.9	26.7	41.3	25.2	39.1
5th day	54.8	x	43.3	x	x

All above data will be consolidated (see proceeding summary section **3.3**) to help determine the rating levels or the change of rating levels, due to the various projects phases.

(7) World Health Organization, 2009, '*Night Noise Guidelines for Europe.*

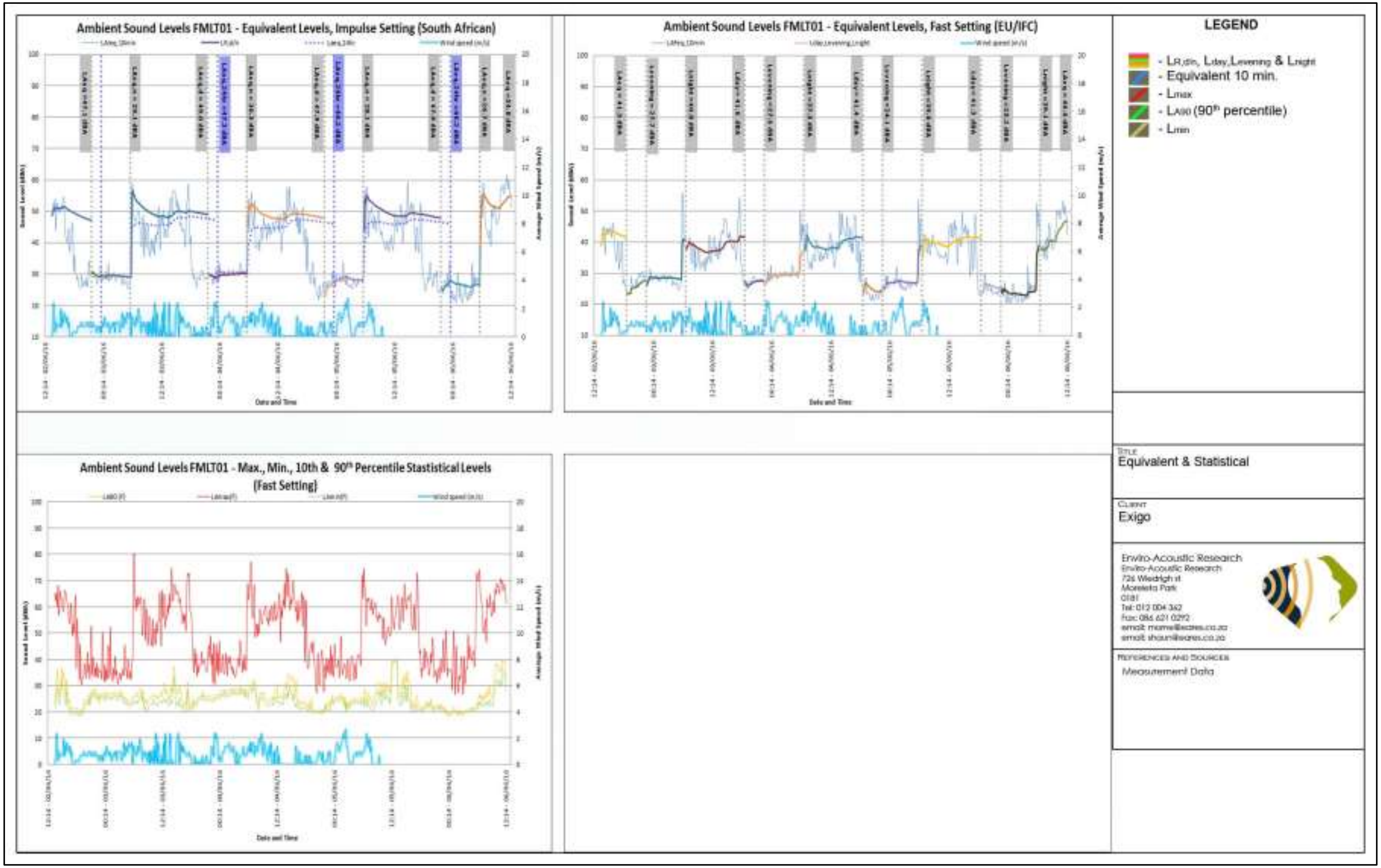

Figure 3-2: Impulse (SA), fast (IFC) & stastistical values

3.2.1.2 Octave Frequencies

Octave data is presented in **Figure 3-3** and **Figure 3-4**, and further discussed below.

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, ocean surf splash etc.). Motor vehicle engine rpm (revolutions per minute, 1000 - 6000 rpm[8]) mostly convert to this range of frequency. Lower frequencies (above infrasound etc.) also have the potential to propagate much further than the higher frequencies. On occasions during the days peaks were measured in lower frequencies. During the night these peaks subsided considerably.

No particular trend was analysable in lower frequencies.

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).

Peaks and troughs were measured during the daytime, subsiding during the night.

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)[9] is also likely to be measured in this range if faunal communication is prevalent. Ambient noise levels during early morning can also increase due to dawn chorus [10].

On occasion higher frequencies were measured during the day, subsiding during the night-time intervals.

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

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

[10] Manoj Singh *et al*. '*Ambient noise levels due to dawn chorus different habitats in Delhi*'. Environment & We An International Journal of Science & Technology. Pg. 124 – 125.

Summary: Spectral Analysis (Figure 3-3 and Figure 3-4):

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.

Higher frequencies measured were contributions from faunal communication (cicada or bird song etc.), although measurements were conducted during winter time when faunal communication may be less than other seasons. Mid-range frequencies were dwelling related sounds such as conversation by homeowners, music/radio playing etc.

Lower frequencies were a contribution from dwelling related mechanical sources (e.g. at a time the garden was maintained with a lawnmower) and times a vehicle operated/traversed on local roads. Surrounding farm equipment may have also been measured. No particular trend to lower frequency peaks could be analysed, during the night lower frequency peaks subsided considerably compared to daytime hours.

Night-time data illustrated a very quiet soundscape with no particular noise/sounds trends or characters during dead-of-night hours, illustrating a trend similar to that of a broadband character at times.

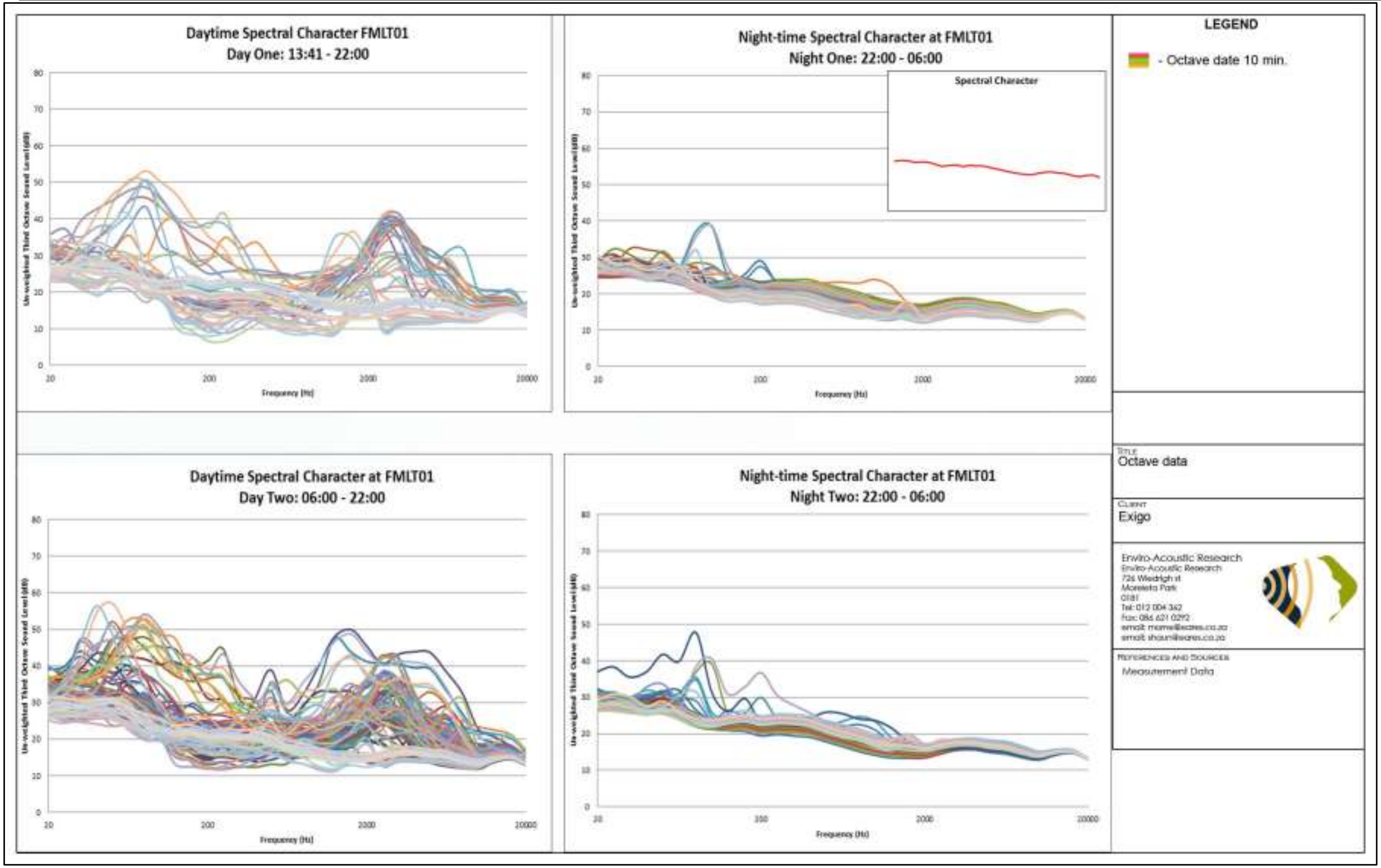

Figure 3-3: Spectral frequency distribution 1st & 2nd day/night

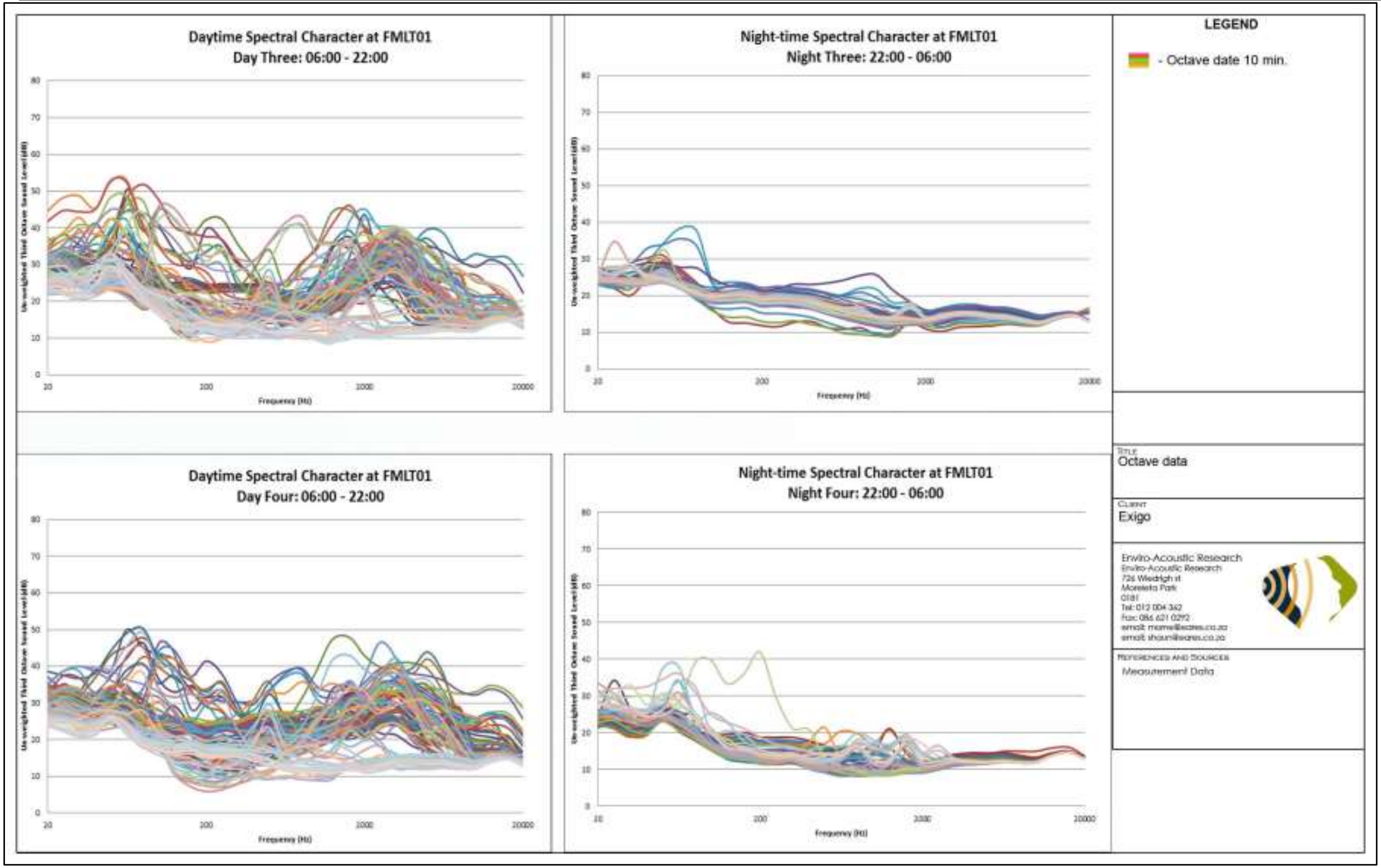

Figure 3-4: Spectral frequency distribution 3rd & 4th day/night

3.2.2 Longer-term Measurement Point FMLT02: Doornhoek Fluorspar Mine Offices

The equipment defined in **Table 3-1** was used for gathering data.

Table 3-5: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	Quest CA-22	J 2080094	June 2016

* 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 in the vicinity of NSD06 to NSD09. As a result the sound level meter was implemented on the property of Doornhoek Fluorspar Mine Offices (NSD07).

Refer to **Table 3-6** highlighting sounds heard during equipment setup, collection and days it was calibrated/inspected. It also provides information on intervening environmental factors as well as investigation alternative measurement localities.

Table 3-6: Noises/sounds heard during site visits

Selected measurement locality - intervening environmental factors		
Doornhoek Fluorspar Mine offices	Equipment was implemented in an open space within the property of Doornhoek Fluorspar Mine offices. During measurement dates no one was on the premises of the property.	
Alterative measurement localities - intervening environmental factors		
NSD08	The property of NSD08 was considered. Due to chicken coops on this property it was selected not to implement equipment here. Measured locality at NSD07 would indicate a worst-case scenario (quieter) baseline, while measurements at NSD08 would have chickens and chicken coop infrastructure (ventilation fans) influencing data (lower of the two baseline localities selected).	
Noises/sounds heard during onsite investigations		
Magnitude Scale Code: • **Barely Audible** • **Audible** • **Dominating**	**Faunal and Natural**	Bird call/communication.
	Residential	N/a
	Industrial & transportation	Traffic on local roads (during event), ventilation shaft from chicken coops at NSD08.

3.2.2.1 Impulse (SA Legislation), Fast (IFC Criteria) & Statically Values

Impulse equivalent sound levels $L_{AIeq,10min}$ (South African legislation in 10 min. bins) and fast equivalent sound levels $L_{AFeq,10min}$ (International guidelines in 10 min. bins) are presented **Figure 3-5** and **Table 3-7** below. Also presented in the table/figure below are the maximum (L_{Amax}), minimum (L_{Amin}) and 90th percentile (L_{A90}) values. The L_{A90} level is presented in this report 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 average sound level. Refer to section **2** discussing these National and International criteria in more detail.

L_{A90} and L_{Amin} (minimum levels) indicated the background sound character levels (not considering the impulsive events i.e. L_{AMax}) had the potential to become moderately quiet. At times (even early morning hours) there was a consistent background noise, while other times the background noise subsided. During the night-times L_{AMax} levels rarely exceeded the amount of events and magnitude of 65 dBA (during the 10 minute measurements) where it may become an annoyance during a peaceful time or when rest is sought.[(11)]

Table 3-7: Impulse (SA), fast (IFC) and satistical values

Period	$L_{AIeq,10min}$ (SA)	$L_{AFeq,10min}$ (IFC)	L_{Amax}	L_{Amin}	L_{A90}
Day Ave.	39.1	34.0	51.7	25.5	27.2
Night Ave.	33.3	32.3	40.2	28.2	29.7
Evening Ave.	x	32.9	x	x	x
Day minimum - maximum					
Day Min.	29.8	24.7	x	21.0	22.0
Day Max.	62.6	53.8	83.5	x	35.3
Night minimum - maximum					
Night Min.	28.2	28.5	x	25.2	26.2
Night Max.	47.8	38.5	65.9	x	34.3
Evening minimum - maximum					
Evening Min.	x	27.6	x	x	x
Evening Max.	x	43.6	x	x	x

$L_{Aeq,16hr}$ day and $L_{Aeq,8hr}$ night (South African Rating level $L_{Rd/n,}$ 16 & 8 hr. equivalent) and $L_{day,}$ $L_{evening}$ and L_{night} (ISO/European Union and IFC: General EHS Guidelines, 12, 4 & 8 hr. equivalent values) are presented in **Figure 3-5** and **Table 3-8** below.

Table 3-8:$L_{R.d/n}$, L_{day}, Levening & L_{night}

Period	$L_{R,d}$ Day (SA)	$L_{R,n}$ Night (SA)	L_{day} Day (IFC)	$L_{evening}$ Evening (IFC)	L_{night} Night (IFC)
1st day/night	39.6	34.5	34.1	34.6	33.3
2nd day/night	46.5	36.5	39.4	34.1	33.6
3rd day/night	39.9	33.7	33.7	32.1	33.3
4th day/night	44.0	32.3	38.5	32.0	32.4
5th day	43.6	x	38.5	x	x

All above data will be consolidated to help determine the rating levels or the change of rating levels, and due to the projects' various operational phases (see proceeding summary section **3.3**).

(11) World Health Organization, 2009, '*Night Noise Guidelines for Europe.*

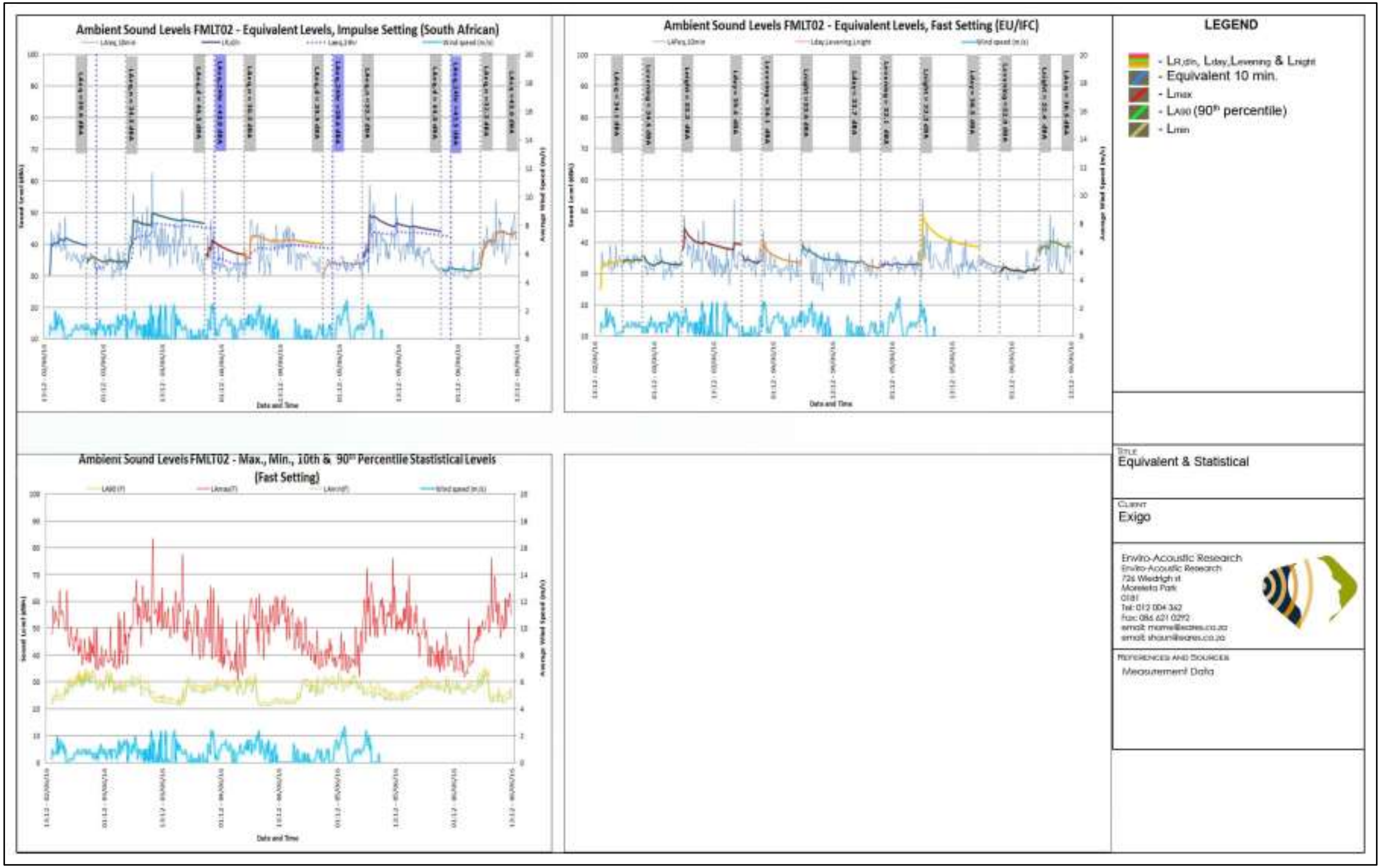

Figure 3-5: Impulse (SA), fast (IFC) & stastistical values

3.2.2.2 Octave Frequencies

Refer to section **3.2.1.2** describing the octave frequencies in more detail. Octave data is presented in **Figure 3-6** and **Figure 3-7**, and further discussed below.

<u>Lower frequencies (20 – 250 Hz, although low frequency is 100 Hz or below):</u> Some low to moderate peaks were measured continuously in the 50 – 63, 125 and 400 Hz bands. A clear trend in mentioned bands was analysable during night-time hours.
<u>Third octave surrounding 1000 Hz</u>: Moderate-low peaks and troughs were measured during the daytime, subsiding during the night.
<u>Higher frequencies (2,000 Hz upwards until ultrasound range)</u>: On occasion higher frequencies at ultrasound range were measured during the late evening and early morning hours. Peaks in the higher frequencies were measured, at times with an associated tone.

Summary: Spectral Analysis Figure 3-6 and Figure 3-7.
Refer to section **3.2.1.2** describing the inserts in the mentioned figures illustrating a basic interpretation of data.

The mid-range frequency contributors were from the road tyre interaction of the vehicles on the local route towards Kwaggafontein. Road tyre interaction was very low-moderate in magnitude due to distance of road from measurement locality. Higher frequencies (and tones) measured were contributions from faunal communication (cicada or bird song etc.), although measurements were conducted during winter time when fauna communication may be less than other seasons. Faunal communication occurred mostly during the night (e.g. crepuscular birds). The infrasound measured would be from faunal echolocation (e.g. bats etc.).

Lower frequencies were a cumulative contribution from mentioned roads vehicle motor revolutions as well as ventilation stacks/condenser units (could not be defined during site investigations) on the property of NSD08 (chicken farm/coops).

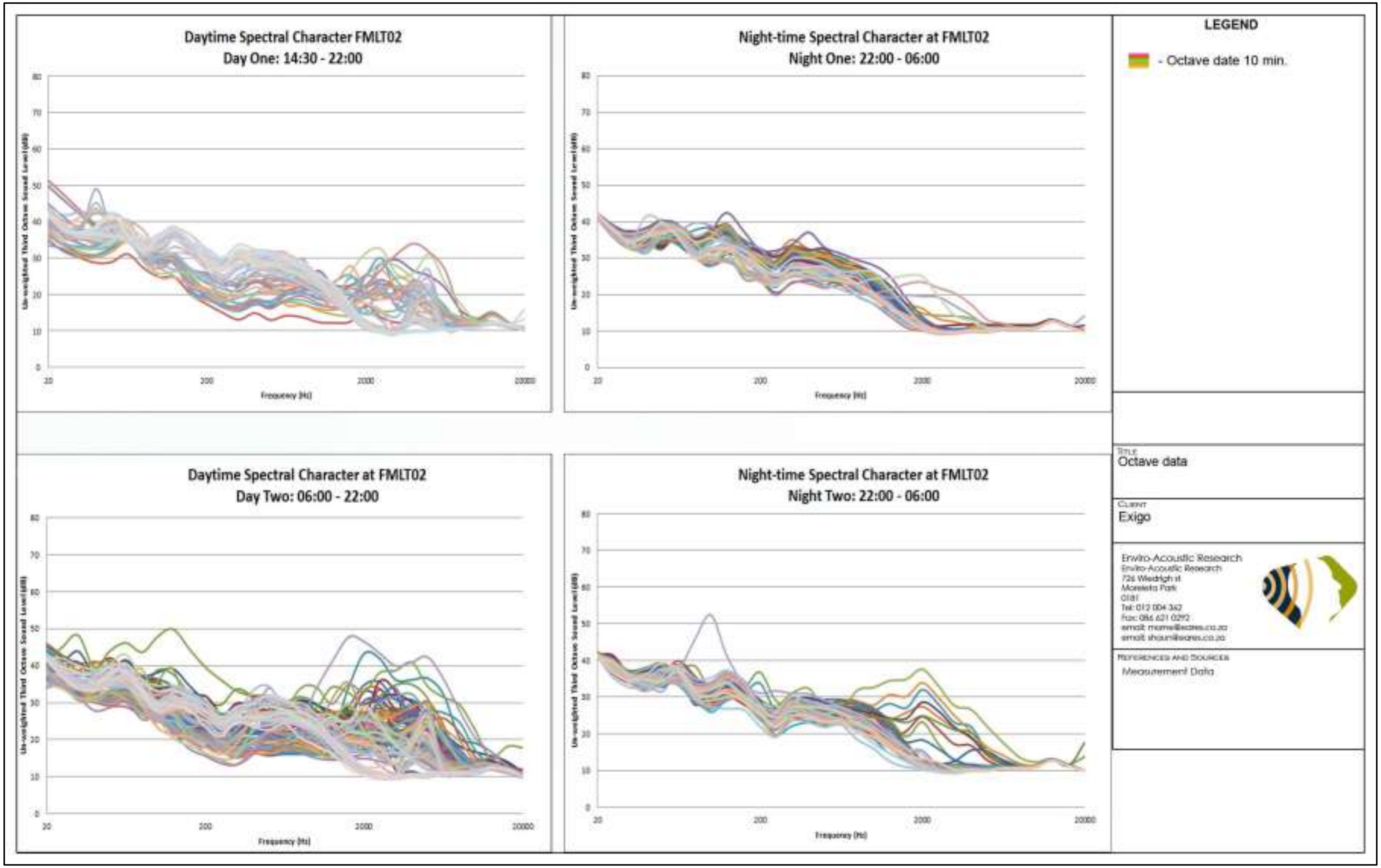

Figure 3-6: Spectral frequency distribution 1st & 2nd day/night

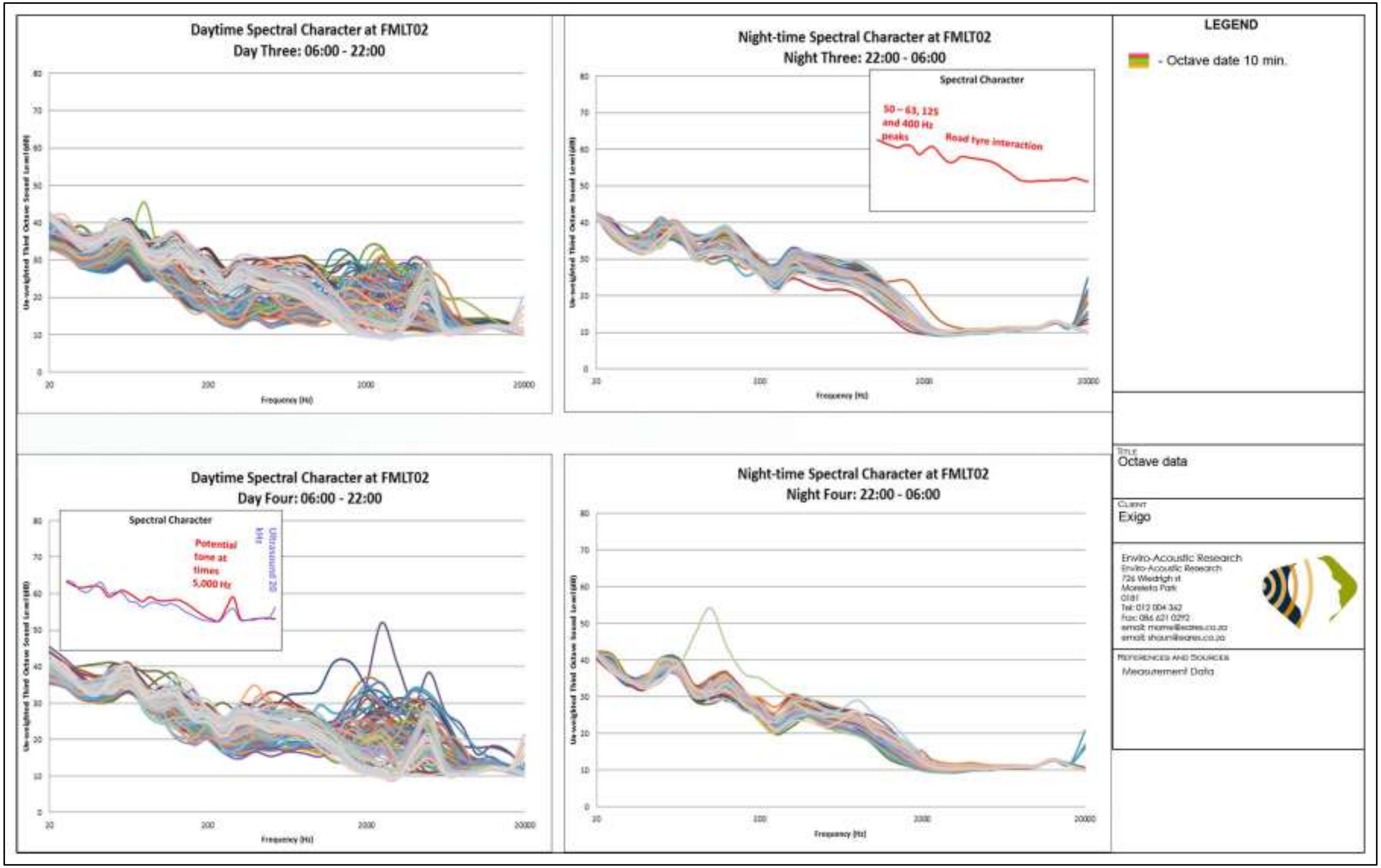

Figure 3-7: Spectral frequency distribution 3rd & 4th day/night

3.2.3 Shorter-Term Measurement Points FMST01 –FMST04: Numerous 10-minute measurements

Ten minute daytime measurements were collected at various localities around the study area. The equipment defined in **Table 3-1** was used for gathering data. The measurement results are presented in **Table 3-9**.

Table 3-9: Results of daytime ambient sound level measurements

Name	Measurement Locality	$L_{AFeq,\ 10min}$ dBA	$L_{AIeq,10min}$ dBA	Comments
FMST01	Route past NSD01 -NSD05	39.3	40.1	Faunal communication as well as community related noises (dogs barking, community members talking) dominated.
		39.9	41.0	
FMST02	Route past NSD06 -NSD09	50.1	51.1	Vehicles passing along route.
		53.4	55.2	
FMST03	Eastern footprint	38.9	40.1	Faunal communication.
		39.3	40.2	
FMST04	Eastern footprint	37.5	40.5	Faunal communication.
		39.0	40.8	

3.3 AMBIENT SOUND LEVELS – SUMMARY

A summary of all L_{Req} based on L_{AIeq} measurements is presented below in **Table 3-10**.

3.3.1 SANS 10103:2008 typical Rating Levels

Rating Levels:

- **FMLT01: Josef Homestead** - Considering the L_{AIeq} daytime data, many of the $L_{R,d/n}$ measurements indicated rating levels slightly higher than a rural or slightly higher rating. Night-time data indicated a rural setting. 10 minute data indicated the maximum levels could achieve a busy urban setting at times.
- **FMLT02: Doornhoek Fluorspar Mine Offices** - Considering the L_{AIeq} daytime data, many of the $L_{R,d/n}$ measurements indicated rating levels slightly higher than a rural or slightly higher rating. Night-time data indicated a rural setting. 10 minute data indicated the maximum levels could achieve an urban/busy urban setting during both day and night periods.
- **FMST01 –FMST04: Numerous 10-minute measurements** – The data indicated a rural to urban rating level.

3.3.2 ISO/European Union and IFC: General EHS Guidelines

IFC residential areas criteria:

- **All measurement localities:** L_{day}, L_{night} levels measured during the day and night (only longer-term measurements) conformed to the recommendation of 55 and 45 dBA respectively and 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.

Table 3-10: Rating level measured date profile ULT01: Ramotse Community/Plant Footprint

Measurement point & Date	Noise district rating based on $L_{AIeq,10min/8/16hr}$ 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)	Comments
FMLT01: Josef Homestead	Rural – Suburban/rural	Rural-suburban	Yes	Measurements were conducted during winter periods and faunal communication during summertime is likely to indicate a higher rating.
FMLT02: Doornhoek Fluorspar Mine Offices	Rural – Suburban/rural	Rural-suburban	Yes	
FMST01 –FMST04	Rural – urban	Rural-suburban	Yes	

The resulting rating level selected for all receptors based in the study area (and taking a precautious stance) is the rural rating level of 45 dBA and 35 dBA (day and night SANS 10103:2008 $L_{Req,d/n}$). The rating level is further discussed in section **5.3.2**.

4 INVESTIGATION OF EXISTING AND FUTURE NOISE SOURCES

The project is separated into its various applicable years namely years 1 to 5, 5 to 10, 10 to 20 and finally 20 to 30. The plant and haul roads will developed initial during the years 1 to 5. During years 5 to 10 the western open cast pits within the study area will be developed. Years 10 to 20 and 20 to 30 will be the development of two separate open cast pits to the east of the study area. Each of these years will be further investigated in terms of five phases namely the planning, construction, operation, closure and post-closure phases. The most important phases in terms of acoustics are the construction and operational phases.

During the construction of the open cast pits at various year intervals (5 to 10, 10 to 20 and 20 to 30) a scenario was designed whereby a direct line of sight from open cast footprints was envisaged. Construction would entail the stripping of topsoil and overburden with overburden likely stockpiled next to pits to be used for backfill/rehabilitation. During the operation of the open cast pits berms and highwalls will have been developed acting as an acoustical screen in relation to receptors.

The noise scenarios investigated concentrated on the noisiest equipment within close proximity to receptors (500m for linear and1, 000m for point noise sources). No receptors could be identified within 1,000m of the proposed processing plant footprint (with the closest receptor app. 2km away). Due to this large distance it was selected not to investigate the plant during any of the phases (although still discussed below for reference purpose).

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. **The scenarios consider that any moveable equipment (noise source that is not linear related) operates as feasible closes as possible to the receptors, while still remaining on the project footprint.**

4.1 POTENTIAL NOISE SOURCES – PLANNING PHASE

No potential noise impact is envisaged during this stage.

4.2 POTENTIAL NOISE SOURCES - CONSTRUCTION PHASE

Potential maximum noise levels generated by construction equipment and 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, the spectral character of the noise, and the ambient surroundings. The average or equivalent sound level is other factors that affects 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 are presented in **Table 4-2**. As mentioned the plant and tailings dam is too far (in terms of acoustics) for acoustical consideration.

4.2.1 Years 5 to 10

4.2.1.1 Delivery/Access Routes

Construction activities may include the following:

- Storerooms and paving aggregate stockpiles. Road paving refers to the various surface options for roads (see **Appendix A**);
- Transport of paving aggregate and materials down the routes;
- Soil Excavations, the removal of soils for foundations by usage of a grader;
- Compaction of soils with a vibrator roller; and
- A road paver and asphalt truck working in conjunction to pave the road if bituminous tar will be used. Roads may likely be unpaved.

4.2.1.2 Processing Plant, Tailings Dam

The following are possibly the main construction related sources of noise for the plant and its infrastructure:

- Vegetation removal and the stripping of topsoil;
- Activities related to the deployment and implementation of services (power lines, communication infrastructure, pipelines);
- Excavation of building foundations and service trenches;
- Piling operations for large buildings and structures;
- Construction of offices and other structures;
- Construction of the tailings dam.

4.2.2 Years 5 to 10, 10 to 20 & 20 to 30

4.2.2.1 Open cast activities

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) operating near a core drill. Furthermore a water dozer and core drill operating alongside the FEL and ADT was considered.

4.2.2.1 Stockpile Development (ROM, softs, hards etc.) & Conveyor Belt

There are many designs and management options available when considering stockpiles. Stockpiles (hards and softs etc.) will be based at the project footprint, while the ROM will be stockpiled at the plant footprint. Construction of conveyor routes and associated drivetrains will occur during these years.

4.2.2.2 Blasting

Rock blasting may be required to break down rock to level the ground inside the footprint. 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 and the blast will be over relatively fast, resulting in a higher acceptance of the noise.

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

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

Equipment Description[12]	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

[12] 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

At the operational phase berms/pit highwalls/overburden stockpiles would likely have already been developed and act as an acoustical screen from operations in relation to receptors. Typical sound power levels associated with various mining equipment for reference purpose are presented in **Table 4-1** (maximum noises) and **Table 4-2** (average or equivalent noises). As can be seen from this table, there is a range of equipment, frequently with different sound power emission levels and spectral characteristics.

4.3.1 Years 1 to 5

4.3.1.1 Processing Plant and Tailings dam

Primary/secondary/tertiary crushing is planned at the processing plant along with onsite buildings (e.g. offices and laboratories etc.). A tailings dam is proposed bordering the plant. As mentioned no receptors could be identified within 1,000m of the proposed plant and tailings dam footprint (with the closest receptor app. 2km away). Due to this large distance it was selected not to investigate the processing process in terms of acoustics during this phase.

4.3.2 Years 5 to 10, 10 to 20 & 20 to 30

4.3.2.1 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
- Run of mine (ROM) is garnered via means of graders, wheel loaders or any other required heavy equipment and loaded onto ADT's etc.;
- Hauling of ROM to stockpiles; and
- Dust suppression by means of water tanker dozers.

A design scenario front end loader (FEL) operating in conjunction with an articulated dump truck (ADT). A grader was considered for ground maintenance working in conjunction with a water dozer. Although similar to the construction phase, berms and highwalls would have been developed during this phase. These acoustical screens may reduce noise levels at receptors from open cast activities.

4.3.2.2 Processing Plant

The processing plant will continue during these years (discussed in more detail section **4.3.1.1**).

4.3.2.3 Stockpile Management (ROM, softs, hards etc.)

See previous section **4.2.2.1** describing the basic construction and operations of stockpiles.

4.3.2.4 Haul Road Design, Specifications & Information

The most important haul route would be during the years 5 – 10 whereby ROM will be hauled by ADT's and not conveyor belts.

Acoustics is not the only environmental and/or engineering 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 ;[13,14]
    - 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) [15], Unpaved Roads
    - Surface texture;[16] [17] [18]
    - Surface porosity[19][20]; and

[13] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed.
[14] Paul Sas. Structural Dynamic Behaviour of Tyres Noise & Vibration Engineering Research Group KU. Leuven. XIX CNIM 15-16/11 Castellon.
[15] Michael Maher, Chris Marshall, Frank Harrison, Kathy Baumgaertner. Context Sensitive Roadway Surfacing Selection Guide. Publication No. FHWA-CFL/TD-05-004. 2005.
[16] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed.
[17] Giuseppe Loprencipe & Giuseppe Cantisani. Unified Analysis of Road Pavement Profiles for Evaluation of Surface Characteristics. Modern Applied Science; Vol. 7, No. 8. 2013.
[18] PIARC. World Road Association: Report of the Committee on Surface Characteristics. 1987.
[19] 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.
[20] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed.

- Single maximum noise events - magnitude and occurrences (L_{AMax}) (vehicles backfiring, maintenance issues, etc.).

From the information received (see **Section 1.4**) a maximum capacity scenario based on 250 000 tons per year with an amount of 20 000 tons per month (tpm) possible. For the purpose of this report a scenario of 10 x 30 ton ADT's p/h was assessed.

Vehicles on public routes were not considered as this would fall under the scope of the relevant authority (e.g. SANRAL etc.).

4.3.2.5 Conveyor belt

A dedicated conveyor belt system is required and may include:

- Conveyor abrasion resistant rubber belts running along idlers from;
- Transfer points at junctions; and
- Conveyor belt drivetrain and gearbox unit/ pulleys with steel cord or rope along the conveyor route or at certain junctions or where required.

4.4 POTENTIAL NOISE SOURCES – CLOSURE AND DECOMMISSIONING PHASE (ALL YEARS)

In general, removal and rehabilitation activities have a significantly lower noise impact than both the construction and operational phases. **The closure phase will be consolidated and considered the same as the construction phase for the following reasons**:

- Removal and rehabilitation activities are generally less intense than construction and operational activities;
- Noise levels are lower and will be limited to daylight hours. This reduces the significance of the noise impact; and
- The impact would be similar or less than the construction phase impact.

4.5 POTENTIAL NOISE SOURCES – POST-CLOSURE PHASE (ALL YEARS

No potential noise impact is envisaged during this stage.

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 and mitigation 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
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
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[21][22]

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 has 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, characteristics 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 make use of sound/hearing to locate a suitable mate; and
- Noises associated with helicopters, motor- and quad bikes significantly affect animals.

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

As such various South African/International guidelines very briefly mention potential noise impacts on wildlife from industrial and commercial industries, it has the issue where no acoustical impact assessment criteria are defined[23]. 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 document's 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 affected 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 activities 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[24]), 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)[25&26]. The high noise

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

levels may see negative influences on animals' cardiovascular systems and behaviour, and may be damaging to the hearing of dogs in the kennel facility[27].

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[28]. 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 (e.g. rats, mice), the laboratory test subjects differ in many aspects (genetics, behaviour, etc.). Also, noise levels of studies are generally very high (at levels over 100 dB), much more than what would be experienced in environmental settings around industrial, commercial or transportation activities.[29] 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 exist dissimilarities in tests conducted and noise levels around commercial and industrial environments, laboratory rodents exposed to high noise levels exhibited physiological and behavioural changes, hearing loss and other effects[30].

5.2 WHY NOISE CONCERNS COMMUNITIES[31]

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.

[27] Wei, B. L. (1969). Physiological effects of audible sound. AAAS Symposium Science, 166(3904), 533-535.
[28] D B Stephens and R d Rader. J R Soc Med. 1983.
[29] USEPA, 1971: *"Effects of Noise on Wildlife and other animals"*.
[30] Ann Linda Baldwin. *"Effect of Noise on Rodent Physiology"*. 2007.
[31] 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, and 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 and 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[32], 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

[32] Image from presentation, Almgren (2011). Sources Milieu, 2010, European Comm., 2010, Jansen, 2009.

local complaint-type situations or to an assessment of the short-term effects of a change in noise climate.

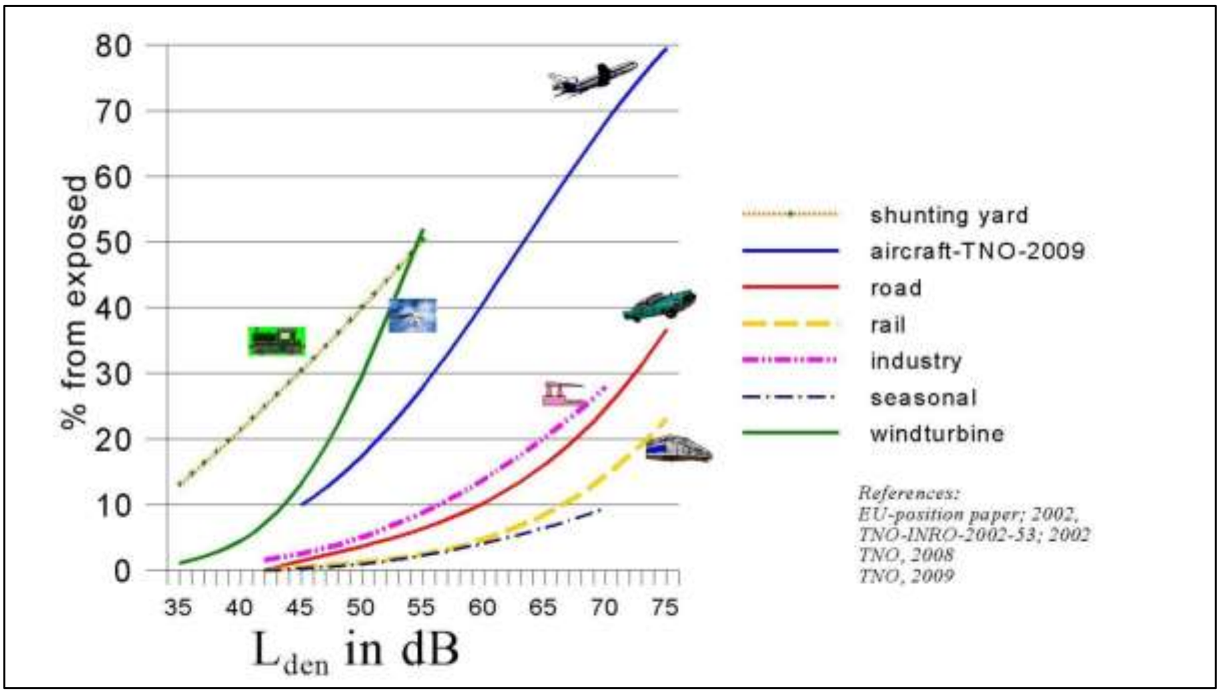

Figure 5-1: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling

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 that 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 of 2014 in terms of the NEMA, SANS 10103:2008, and guidelines from the WHO.

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, 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 WHO, World Bank and IFC for residential areas, as well as the South African SANS10103:2008 guidelines.

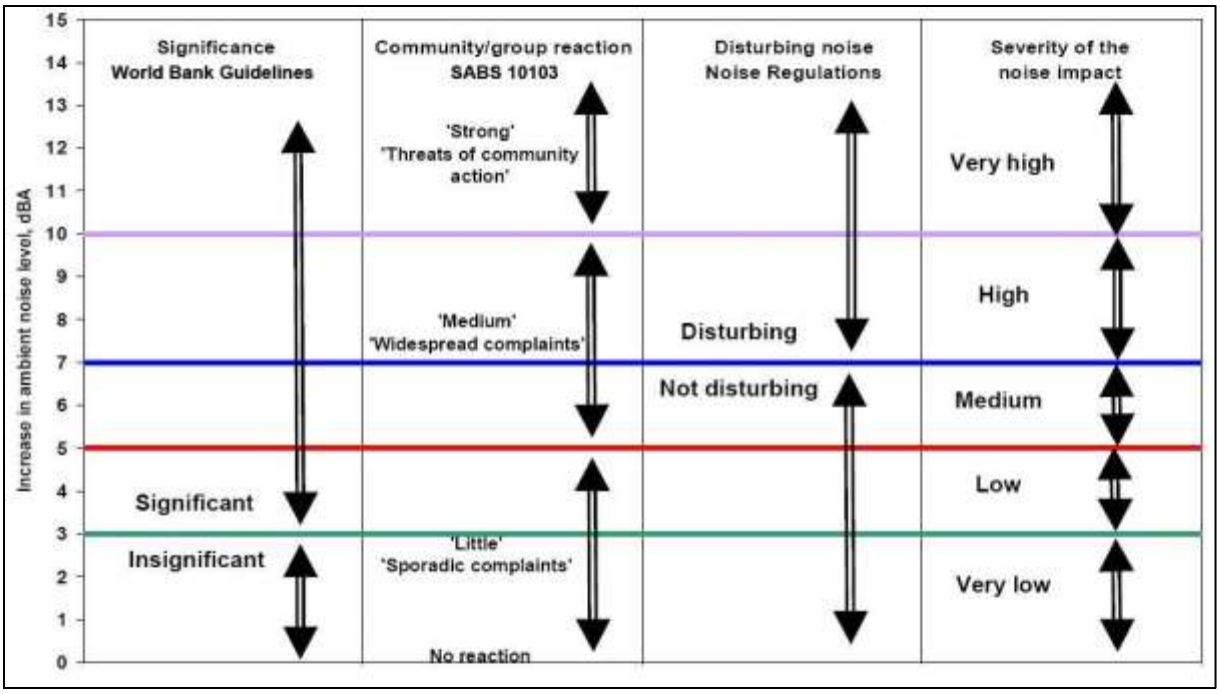

Figure 5-2: Criteria to assess the significance of impacts stemming from noise

During site measurements (**Section 3.2**), $L_{AIeq.16/8hr/10\ min}$ ranged between rural to suburban, at times had the potential to be busy urban. By considering other measured variables and by taking a precautionary 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:

- Rural district daytime rating of $L_{Req,d}$ of 45 dBA; and
- Rural district night-time rating $L_{Req,n}$ of 35 dBA.

International guidelines should also be considered. The IFC residential, institutional and educational referenced areas include ratings of:

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

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 by 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	EARES rating colour code
Type of district	Equivalent continuous rating level ($L_{Req,T}$) for noise dBA						
	Outdoors			Indoors, with open windows			
	Day/night $L_{R,dn}$	Daytime $L_{Req,d}$	Night-time $L_{Req,n}$	Day/night $L_{R,dn}$	Daytime $L_{Req,d}$	Night-time $L_{Req,n}$	
a) Rural districts	45	45	35	35	35	25	Rural
b) Suburban districts with little road traffic	50	50	40	40	40	30	Suburban
c) Urban districts	55	55	45	45	45	35	Urban
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40	Busy urban
e) Central business districts	65	65	55	55	55	45	Business
f) Industrial districts	70	70	60	60	60	50	Industrial

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 and other sounds we consider "normal", such as the hum (magnetostriction) from a variety of appliances such as freezers and fridges, drawing standby power.

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

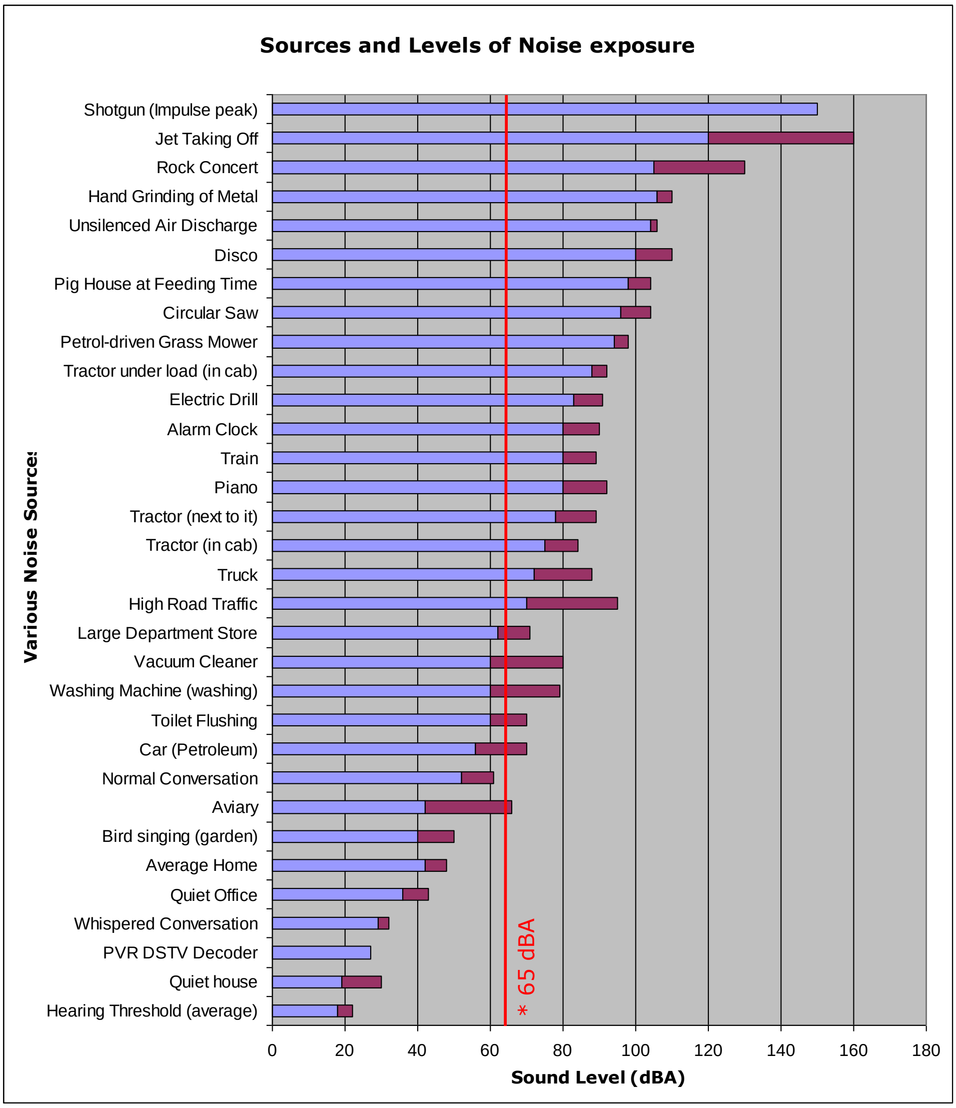

Figure 5-3: Typical Noise Sources and associated Sound Pressure Level

5.3.4 Determining the Significance of the Noise Impact

The Impact Matrix variables were set out by the main consultant Exigo (Pty) Ltd. In the below tables the impact matrix has been further defined in terms of acoustics (by EARES, see bold text).

The impact consequence is determined by the summing the scores of Magnitude **Table 5-2**), Duration (**Table 5-3**) and Scale (**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**). Furthermore the impact is divided into positive and negative (see also **Table 5-6**).

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

Table 5-2: Impact Assessment Criteria - Magnitude

Magnitude/ Severity: Does the impact destroy the environment, or alter its function.		
Rating	**Description**	**Score**
Low	The impact alters the affected environment in such a way that natural processes are not affected. **In terms of acoustics the increase in average sound pressure levels between 0 < 5 dB from the expected ambient sound levels will be considered. 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.**	2
Medium	The affected environment is altered, but functions and processes continue in a modified way. **In terms of acoustics the increase in average sound pressure levels between 5 < 10 dB from the expected ambient sound levels will be considered. The ambient sound levels will be defined by the Rating Level. Total projected outdoor noise level exceeds the Rating Level and/or Equator Principle.**	6
High	"Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases. **In terms of acoustics the total projected outdoor noise levels higher than 10 dB above the Rating Level and/or Equator Principle. 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 section 2.2.1.**	8

Table 5-3: Impact Assessment Criteria - Duration

Duration: The lifetime of the impact		
Rating	**Description**	**Score**
Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.	1
Medium term	The impact will last up to the end of the phases, where after it will be negated.	3
Long term	The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.	4
Permanent	Impact that will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.	5

Table 5-4: Impact Assessment Criteria – Scale

Scale: The physical and spatial size of the impact		
Rating	**Description**	**Score**
Local	The impacted area extends only as far as the activity, e.g. footprint	1
Site	The impact could affect the whole, or a measurable portion of the above mentioned properties.	2
Regional	The impact could affect the area including the neighbouring residential areas.	3

Table 5-5: Impact Assessment Criteria - Probability

Probability: This describes the likelihood of the impact actually occurring.		
Rating	**Description**	**Score**
Improbable	The possibility of the impact occurring is very low, due to the circumstances, design or experience.	1
Probable	There is a probability that the impact will occur to the extent that provision must be made therefore.	2
Highly Probable	It is most likely that the impact will occur at some stage of the development.	4
Definite	The impact will take place regardless of any prevention plans, and there can only be relied on mitigatory actions or contingency plans to contain the effect.	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
Negative		Positive	
Negative effect (in terms of acoustics)		**Positive effect (in terms of acoustics)**	

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 (S) value for each impact (prior to the implementation of mitigation measures). It is also presented in **Table 5-7**.

Table 5-7: Significance without mitigation scale

s</=20	**Negligible**	The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.
s</=40	**Low**	The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.
s</=60	**Moderate**	The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.
s>60	**High**	The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

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. The Significance scoring will be considered as (above table WOM **Table 5-7**), however in conjunction with the effect of the mitigation effect in the following table:

Table 5-8: Mitigation Effect

Mitigation Effect: Degree to which the impact can be managed following mitigation	
Rating	**Description**
Can be reversed	Can be avoided, managed or mitigated in such a way that natural processes are not affected and returned to natural state
Can be avoided, managed or mitigated	Can be avoided, managed or mitigated to the degree that functions and processes continue in a modified way)
May cause irreplaceable loss of resources	Irreversible impact (may cause irreplaceable loss of resources). Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

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 were 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 illustrates the potential extent of the calculated noise 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, and are dependent on faunal characteristics (mating season, dawn chorus[33] 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 baseline. Many faunal species are more active during warmer periods than colder periods. Cicadas are 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, thus magnifying noise levels they produce from their tymbals[34];
- 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 the dawn chorus of bird songs). This generally is still considered naturally quiet and accepted as features of the natural baseline, and in various cases sought after and pleasing;
- Considering one or more sound descriptors 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. However, South African legislation requires consideration of the 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

[33] Environ. We Int. Sci. Tech. *Ambient noise levels due to dawn chorus at different habitats in Delhi*. 2001. Pg. 134.
[34] 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. [35] 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 baseline 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 noises, voices, animals and equipment (including TVs 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 baseline 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 are subject to. While the octave sound power

[35] 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 exact 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-engineer 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 are 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 is also affected 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.

8 SCENARIO: FUTURE NOISE CLIMATE

8.1 INVESTIGATED SCENARIOS

Various scenarios are applicable, with the most important being the construction/closure of the pits and the operations there of. The various phases are discussed in more detail in section **4**. The most important times for an assessment are night-time hours (22:00 – 06:00) and will be focused on in the proceeding impact assessment.

The night scenarios assessed were then further separated into its relevant years of operations (see also above section **8**). The scenario investigated during each yearly interval will be when equipment operates within the limits of the project footprint in a grid by grid fashion, but as feasibly close to study area receptors. As mentioned the processing plant (and associated tailings dam) was too far from any receptors to be further considered in terms of environmental acoustics. The haul routes were assessed separately, concentrating on potential maximum noise levels.

8.1.1 Investigated Construction/Closure, Operational and Haul Route Scenarios (all years)

The primary and secondary corrections considered for the construction/closure and operational phases are presented in **Table 8-1**, with the layout presented in **Figure 8-1**. The subsequent consolidated corrections, specifications and layouts were used to design the various scenarios for impact assessment purposes. The closest (to receptors) and nosiest activities were identified and used for assessment purpose.

Table 8-1: $L_{R,d}$ construction scenario investigated

Intervening environmental factors	
Receiver(s)	See layout in **Figure 1-2** & **Figure 8-1**.
Indoor correction (screening)	-20 dBA.
Intervening ground correction	Medium-hard nature (50% soft).
Façade correction	No.
Metrological	Activities assessed functioned during wind-still conditions during good sound propagation conditions (20°C and 80% humidity).
Elevations	Yes.
Construction/Closure – see Figure 8-1	
Point sources	See **Section 4.2** for point sources. Noise sources considered over an hour period $L_{Req,1hr.}$
Berms/highwalls/acoustical screens	No berms or barriers considered.
Operational – see Figure 8-1	
Operational phase	See **Section 4.3.** Noise sources considered over an hour period $L_{Req,1hr.}$ Plant in **Figure 8-1** not considered (purple line).
Berms/highwalls/acoustical-screens	Yes, berms/pit highwalls considered at the project footprint as illustrated as a red lines in **Figure 8-1**
Haul routes – see Figure 8-1	
Traffic (p/hr.) & % heavy vehicles	8 x heavy vehicles
Road Surface/lanes/speeds	Asphalt/ Single lane/ An estimated 60 km/h
Stop junction(s)	No, continuous traffic movement assessed.

Figure 8-1: Investigated scenarios

9 MODELLING RESULTS AND IMPACT ASSESSMENT

9.1 MODELLED SCENARIOS

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

Sections **9.1.1** to **9.1.4** assesses the various years (1 to 5, 5 to 10, 10 to 20 and 20 to 30 respectively) and for the various phases.

9.1.1 Years 1 - 5

Initial the plant (and associated tailings dam) and haul routes will be developed. The outcome of the impact assessment is presented in **Table 9-1**.

9.1.1.1 Construction/Closure Phase $L_{Req,1hr}$ – Worst-case Maximum Noise Levels

No receptors are within 1,000m of the plant and associated tailings dam (no noise impact envisaged). Road construction will be over 500m from receptors. This phase will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guidelines and IFC performance standards.

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

No receptors are within 1,000m of the plant and associated tailings dam (no noise impact envisaged). This phase will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guidelines and IFC performance standards.

The closest receptors to the haul routes are over 500m away (namely receptor NSD06, see **Figure 1-2** and **Figure 8-1**). Modelled scenarios indicated that receptors would need to be bordering (within 100m) the route for a potential noise impact (see **Figure 9-1**). The modelled scenario indicated that noise levels from haul routes (while audible at receptors) will be of insignificant levels.

This phase will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guidelines and IFC performance standards.

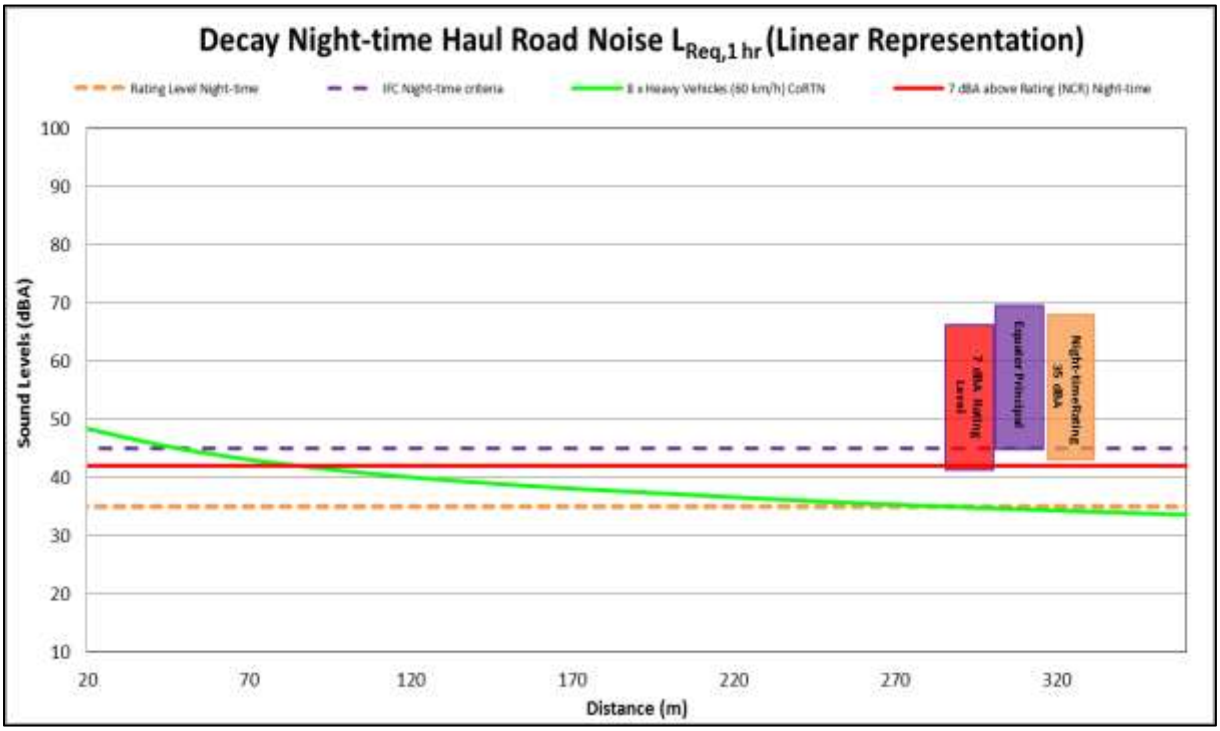

Figure 9-1:Haul routes, 10 x heavy vehicles p/h

9.1.1.1 Planning & Post Closure Phases

No receptors are within 1,000m of the plant and associated tailings dam (no noise impact envisaged). Road construction will be over 500m from receptors.

These phases will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guidelines and IFC performance standards.

Table 9-1: Impact Assessment: 1 – 5 years night-time assessments

Receptors (NSD)	Activity	Impact	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigation Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
Planning Phase																
All receptors	Years 1 - 5	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	No noise envisaged during this phase. The developer can consider various technical and management options during this phase to ensure a negligible rating during other phases (such as equipment or layout specifications).	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
Construction Phase																
All receptors	Years 1 - 5	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	No receptors are within 1,000m of the plant. Roads construction will not impact on receptors.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
Operational Phase																
All receptors	Years 1 - 5	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible	No receptors are within 1,000m of the plant. Roads operation will not impact on receptors.	Can be reversed
			WM	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible		Can be reversed
Closure and Decommissioning Phase																
All receptors	Years 1 - 5	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
Post-Closure Phase																
All receptors	Years 1 - 5	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed

9.1.2 Years 5 - 10

During this phase a large mountain region bisecting the study area will act as a buffer of noise from open cast activities to receptors. The outcome of the impact assessment is presented in **Table 9-2**.

9.1.2.1 Construction/Closure Phase $L_{Req,1hr}$ – Worst-case Maximum Noise Levels

During the 5 - 10 year periods the developer will be conducting surface preparation/overburden removal on the furthermost western open cast pits. It is represented in **Figure 9-2**, using contours of constant noise levels. The resulting future noise projections indicate that the construction of the project will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards.

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

The outcome of the night-time operational ROM mining is represented in **Figure 9-3** as contours of night-time noise levels. The resulting future noise projections indicate that the operations will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards.

9.1.2.3 Planning & Post Closure Phases

These phases will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guidelines and IFC performance standards.

Table 9-2: Impact Assessment: 5 - 10 years night-time assessments

Receptors (NSD)	Activity	Impact	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigation Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
Planning Phase																
1 to 5	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	No noise envisaged during this phase. The developer can consider various technical and management options during this phase to ensure a negligible rating during other phases (such as equipment or layout specifications).	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
5 to 10	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
Construction Phase																
1 to 5	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
5 to 10	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
Operational Phase																
1 to 5	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible		Can be reversed
5 to 10	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible		Can be reversed
Closure and Decommissioning Phase																
1 to 5	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed

5 to 10	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
Post-Closure Phase																
1 to 5	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	No potential high magnitude noise generating activities envisaged to operate during this phase.	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
5 to 10	Open cast years 5 - 10	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed

Figure 9-2: Projected 5 - 10 years night-time construction noise rating levels

Figure 9-3: Projected 5 - 10 years night-time operational noise rating levels

9.1.3 Years 10 - 20 Open Cast Activities

The outcome of the impact assessment for the years 10 - 20 is presented in **Table 9-3**.

9.1.3.1 Construction/Closure Phase $L_{Req,1hr}$ – Worst-case Maximum Noise Levels

During the 10 - 20 year period the developer will be conducting surface preparation (and subsequent ROM mining) on the lower of the two eastern footprints. It is represented in **Figure 9-4**, using contours of constant noise levels. The resulting future noise projections indicate that the construction of the project will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards. There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low (see proceeding section **10**).

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

The outcome of the first 10 years night-time operational ROM mining is represented in **Figure 9-5** as contours of night-time noise levels. The resulting future noise projections indicate that the operations will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards. There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low (see proceeding section **10**).

9.1.3.3 Planning & Post Closure Phases

These phases will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guidelines and IFC performance standards.

Table 9-3: Impact Assessment: 10 - 20 years night-time assessments

Receptors (NSD)	Activity	Impact	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigation Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
Planning Phase																
1 to 9	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	No noise envisaged during this phase. The developer can consider various technical and management options during this phase to ensure a negligible rating during other phases (such as equipment or layout specifications). See also section **10**.	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
Construction Phase																
1 to 9	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	No night-time topsoil/overburden clearance is recommended within 1,000m of these receptors without a berm in place. Berm and highwalls should be constructed within 1,000m of these receptors and during the daytime periods only before night-time work is considered. Berm specifications are highlighted in section **10.** Communication between the receptors and developer needs to be implemented and maintained highlighting the outcome of this study. **It should be noted that these receptors (NSD10) is a business, during site investigations discussions with workers indicated that employees do make use of the facility as accommodation during the night-time hours. If the receptors are to be relocated or workers not to reside at this facility during the night, a negligible rating would be applicable;** An Acoustical Measurement & Audit Programme must be developed and implemented. A bi-annual measurement run is recommended. If blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist The mine should investigate the use of white-noise generators instead of tonal reverse alarms on heavy vehicles. 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”.	Can be avoided, managed or mitigated

															Ensuring that equipment operating in open cast pits are well maintained and fitted with the correct and appropriate noise abatement measures. Acoustical mufflers (or silencers) should be considered on equipment exhausts. 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.	
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	Implementation of mitigation options above in the WM section is deemed sufficient to ensure a negligible rating.	Can be reversed
Operational Phase																
1 to 9	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible		Can be reversed
10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Probable	2	Long term	4	Site	2	Medium	6	24	Low	See Construction Phase mitigation options above (all points relevant for this phase). The most important mitigation measure is to ensure that berms are implemented and maintained.	Can be avoided, managed or mitigated
			WM	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible	Implementation of mitigation options above in the WM section is deemed sufficient to ensure a negligible rating.	Can be reversed
Closure and Decommissioning Phase																
1 to 9	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	See Construction Phase mitigation options above (all points relevant for this phase). The most important mitigation measure is to ensure that berms are implemented and maintained.	Can be avoided, managed or mitigated
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	Implementation of mitigation options above in the WM section is deemed sufficient to ensure a negligible rating.	Can be reversed
Post-Closure Phase																
1 to 9	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	No potential high magnitude noise generating activities envisaged to operate during this phase.	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed

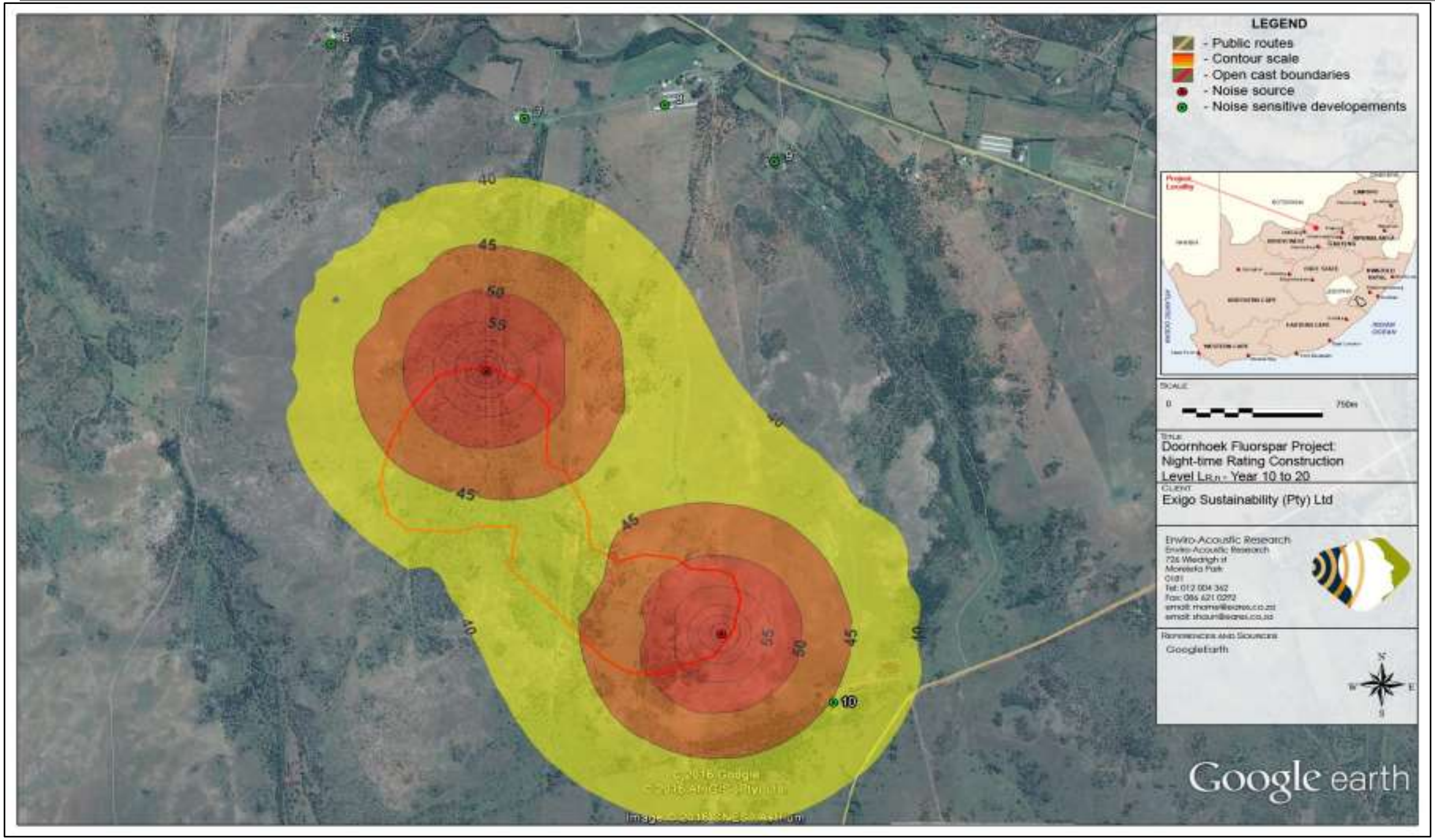

Figure 9-4: Projected year 10 – 20 night-time construction noise rating levels[36]

[36] The scenarios consider that any moveable equipment (noise source that is not linear related) operates as feasible closes as possible to the receptors, while still remaining on the project footprint.

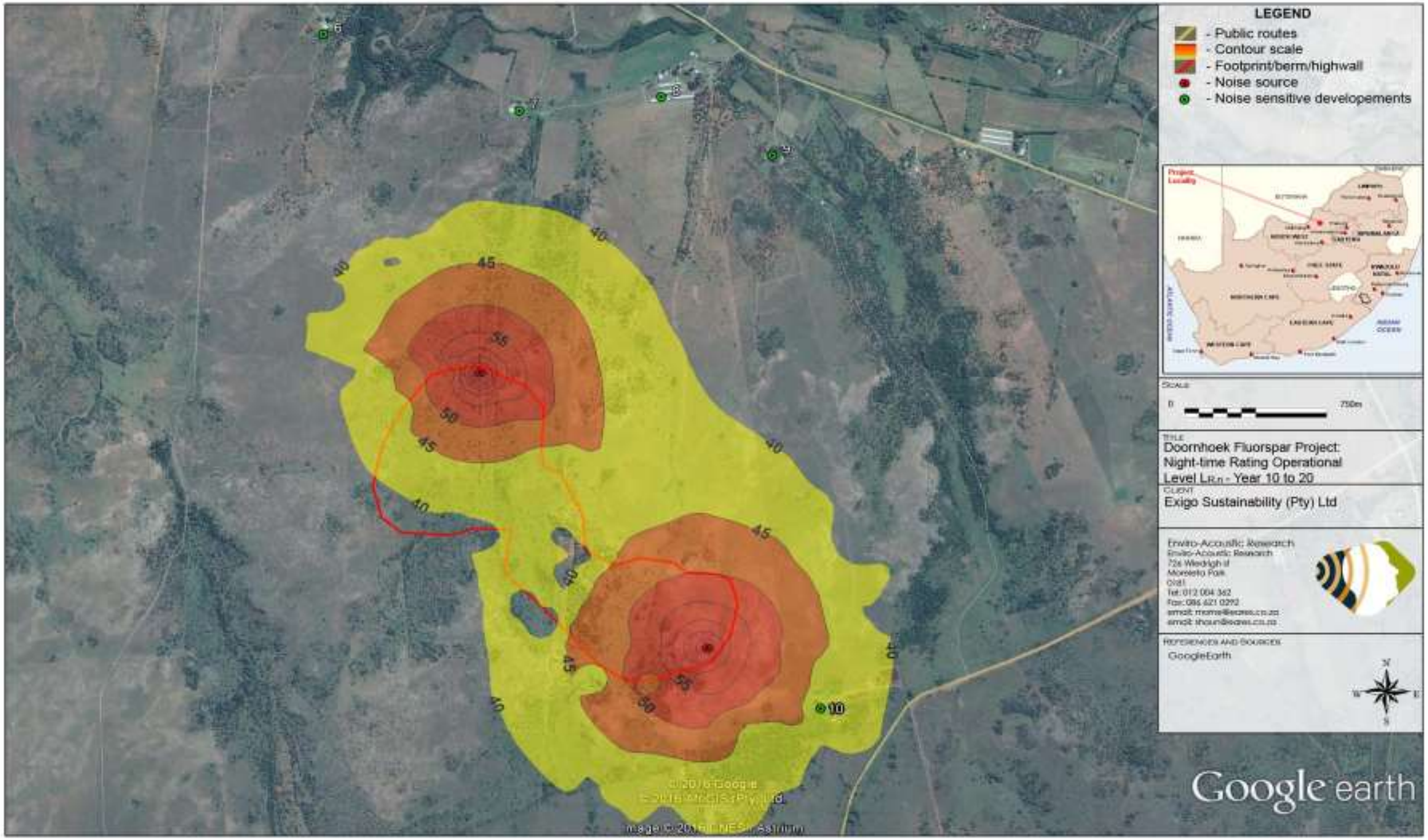

Figure 9-5: Projected year 10 – 20 night-time operational noise rating levels[37]

[37] The scenarios consider that any moveable equipment (noise source that is not linear related) operates as feasible closes as possible to the receptors, while still remaining on the project footprint.

9.1.4 Years 20 - 30 Open Cast Activities

The outcome of the impact assessment is presented in **Table 9-4**.

9.1.4.1 Construction/Closure Phase $L_{Req,1hr}$ – Worst-case Maximum Noise Levels

During the 10 - 20 year period the developer will be conducting surface preparation (and subsequent ROM mining) on the lower of the two eastern footprints. It is represented in **Figure 9-6**, using contours of constant noise levels. The resulting future noise projections indicate that the construction of the project will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards. There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low (see proceeding section **10**).

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

The outcome of the first 10 years night-time operational ROM mining is represented in **Figure 9-7** as contours of night-time noise levels. During this phase berms and pit highwalls will have been established. The resulting future noise projections indicate that the operations will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards. There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low (see proceeding section **10**).

9.1.4.3 Planning & Post Closure Phases

These phases will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guidelines and IFC performance standards.

Table 9-4: Impact Assessment: 20 - 30 years night-time assessments

Receptors (NSD)	Activity	Impact	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigation Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
Planning Phase																
1 to 7 & 9 to 10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	No noise envisaged during this phase. The developer can consider various technical and management options during this phase to ensure a negligible rating during other phases (such as equipment or layout specifications).	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
8	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
Construction Phase																
1 to 7 & 9 to 10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	**None required. It should be noted that NSD07 is the office of the developer. At the consent of the developer the noise levels at this dwelling was discarded and a negligible rating was considered.**	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
8	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Communication between the receptors and developer needs to be implemented and maintained highlighting the outcome of this study. No night-time topsoil/overburden clearance is recommended within 1,000m of these receptors without a berm in place. Berm and highwalls should be constructed within 1,000m of these receptors and during the daytime periods only before night-time work is considered. Berm specifications are highlighted in section **10.** An Acoustical Measurement & Audit Programme must be developed and implemented. A bi-annual measurement run is recommended. The mine should investigate the use of white-noise generators instead of tonal reverse alarms on heavy vehicles. 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". Ensuring that equipment operating in open cast pits are well maintained and fitted with the correct and appropriate noise abatement measures. Acoustical mufflers (or silencers) should be considered on equipment exhausts. 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.	Can be avoided, managed or mitigated
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	Implementation of mitigation options above in the WM section is deemed sufficient to ensure a negligible rating.	Can be reversed
Operational Phase																
1 to 7 & 9 to 10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible		Can be reversed
8	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Probable	2	Long term	4	Site	2	Medium	6	24	Low	**See Construction Phase mitigation options above (all points relevant for this phase).** The most important mitigation measure is to ensure that berms are implemented and maintained.	Can be avoided, managed or mitigated
			WM	**Negative**	Improbable	1	Long term	4	Site	2	Low	2	8	Negligible	Implementation of mitigation options above in the WM section is deemed sufficient to ensure a negligible rating.	Can be reversed
Closure and Decommissioning Phase																

1 to 7 & 9 to 10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	None required.	Can be reversed
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible		Can be reversed
8	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	**See Construction Phase mitigation options above (all points relevant for this phase).** The most important mitigation measure is to ensure that berms are implemented and maintained.	Can be avoided, managed or mitigated
			WM	**Negative**	Improbable	1	Medium term	3	Site	2	Low	2	7	Negligible	Implementation of mitigation options above in the WM section is deemed sufficient to ensure a negligible rating.	Can be reversed
Post-Closure Phase																
1 to 7 & 9 to 10	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	No potential high magnitude noise generating activities envisaged to operate during this phase.	Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
8	Open cast years 10 - 20	Potential increase/change of ambient/rating levels.	**WOM**	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed
			WM	**Negative**	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible		Can be reversed

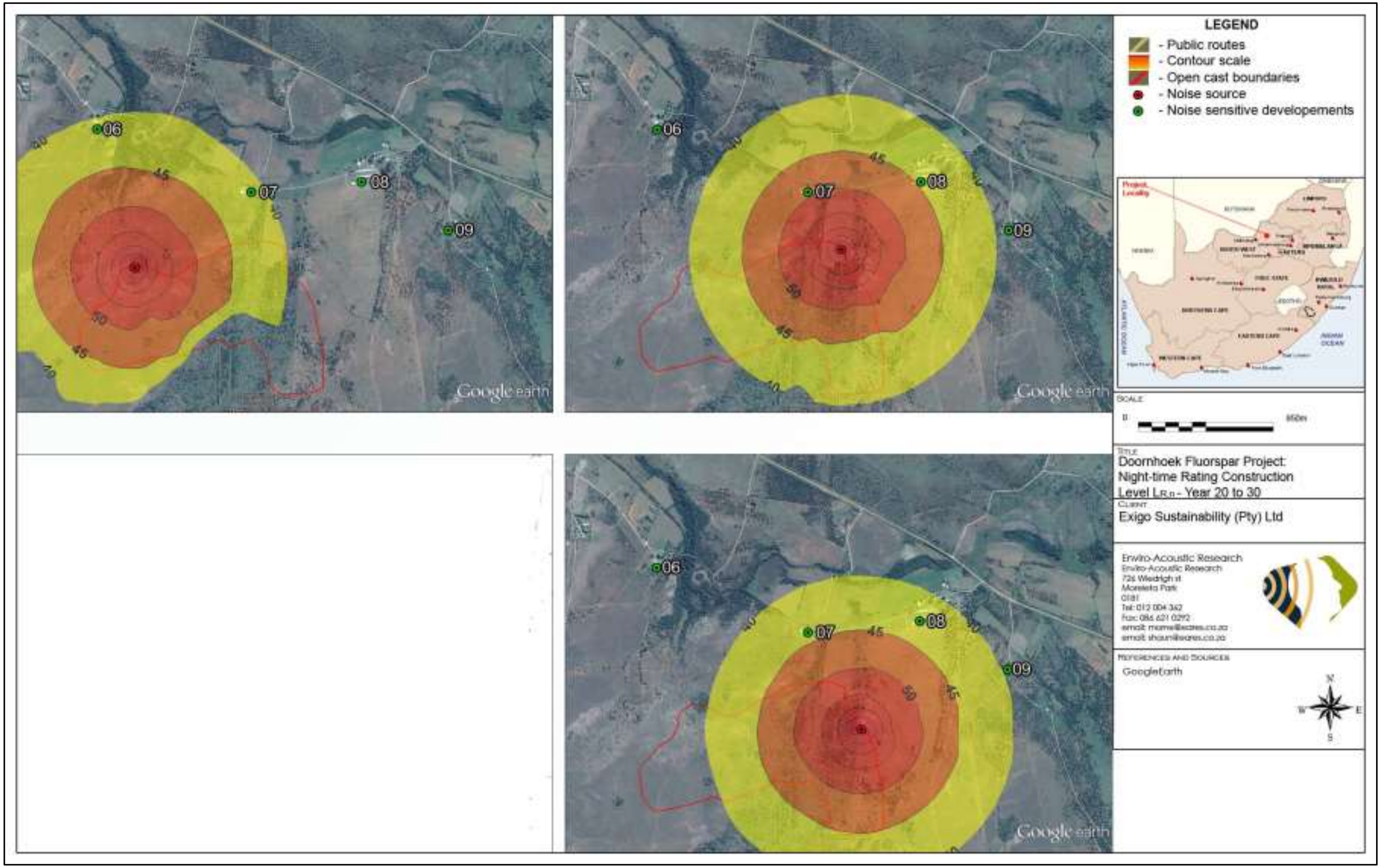

Figure 9-6: Projected year 20 – 30 night-time construction noise rating levels

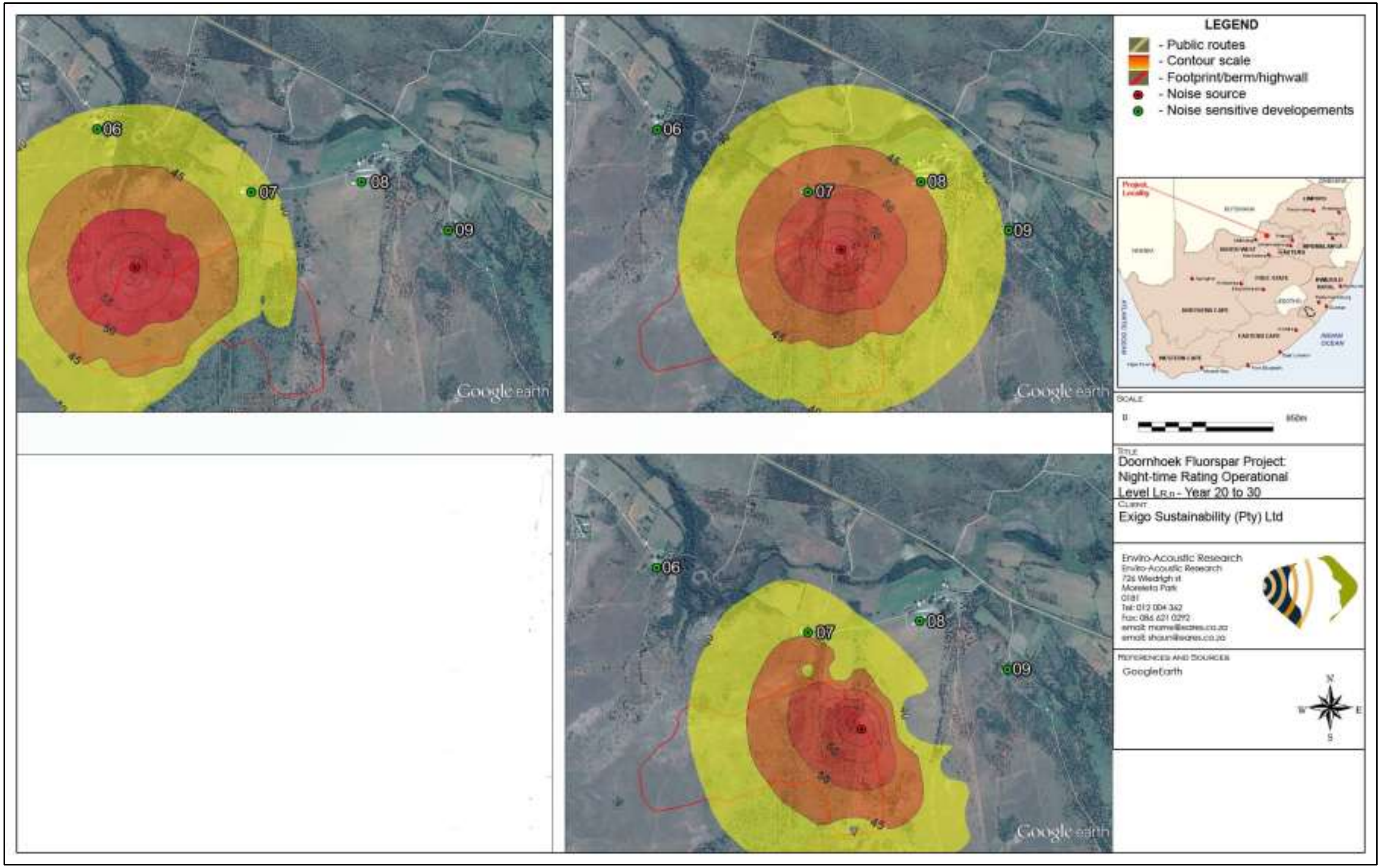

Figure 9-7: Projected year 20 – 30 night-time operational noise rating levels

10 MITIGATION OPTIONS

Based on the project outcome of the modelled scenarios in section **9** above, mitigation options are recommended for the construction/closure and operation of open cast pits during the 10 – 20 and 20 – 30 year time line periods. It should be noted that NSD07 is the office of the developer. At the consent of the developer the noise levels at this dwelling was discarded and a negligible rating was considered.

10.1 YEAR 1 TO 5

10.1.1 Planning Phase

During planning phase there is no potential for a noise impact. However during this phase the development team can implement various technical and management options to ensure a low or negligible significance rating. **None of these options are mandatory, but highly recommended.** These options are:

- Haul road designs could consider the below design elements that would be applicable during all phases of the project:
  - Limit the maximum speed on the haul roads to 50 - 70 km/h. 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 maintaining these unpaved routes by regularly smoothing out irregularities on the routes.
- 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. 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; and

- The mine should investigate the use of white-noise generators instead of tonal reverse alarms on heavy vehicles[38]. 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".*

10.1.2 Construction Phase

There exist a negligible potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- An Acoustical Measurement & Audit Programme must be developed and implemented during this phase. The measurement protocol details are entailed in section **11**; and
- If blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist.

10.1.3 Operational Phase

There exist a negligible potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- An Acoustical Measurement & Audit Programme must be developed and implemented during this phase. The measurement protocol details are entailed in section **11**;
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.1.4 Closure and Decommissioning Phase

There exist a negligible potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

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

- An Acoustical Measurement & Audit Programme must be developed and implemented during this phase. The measurement protocol details are entailed in section **11**;
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.1.5 Post Closure Phase

No mitigation options are required during this phase.

10.2 YEAR 5 TO 10

10.2.1 Planning Phase

During planning phase there is no potential for a noise impact. However during this phase the development team can implement various technical and management options to ensure a low or negligible significance rating. **None of these options are mandatory, but highly recommended.** These mitigation options are highlighted in section **10.1.1**.

10.2.2 Construction Phase

There exist a negligible potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme mentioned in section **10.1.2**. The measurement protocol details are entailed in section **11**;
- If blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist;

10.2.3 Operational Phase

There exist a negligible potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme must be maintained (section **11**);
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.2.4 Closure and Decommissioning Phase

There exist a negligible potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme must be maintained (section **11**);
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.2.5 Post Closure Phase

No mitigation options are required during this phase.

10.3 YEAR 10 TO 20

10.3.1 Planning Phase

During planning phase there is no potential for a noise impact. However during this phase the development team can implement various technical and management options to ensure a low or negligible significance rating. **None of these options are mandatory, but highly recommended.** These mitigation options are highlighted in section **10.1.1**.

10.3.2 Construction Phase

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme mentioned in section **10.1.2**. The measurement protocol details are entailed in section **11**;
- If blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist;
- Communication between the receptors NSD10 and the developer needs to be implemented and maintained highlighting the outcome of this study. **It should be noted that receptor (NSD10) is a business, during site investigations discussions with workers indicated that employees do make use of the facility as accommodation during the night-time hours**. **If the receptors are to be relocated or workers not to reside at this facility during the night, a negligible rating would be applicable;**
- Subsequently the modelled contours of noise levels indicated any receptors within the 42 - 45 dBA night-time contours (app. 7 dBA above the identified rating level) would require mitigation options. A night-time buffers/ constraint map is presented in **Figure 10-1** illustrating recommended night-time buffers with no berms in place (i.e. times of topsoil/overburden removal). The following mitigation options when construction/topsoil or overburden removal is to occur during the

night in these buffers (and **should be highly considered and/or mandatory**) and include:

- No night-time topsoil and overburden clearance should be conducted in these buffers without berm/barriers, only daytime work allowable (i.e. 06:00 – 22:00);
- Berm constituent sourced from outside the constraints buffer zone and built during daytime hours only (06:00 – 22:00) before site clearance or overburden removal is to take place. The most important areas where a berm would be required are presented in **Figure 10-1** highlighting the need for berms near receptors NSD10. The following factors regarding the berms/barriers should be mandatory and include:
    1. 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, 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 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];
    2. The barrier should be sufficiently long to block the line of sight from receptors to the sides of the mining operations; and
    3. 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.

[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.
[42] Norton, M.P. and Karczub, D.G, "*Fundamentals of Noise and Vibration Analysis for Engineers",* Second Edition, 2003, p.600.

10.3.3 Operational Phase

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme must be maintained (section **11**);
- **Berms, barriers and highwalls as discussed in the above construction phase must have been implemented prior to this operational phase**. The most important areas for berms and barriers are illustrated in the constraints maps in **Figure 10-1**; and
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.3.4 Closure and Decommissioning Phase

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme must be maintained (section **11**);
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.3.5 Post Closure Phase

No mitigation options are required during this phase.

10.4 YEAR 20 TO 30

10.4.1 Planning Phase

During planning phase there is no potential for a noise impact. However during this phase the development team can implement various technical and management options to ensure a low or negligible significance rating. **None of these options are mandatory, but highly recommended.** These mitigation options are highlighted in section **10.1.1**.

10.4.2 Construction Phase

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme mentioned in section **10.1.2**. The measurement protocol details are entailed in section **11**;

- If blasting is required to take place near a receptors dwelling (within 500m), the developer must consult with a Vibration & Blasting Specialist;
- Communication between the receptors NSD08 and the developer needs to be implemented and maintained highlighting the outcome of this study;
- Subsequently the modelled contours of noise levels indicated any receptors within the 42 - 45 dBA night-time contours (app. 7 dBA above the identified rating level) would require mitigation options. A night-time buffers/ constraint map is presented in **Figure 10-2** illustrating recommended night-time buffers with no berms in place (i.e. times of topsoil/overburden removal). The following mitigation options when construction/topsoil or overburden removal is to occur during the night in these buffers (and **should be highly considered and/or mandatory**) and include:
  - No night-time topsoil and overburden clearance should be conducted in these buffers without berm/barriers, only daytime work allowable (i.e. 06:00 – 22:00);
  - Berm constituent sourced from outside the constraints buffer zone and built during daytime hours only (06:00 – 22:00) before site clearance or overburden removal is to take place. The most important areas where a berm would be required are presented in **Figure 10-2** highlighting the need for berms near receptors NSD08. The following factors regarding the berms/barriers should be mandatory and include:
    4. 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, although the higher the berm/barrier the better acoustical screen tool it will be[43]. 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) [44] and sufficient in thickness. A brick wall provides a surface density of 244 kg/m^2 at thickness of 150 mm[45] 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

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

upper night-time atmosphere. Barrier height cannot effect this propagation[46];

5. The barrier should be sufficiently long to block the line of sight from receptors to the sides of the mining operations; and
6. 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.

10.4.3 Operational Phase

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme must be maintained (section **11**);
- **Berms, barriers and highwalls as discussed in the above construction phase must have been implemented prior to this operational phase**. The most important areas for berms and barriers are illustrated in the constraints maps in **Figure 10-2**; and
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.4.4 Closure and Decommissioning Phase

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. Mitigation options include:

- The Acoustical Measurement & Audit Programme must be maintained (section **11**);
- All other mitigation options highlighted during the construction phase will be relevant for this phase.

10.4.5 Post Closure Phase

No mitigation options are required during this phase.

[46] Norton, M.P. and Karczub, D.G, *"Fundamentals of Noise and Vibration Analysis for Engineers",* Second Edition, 2003, p.600.

Figure 10-1: Construction phase buffers/constraints map year 10 – 20

Figure 10-2:Construction phase buffers/constraints map year 20 - 30

11 ENVIRONMENTAL MEASUREMENT 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 measurements is recommended due to the low (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.

11.1 MEASUREMENT LOCALITIES AND PROCEDURES

11.1.1 Measurement Localities

Annual noise measurements are recommended at **NSD08 and NSD10**.

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.

11.1.2 Measurement Frequencies

Noise measurements should be conducted on a bi-annual basis at the measurement locations identified in **section 11.1.1** (or any additional measurement locations that can be motivated) using a defined measurement procedure (see **section 11.1.3**). Noise measurements should continue during the construction and operational phase (bi-annual) for the first two years of operation when the noise monitoring plan can be reviewed (measurements increased, continued, reduced or stopped). **It is also highly recommended that baseline measurements are conducted before the construction phases commence (e.g. 1 or 2 measurement runs before construction phase). This will enable the baseline to be further defined before any activities takes place.**

11.1.3 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.

11.2 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.

11.3 DATA CAPTURE PROTOCOLS

11.3.1 Measurement Technique

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

11.3.2 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.

11.3.3 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.

11.3.4 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.

11.4 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).

12 CONCLUSIONS AND RECOMMENDATIONS

Assessments done in this document are as recommended by national and international guidelines and regulations SANS 10103, SANS 10328 and GN R154 of 1992. The report considers worst-case scenarios, evaluating the potential noise impact during peak hours.

Five phases were evaluated as per main consultant's criteria, namely the planning, construction, operational, closure/ decommissioning and post closure phases. The most important times for an assessment for an assessment are night-time hours (22:00 – 06:00). The night scenarios were then further separated into its relevant years of operations. These are the yearly periods of the first 5 - 10 years, 10 – 20 and finally 20 –30 year periods.

The resulting future noise projections indicate that the operations will comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and IFC performance standards.

Communication channels between the identified receptors and the mine needs to be implemented during all phases, highlighting the outcome of this study. Berms/barriers are required at certain sections of open cast footprint sections (refer to document highlighting specifications). A bi-annual measurement programme is recommended before/during all phases up to the end of the operational phase.

There exist a low potential for a noise impact and mitigation is recommended to ensure that the noise impact remains low. From a noise impact perspective it is recommended that the project be authorised subject to the implementation of the mitigation measures contained in this report.

13 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 since 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 and 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)*

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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
Pavement	Road surface or pavement is the durable surface material laid down on an area intended

	to sustain vehicular or foot traffic, such as a road or walkway.
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 FMLT01: Josef Homestead

Photo B 2: Measurement location FMLT02: Doornhoek Fluorspar Mine Offices

Photo B 3: Measurement location FMST03

Photo B 3: Measurement location FMST04

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	Residential	413260	7154999
2	Residential	413270	7155174
3	Residential	413315	7155357
4	Residential	413693	7155211
5	Residential	413771	7155450
6	Residential	419432	7156784
7	Residential	420484	7156358
8	Residential	421244	7156440
9	Residential	421838	7156110
10	Business & residential	422169	7152967

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

Point name	Location Latitude (m E)	Location Longitude (m S)
FMLT01	413672	7155216
FMLT02	420484	7156339
FMST01	414047	7155325
FMST02	421900	7156578
FMST03	422472	7152887
FMST04	421857	7151501

End of Report