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Transnet SOC

NOISE STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

Development of the Richards Bay Port Expansion in Richards Bay, KwaZulu-Natal

Study done for:

AECOM

Prepared by:

EAR
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EXECUTIVE SUMMARY

Introduction

Enviro-Acoustic Research (EARES) was contracted by AECOM (Pty) Ltd (the main consultant) to conduct an Environmental Noise Impact Assessment (ENIA) for Transnet SOC's Ltd (hereafter referred to as Transnet) proposed Port Expansion project. This assessment investigates the potential noise impact from a railway balloon on the project as it is the only source of noise within 1,000 m of a receptor.

This report describes the Noise Rating Levels and potential noise impact that the operation of the development may have on the surrounding receptors sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report only briefly discusses the basic principles of potential noise impacts on wildlife. The Terms of Reference (TOR) for this study is based on the National/International guidelines and regulations such as GN R154 Noise Control Regulations 1992, United Kingdom Department of Transport - Calculation of Railway Noise (CRN), SANS 10328 and SANS 10103 guidelines.

BASELINE

Residential areas and potential noise-sensitive developments/receptors were identified using tools such as Google Earth®. This includes receptors up to a distance of 1,000 meters from the closest industrial processes as per SANS 10328:2003. This was further supported by a site visit to confirm the status of the identified dwellings. Three receptors in the study area were numbered from NSD01 to NSD03 in this document. The reason for the site visit, apart from measuring ambient sound levels was to confirm the presence/existence of derelict or abandoned dwellings that could possibly be seen as sensitive receptors, small dwellings that could not be identified on the aerial image and dwellings that might have been constructed after the date of the aerial photograph. The status of the building (derelict, commercial, industrial or residential) needed to be established as well.

Ambient sound levels were measured at four locations on 17th – 21st January 2013. Two class-1 SLMs as well as a portable weather station was used for measurements. The internal clocks were set to GMT+2. The sound level meters would measure "average" sound levels over 10 minutes periods, save the data and start with a new 10 minute measurement till the instrument was stopped. The measurement locations were numbered from RP01 – RP03. These measurements were conducted over a period of at least 72 hour periods

Both the longer-term monitoring locations reflected an area with sound levels slightly higher than an urban setting, but at times with a busy urban/central business district sound character. Although it is always likely that a degree of over-engineering or precautionary principals are adhered to in environmental assessments, there is a high confidence in ambient sound levels measured and the subsequent Rating Levels determined.

There is a high confidence level in L_{Aeq} measured data and subsequently the Noise Rating Levels determined. The Noise Control Regulations for an industrial zone would be the applicable South African Legislation. It is also recommended that the project consider the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas. Seasonal changes in ambient sound levels must be considered, and measured data may change depending on season.

FINDINGS

The resulting future noise projections indicated that the operations of the project as modelled for representation would comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and International Finance Corporation. Subsequently there is a low significance for a noise impact to occur during operations. There is always the likelihood that a degree of over-engineering or precautionary principals are adhered to in environmental assessments. However there is a high confidence level in the consecutive calculated Rating Level and assessment. It should be noted, while a low significance of a noise impact was identified, it is definite that the train operations will be audible during quiet times. This may cause a noise annoyance and people may complain about these sounds at times.

The Rating Level for the area must consider the land use as proclaimed by local authorities, as well as acoustical legislation and guidelines. With the local authority demarcating the project footprint as industrial, the corresponding Rating Level as per GN R154 and SANS10103:2008 would likely be high (industrial rating level). This may not be relevant to the surrounding properties in relation to the project, however the situation could pose problems when a receptor/dwelling or community is based adjacent/ bordering or within close proximity to industrial land zoning.

RECOMMENDATIONS

With a risk of a noise impact developing during the night-time hours of low significance, mitigation options are included for evaluation by Transnet to ensure a low rating.

Commercial railway line activities are exempted from certain requirements of Government Notice R154 of 1992 (Noise Control Regulations) – Regulation 2.(c) - *"Provided that the provisions of this paragraph* (in reference to noise emanating from a development) *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"*. Furthermore the locomotive horns is exempted from the 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".*

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

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

Title:

De Jager, M. (2014). "*Noise Study for Environmental Impact Assessment: Development of the Richards Bay Port Expansion in Richards Bay, KwaZulu-Natal*", Enviro-Acoustic Research cc, Pretoria

Client:

AECOM (Pty) Ltd
on behalf of
Transnet SOC Ltd.

Centurion
Gauteng

Report no:

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GLOSSARY OF ABBREVIATIONS

AZSL	Acceptable Zone Sound Level (Rating Level)
CWR	Continuous Welded Rails
dB	Decibel
EARES	Enviro-Acoustic Research cc
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act (Act 78 of 1989)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
ENIA	Environmental Noise Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
GFB	General Freight Bulk
IAPs	Interested and Affected Parties
i.e.	that is
IEM	Integrated Environmental Management
km/h	kilometres per hour
m	Meters (measurement of distance)
m^2	Square meter
m^3	Cubic meter
m/s	Meters per second
mamsl	Meters above mean sea level
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
NSD	Noise-Sensitive Development
PPE	Personal Protective Equipment
PPP	Public Participation Process
SABS	South African Bureau of Standards
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
TOR	Terms of Reference
UTM	Universal Transverse Mercator
VdB	Vibration decibels
WHO	World Health Organisation

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research (EARES) was contracted by AECOM (Pty) Ltd (the main consultant) to conduct an Environmental Noise Impact Assessment (ENIA) for Transnet SOC (hereafter referred to as Transnet) proposed Richards Bay Port Expansion project. This assessment investigates the potential noise impact from a railway balloon on the project as it is the only source of noise within 1,000 m of a receptor.

This report describes the Noise Rating Levels and potential noise impact that the operations of the development may have on the surrounding receptors sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report only briefly discusses the basic principles of potential noise impacts on wildlife. The Terms of Reference (TOR) for this study is based on the National/International guidelines and regulations such as: SANS 10103:2008, SANS 10210:2004, SANS 10328, SANS 10357, GN R154 and IFC: General EHS Guidelines (Equator Principal).

1.2 BRIEF PROJECT DESCRIPTION

1.2.1 Project Overview

Transnet Port Terminals proposes to expand their storage and capacity of their dry bulk cargo terminal within the Port of Richards (refer to **Figure 1-1**). The relevant authority is the uMhlathuze District Municipality[1].

1.2.2 Product Transport

The railway balloon is required to allow incoming trains to exit the yard from the same side as they enter without multi-directional movements and shunting which is operationally inefficient. The balloon therefore provides a substantial increase in the efficiency of operations resulting in reduced turnaround times. It also allows for a greater level of safety due to the elimination of shunting.

1.3 STUDY AREA

The study area is described in terms of environmental components that may contribute to or change the sound character in the area. As mentioned only receptors within 1,000 m of project infrastructure will be considered, namely dwellings surrounding the proposed rail

[1] Information supplied by main consultant and Transnet

loop to the east of the project boundary. The study area can be described as micro in setting/size (in terms of acoustics) at approximately 1.5 km^2 in size.

1.3.1 Topography

ENPAT[2] (1998) describes the topography as *"Plains"* , while Musina L. & Rutherford (The vegetation of South Africa, Lesotho and Swaziland) [3] delineates the area as*" flat coastal plan".* There are little natural features that could act as noise barriers considering practical distances at which sound propagates.

1.3.2 Surrounding Land Use

The area in the vicinity of the proposed operations is currently classified as "Urban/built-up land: industrial/transport".[4] During site investigations the entire project boundary were seen to fall within an industrial/commercial setting. Besides the residential areas of Brackenham, Arboretum and Meerensee all other immediate areas around or on the footprint is classified as industrial/commercially zoned (telephonic discussions with uMhlathuze Local Municipality Town Planning). Certain hospitality facilities are based within the study area (refer to **Section 1.3.4** further below for more information).

The local municipality with jurisdiction in the area falls under the uMhlathuze municipality, while the district is the Uthungulu District Municipality. The town of Richards Bay serves as an export port for coal, aluminium, titanium and other heavy minerals.

1.3.3 Roads and Railways

The most important road (in terms of calculable acoustics) is the R34 "John Ross Parkway" Road. This road is presumably an urban principal arterial (provincial) main road[5]. The route links Richards Bay to the town of Empangeni. A smaller route (in terms of calculable acoustics) is based adjacent to the only community in the study area, namely the Ridge Town Road.

1.3.4 Potential Sensitive Receptors (Noise-Sensitive Developments)

Residential areas and potential noise-sensitive developments/receptors were identified using tools such as Google Earth® with the areas up to a distance of 1,000 m (recommendation by SANS 10328:2003) from development footprint (receptors illustrated in **Figure 1-1**). This was supported by a site visit to confirm the status of the identified dwellings. Noise-

[2] Van Riet, W. Claassen, P. van Rensburg, J. van Viegen & L. du Plessis, "*Environmental Potential Atlas for South Africa*", Pretoria, 1998.
[3] Musina L. & Rutherford." The vegetation of South Africa, Lesotho and Swaziland". Strelitzia 19, South African National Biodiversity Institute, Pretoria. 2006.
[4] Van Riet, W. Claassen, P. van Rensburg, J. van Viegen & L. du Plessis, "*Environmental Potential Atlas for South Africa*", Pretoria, 1998.
[5] Committee of Transport Officials. "*TRH 26, South African Road Classification and Access Management Manual*". Version 1.0.2012.

sensitive developments (representing a number of potential receptors) in the study area were numbered from NSD01 to NSD03. Receptors illustrated are representative of outer dwellings of communities facing the project footprint. Other communities or receptors are further than 1,000 m from the project footprint and was not considered (including Brackenham, Arboretum *et al*).

The reason for the site visit, apart from measuring ambient sound levels (at certain receptors) 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.

NSD01 represents the community of Waterways Estate within Meerenseer, while NSD02 is the Mzingazi Waterfront Village Estate. The Protea Hotel based in the study area is represented by NSD03 in this document. Localities of receptors are further defined in **Appendix C.1** in latitude and longitude co-ordinates (WGS84).

1.3.5 Other industrial and commercial processes

As mentioned the surrounding land use is based in an industrial zoned area, other industrial processes are very predominant around the project footprint.

1.3.6 Ground Conditions and Vegetation

The location where the development is proposed is in the *"Savannah"* biomes. The vegetation for the area is classified as "pockets of various forest types, thickets, primary and secondary grasslands, extensive timber plantations and cane fields"[6]. Due to the large amount of anthropogenic activities in the study area (industrial and residential) ground natural ground cover is mostly stripped to make way for industrial processes, residential infrastructure and agricultural activities. The mean annual evaporation ranges between 1700 - 1800 mm per annum, while mean annual precipitation is approximately 1071 - 1336 mm per annum[7].

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, which implies that it is not particularly 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.

[6] Musina L. & Rutherford." The vegetation of South Africa, Lesotho and Swaziland". Strelitzia 19, South African National Biodiversity Institute, Pretoria. 2006.
[7] South African Water Research Commission, "*Water Resources of South Africa 2005 (WR2005).* WRC Report No.: K5/1491", South Africa: WRC Publications, 2009.

1.3.7 Fauna[8]

The study site is urbanised with residential and industrial land uses. Due to the lighting, there is increased insect (mostly Crickets and/or Cicada) activity during night-time hours which is evident in the measured baseline (**Section 3**).

1.4 AVAILABLE INFORMATION

Acoustical assessments are available for the rest of the railway line as well as the baseline study for this project. They are:

- De Jager, M. (2013). *"Noise Study for Environmental Impact Assessment: Development of the Swaziland Rail Link – Work Package 2: Davel Railway Yard and Connections – Mpumalanga"*. Enviro-Acoustic Research cc, Pretoria;
- De Jager, M. (2013). *"Noise Study for Environmental Impact Assessment: Development of the Swaziland Rail Link – Work Package 1, 4 and 5: Nerston to Sidvokodvo - Swaziland Section".* Enviro-Acoustic Research cc, Pretoria;
- De Jager, M. (2013). *"Noise Study for Environmental Impact Assessment: Development of the Swaziland Rail Link – Work Package 1 and 3: Davel to Nerston – Republic of South Africa Section*." Enviro-Acoustic Research cc, Pretoria;
- De Jager, M. (2013). "*Noise Study for Environmental Impact Assessment: Development of the Swaziland Rail Link – Work Package 6: Golela to Nsese– KwaZulu Nata".* Enviro-Acoustic Research cc, Pretoria;
- De Jager, M. (2013) *"Acoustical Ambient Sound Levels - Acoustical Baseline Study on the Ambient Sound Levels for the Proposed Port of Richards Bay Expansions, Kwa-Zulu/Natal"* MENCO M2 Environmental Connections cc, Pretoria; and
- De Jager, M. (2014): "*Noise Study to define the accuracy of propagation modelling - Addendum to the Environmental Noise Studies for the Swaziland Rail Link*". Enviro-Acoustic Research cc, Pretoria.

[8] Department of Agriculture, Environmental Affairs & Rural Development. Bioresource Programme – A Natural Resources Classification System for KwaZulu-Natal. 2013

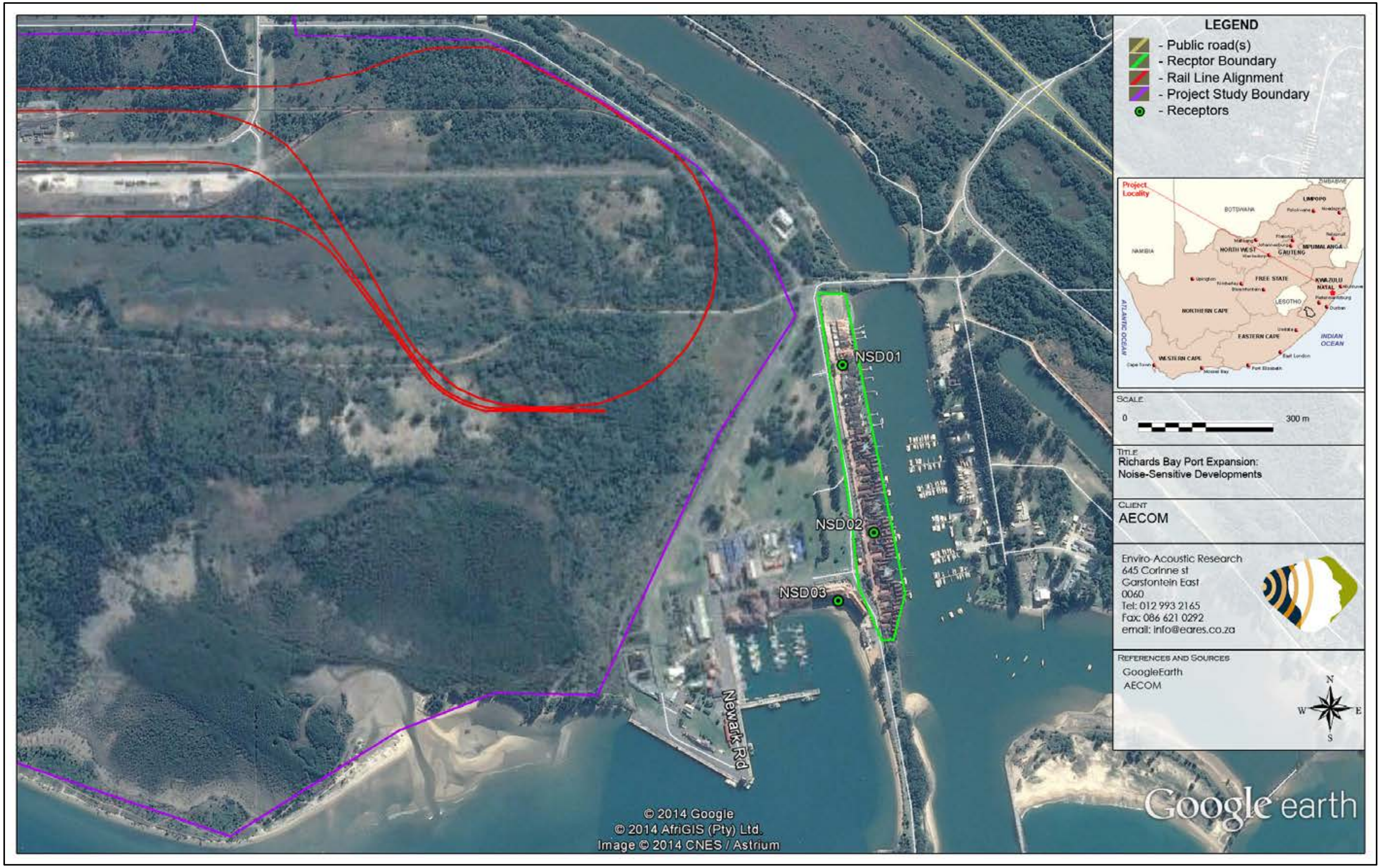

Figure 1-1: Site map indicating the proposed rail loop and potential receptors

1.5 TERMS OF REFERENCE (TOR)

SANS 10328:2008 (Edition 3) specifies the methods to be used in order to assess the noise impacts on the environment as result of a proposed *or* existing activity.

The standard also stipulates the minimum requirements to be assessed for an EIA. These minimum requirements are:

1. the purpose of the investigation;
2. a brief description of the planned *or* existing development or the changes that are being considered;
3. a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements
4. the identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics;
5. the identified noise sources that were not taken into account and the reasons as to why they were not assessed;
6. the identified noise-sensitive developments and the noise impact on them;
7. where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;
8. an explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations;
9. an explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question;
10. the location of measuring or calculating points in a sketch or on a map;
11. quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;
12. alternatives that were considered and the results of those that were assessed;
13. a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
14. 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;
15. conclusions that were reached;
16. proposed recommendations;

17. if remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority; and
18. any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

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 2.6**).

"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.

2.2.1 National Noise Control Regulations (GN R154 of 1992)

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

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exists in the Free State, Gauteng and Western Cape provinces with no provincial regulations in KZN.

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, exceeds 61 dBA; or

ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

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

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

In addition:
In terms of Regulation 2 -
"A local authority may –
(c):" if a noise emanating from a building, premises, vehicle, recreational vehicle or street is a disturbing noise or noise nuisance, or may in the opinion of the local authority concerned be a disturbing noise or noise nuisance, instruct in writing the person causing such noise or who is responsible therefor, or the owner or occupant of such building or premises from which or from where such noise emanates or may emanate, or all such persons, to discontinue or cause to be discontinued such noise, or to take steps to lower the lever of the noise to a level conforming to the requirements of these Regulations within the period stipulated in the instruction: Provided that the provisions of this paragraph shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles;
(d): before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests are conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings or that, for the purposes of regulation 3(b) or (c), reports or certificates in relation to the noise impact to the satisfaction of that local authority are submitted by the owner, developer, tenant or occupant to the local authority on written demand";

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

Clause 7.(1) however exempts noise of the following activities, namely -

"The provisions of these regulations shall not apply, if -

(a) the emission of sound is for the purposes of warning people of a dangerous situation;

(b) the emission of sound takes place during an emergency."

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

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

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

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

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

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

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

(b) for determining –

(i) a definition of noise

(ii) the maximum levels of noise

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

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

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

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

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

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

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

2.5 ROAD TRAFFIC ACT, 1996 (ACT NO 93 OF 1996)

The Road Traffic Act of 1996 provides, *inter alia*, that *no person shall operate or permit to be operated on a public road and vehicle causing noise in excess of the prescribed noise level.* The Act, however, does not prescribe noise levels, but empowers the Minister of Transport to issue regulations prescribing them. The consolidated Road Traffic Regulations in terms of the Act do not prescribe any such noise levels, although the noise levels specified in the South African National Standard SANS 10181 (SABS 0181) have been specified as control standards.

2.6 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from mines, 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 SANS10103:2008 does stipulate *"for industries legitimately operating in an industrial district during the entire 24 h day/night cycle,* $L_{Req,d}$ *=* $L_{Req,n}$ *=70 dBA can be considered as typical and normal"*

2.7 NATIONAL TRANSPORT POLICY (SEPTEMBER 1996)

The White Paper sets the vision for transport in South Africa that provides for "*safe, reliable, effective, efficient and fully integrated transport operations and infrastructure which are environmentally and economically sustainable"*. The White Paper further states that "*the provision of transportation infrastructure and the operation of the transportation system have the potential for causing damage to the physical and social environment, inter alia, through atmospheric and noise pollution, ecological damage and severance. … The Department of Transport is committed to an integrated environmental management approach in the provision of transport*". It is also stated that "*As part of the overall long-term vision for the South African transport system, transport infrastructure will, inter alia, be structured to ensure environmental sustainability and internationally accepted standards*". One of the strategic objectives for transport infrastructure to achieve this vision is to promote environmental protection and resource conservation.

2.8 INTERNATIONAL GUIDELINES

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

2.8.1 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 behaviour.

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

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

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

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

2.8.2 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."

2.8.3 Equator Principles

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

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

April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

2.8.4 IFC: General EHS Guidelines – Environmental Noise Management

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

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

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

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

It sets noise level guidelines (see) as well as highlighting the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development. It is therefore the considered opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

Table 2-1: 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 $L_{Aeq,1\ hr}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the IEC standards, which requires the fast detector setting on the Sound Level Meter during measurements in Europe.

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

The United States National Park Services identifies that "intrusive" un-natural sounds are concern for the National Park Services (United States[9]) 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[10] 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[11] and other pleasant sounds that visitors seek when going to parks or wilderness areas.

[9] National Park Services, "Soundscape Preservation and Noise Management", 2000, p. 1.
[10] Environ. We Int. Sci. Tech, "Ambient noise levels due to dawn chorus at different habitats in Delhi", 2001, p. 134.
[11] Panatcha Anusasananan, Suksan Suwanarat, Nipon Thangprasert, "Acoustic Characteristics of Zebra Dove in Thailand", p. 4.

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[12]. 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.

2.8.6 Environmental Management Systems

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

2.8.6.1 ISO 14000

ISO 14000 is a family of standards related to environmental management that exists to help organizations (a) minimize how their operations (processes etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land); (b) comply with applicable laws, regulations, and other environmentally oriented requirements, and (c) continually improve in the above. The term continual improvement refers to an ongoing process of performance enhancement. In the context of this environmental standard, it means that you need to enhance your organization's overall environmental performance by enhancing its environmental management system and by improving its ability to manage the environmental aspects of its activities, products, and services. Continual improvements can be achieved by carrying out internal audits, performing management reviews, analyzing data, and implementing corrective and preventive actions.

2.9 INTERNATIONAL GUIDELINES – STANDARDS FOR NOISE FROM RAILWAYS

2.9.1 International Guidelines - Appropriate Noise Limits for Railway Lines

Noise reception limits exist on a national level in various forms for new and upgraded railway lines. Limits for existing railway lines are only in force in Switzerland, Denmark, and Italy and will be in Sweden from 2015 on. Mandatory reception limits or insulation standards for new buildings along existing railway lines are, for example, in force in Finland, France and Switzerland. Recommended International Standards relating to the $\mathbf{L_{Aeq,T}}$ (dBA)whereby the T varies depending on the country is illustrated in **Figure 2-1** and **Table 2-2**.

[12] E.g. State of Oregon's Environmental Standards for Wilderness Areas

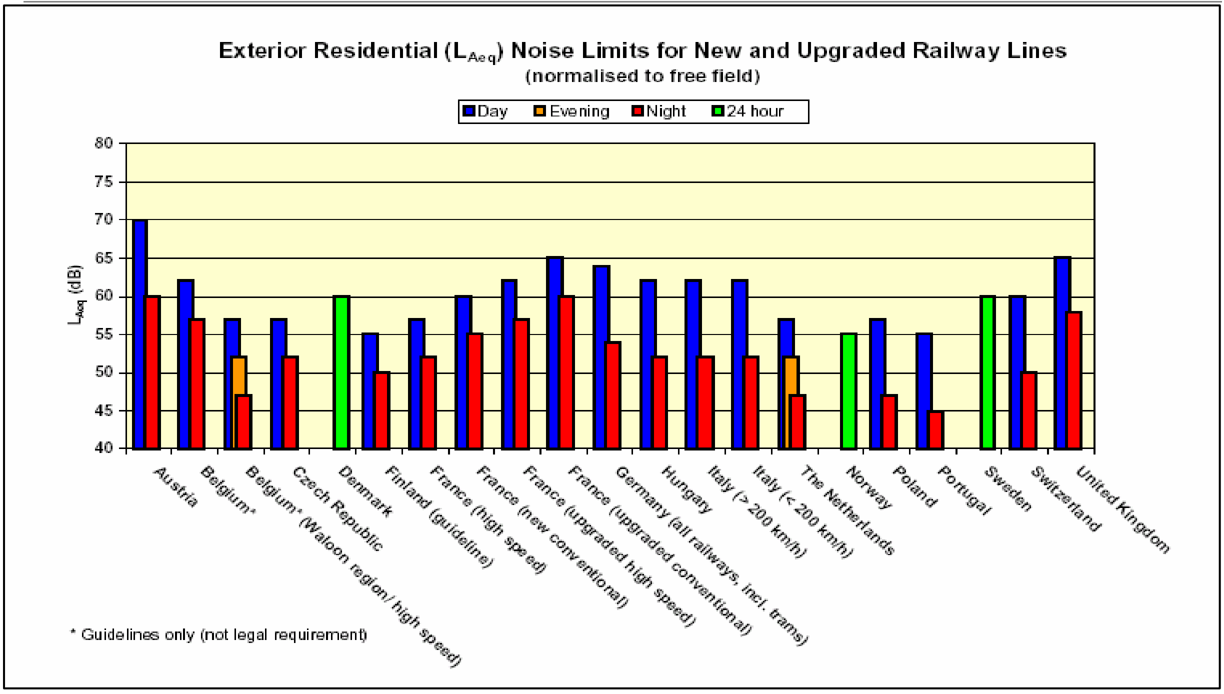

Figure 2-1: Residential Noise Limits for New and Upgraded Railway Lines[13]

These limits are however not completely comparable, as they differ in terms of:

- Indicators;
- Reference time intervals;
- Receiver locations (free-field (reflection at the building not considered) or at the façade);
- The difference in levels amounts to 3 dB(A));
- Emission assumptions (levels, location);
- Transmission factors (e.g. weather conditions etc);
- Definition of substantial upgrading; and
- Sometimes the limits are increased depending on existing exposure levels (Austria, France). In Italy limits depend on the distance from the track.

2.9.2 International Guidelines - Appropriate L_{Amax} limits

The single noise events (**L_{Amax}**) magnitude and number of events have been investigated in various International documents including the World Health Organization, 2009: "*Night Noise Guidelines for Europe*" [14] briefly discussed in **Section 2**. International countries **L_{Amax}** outdoor values generally range between 73 to 88 dBA[15]. Several railway activities, including train pass-bys, emit repetitive noises of a significant level for brief periods of time that can interfere with sleep, communications, and the wellbeing of the residents of

[13] European Commission, 2003
[14] World Health Organization, 2009: "*Night Noise Guidelines for Europe*
[15] Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment

neighbouring properties (WHO 1999). A brief overview of International Standards and guidelines relating to the magnitude of the $\mathbf{L_{Amax}}$ singular event (source *"Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment"* [16]*)* is presented in **Table 2-2.**

COUNTRY	PERIOD (T)	L_{Amax} (dBA)	$L_{Aeq,T}$ (dBA)
Australia	06h00 – 06h00	85	60
Austria	06h00 – 22h00		60
	22h00 – 06h00		50
Denmark	06h00 – 06h00	88	60
France	06h00 – 22h00		60
	22h00 – 06h00		55
Germany	06h00 – 22h00		59
	22h00 – 06h00		49
Hong Kong	07h00 – 23h00		65 - 70
	23h00 – 07h00		55 - 60
Italy	06h00 – 22h00		55
	22h00 – 06h00		45
Japan	07h00 – 22h00	70	60
	22h00 – 07h00	70	55
Netherlands	07h00 – 19h00	73	55 (60)
	19h00 – 23h00	73	50
	23h00 – 07h00	73	45 (50)
Norway	06h00 – 06h00		60
South Korea	06h00 – 22h00		65
	22h00 – 06h00		55
Sweden	06h00 – 06h00		63
Switzerland	06h00 – 22h00		55 – 60
	22h00 – 06h00		45 – 50
UK	06h00 – 24h00	85	68
	24h00 – 06h00	85	63
USA	1hr		67
	06h00 – 06h00		55 (L_{dn})

Table 2-2: International Railway (L_{Amax}) magnitude

[16]Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment

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 LIMITATIONS - ACOUSTICAL MEASUREMENTS AND ASSESSMENTS

Limitations due to environmental acoustical measurements include the following:

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. A high measurement may not necessarily mean that the area is always noisy. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of day, dependant on faunal characteristics (mating season, dawn chorus[17] early hours of the morning, temperature etc.), vegetation in the area and meteorological conditions (especially wind). This excludes the potential effect of sounds from anthropogenic origin;
- As mentioned above seasonal changes in the surrounding environment can change the measured soundscape. Many faunal species are more active during warmer periods than colder periods. Cicada is usually only active during warmer periods. Certain cicada species can generate noise levels up to 120 dB for mating or distress purposes, sometimes singing in synchronisation magnifying noise levels they produce from their tymbals[18];
- 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 important factor to consider when compiling an environmental acoustical report;

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

- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises;
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high due to faunal activity which can dominate the sound levels around the measurement point (specifically during summertime, rainfall event or during dawn chorus of bird songs). This generally is still considered naturally quiet and accepted as features of the natural soundscape, and in various cases sought after and pleasing;
- Considering one or more sound descriptor or equivalent can improve an acoustical assessment. Parameters such as L_{AMin}, $L_{Aeq,I}$, $L_{Aeq,F}$, L_{Ceq}, L_{AMax}, L_{A10}, L_{A90} and spectral analysis forms part of the many variables that can be considered. The South African Legislation however is the $L_{Aeq,I}$ 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 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. [19] 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 environmental ambient soundscape contributors of significance (faunal, roads traffic, railway traffic movement etc.); and
- As a residential area develops the presence of people will result in increased dwelling related sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV's and Radios). The result is that ambient sound levels will increase as an area matures.

3.3 Ambient Sound Level Measurements – Richards Bay ENIA

Ambient sound levels were measured at four locations on 17th – 21st January 2013. Two class-1 SLMs as well as a portable weather station was used for measurements. The internal clocks were set to GMT+2. The sound level meters would measure "average" sound levels over 10 minutes periods, save the data and start with a new 10 minute measurement till the instrument was stopped. The measurement locations were numbered from RP01 – RP03 (see **Appendix C.2** for measurement locations in UTM, latitude and longitude). These measurements were conducted over a period of at least 72 hour periods. Measured localities are illustrated in **Figure 3-1.**

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

3.3.1 Measurement Point RP01: Receptor NSD01 – Waterways Residential Estate

A number of 10 minute measurements were taken over a day/night period from 18th – 21st January 2013. The equipment defined in **Table 3-1** was used for gathering data. Measured sound levels are presented in **Figure 3-2** and **Figure 3-3**.

Table 3-1: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Svan 955	27637	25July 2012
Microphone*	ACO 7052E	49596	25July 2012
Calibrator	Rion NC-74	34494286	24 February 2012
Weather Station	WH3081PC	-	-

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

The measurement location was selected to be reflective of the typical sound levels within close proximity of the Waterways Residential Estate. As a result a SLM was erected at the boundary. This location was also chosen as it was a safe area for the equipment to be left overnight. Numerous other localities were investigated, these localities had issues with equipment security. There was a water feature near the measurement location since no other suitable location could be sourced to place the sound level meter. The property boundary wall (barrier) acted as a buffer of noise from the Ridge Town Road in front of the dwellings. Many buildings on this estate had a direct view to this road. Some trees and buildings were present near the sound level meter. Certain measurements would reflect road traffic noise of residents traversing the area within the estate.

Figure 3-1: Locality of ambient sound measurement and measurement train scenarios

Refer to **Appendix B.1** for a photo of this measured location. **Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-2** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-2: Noises/sounds heard during site visits at RP01

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible, Audible, Dominating	Faunal and Natural: Bird song.
	Residential and other Anthropogenic: Conversation from community members.
	Industries, Commercial and Road Traffic: Vehicle movement on adjacent road (during passing event(s)).

Impulse equivalent sound levels (South African legislation): Figure 3-2 illustrates the impulse 10 minute equivalent (average) sound levels for the day and night-time periods. During the daytime $L_{Aeq,I}$ values ranged between 50.7 to 71.9 dBA. The night-time $L_{Aeq,I}$ values ranged between 50.2 to 70.7 dBA. The average value of the 299 10-minute equivalent daytime sound level measurements were calculated at 56.7 dBA, while the average for the 144 night-time measurements were calculated at 55.3 dBA.

Calculated 16 hour day $L_{Aeq,16\ h}$ values were calculated each day in chronological order as 58.2, 58.4 and 59.1 dBA. Calculated 8 hour night $L_{Aeq,8\ h}$ values were calculated as 59.8, 57.9 and 54.2 dBA.

Fast equivalent sound levels (International guidelines): Figure 3-2 illustrates the fast 10 minute equivalent (average) sound levels for the day and night-time periods. During the daytime $L_{Aeq,F}$ values ranged between 49.2 to 67.2 dBA. The night-time $L_{Aeq,F}$ values ranged between 47.3 to 64.9 dBA. The average value of the 299 10 min. equivalent daytime measurements were calculated at 55.1 dBA, while the average for the 144 night-time measurements were calculated at 53.3 dBA. $L_{Aeq,F}$ values are illustrated in this document for reference purpose.

The day/night 10 minute values ($L_{Aeq,F}$) remained below the impulse ($L_{Aeq,I}$) correspondent values, at times very closely mimicking its contours. Night-time hours generally indicated times when the fast and impulse setting were further in value (less impulsive noise events). Calculated 16 hour day $L_{Aeq,16\ h}$ values were calculated each day in chronological order as 56.4, 56.7 and 56.1 dBA. Calculated 8 hour night $L_{Aeq,8\ h}$ values were calculated as 56.6, 56.7 and 52.1 dBA.

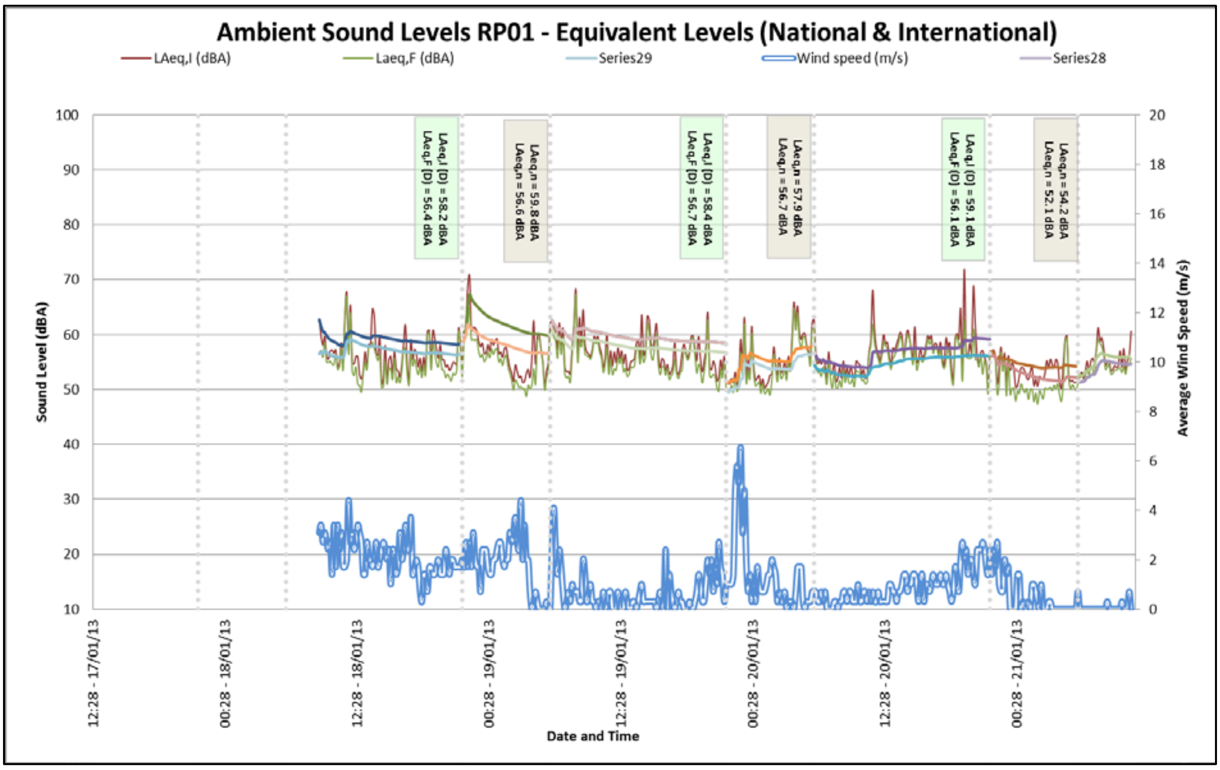

Figure 3-2: Ambient Sound Levels at RP01

Statistical sound levels ($L_{A90,f}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient sounds) that impacts on the average sound level. It is illustrated on **Figure 3-3**. $L_{A90,f}$ daytime values ranged from 44.7 to 60.4 dBA90. The night-time $L_{A90,f}$ values ranged from 45.4 to 62.2 dBA90.

Measured $L_{A90,f}$ data indicated an area that never became really quiet, even during the night-times. Generally the ambient soundscape had consistent continuous night sounds in the area, only pierced on occasion by higher magnitude noise events ($L_{Amax.F}$). The L_{A90} statistical value was consistently above 44 dBA90, even during the dead of the night. L_{A90} data also increased at roughly 05:00 – 06:00 on the mornings, and would most likely be attributed to the surrounding area awakening during the dawn period preparing for their daily routine (bird dawn chorus, increased traffic flow on roads etc.).

Maximum noise levels ($L_{Amax,F}$) RMS: Maximum sound levels are illustrated on **Figure 3-3** with the loudest day sound measured at 91.3 dBA (averaged 68.6 dBA), while night-time loudest sound measured at 90.4 dB (averaged 64.3 dBA). L_{Amax} levels exceeded 55 dBA on many occasions during the night-times (during the 10 minute measurements) where noise events may become an annoyance.[20]

Maximum sound events were of sufficient duration (or a number of short events) and/or magnitude to impact on certain periods of the L_{Aeq} graphs and 90th percentile statistical values.

Minimum noise levels ($L_{Amin,F}$) RMS: Minimum noise levels are illustrated on **Figure 3-3** with the quietest sounds measured during the day at 41.7 dBA (averaged 48.9 dBA), while night-time quietest was measured at 43.9 dBA (averaged 48.1 dBA).

It illustrates an area that rarely becomes quiet with both the $L_{Amin,I}$ and L_{A90} values remaining above the 40 dBA plain. L_{A90} statistical and L_{AMin} values illustrated simultaneously as seen in **Figure 3-3** indicated that the measured ambient 90th percentile statistical equivalent values almost mimicked the RMS (root mean square) minimum values.

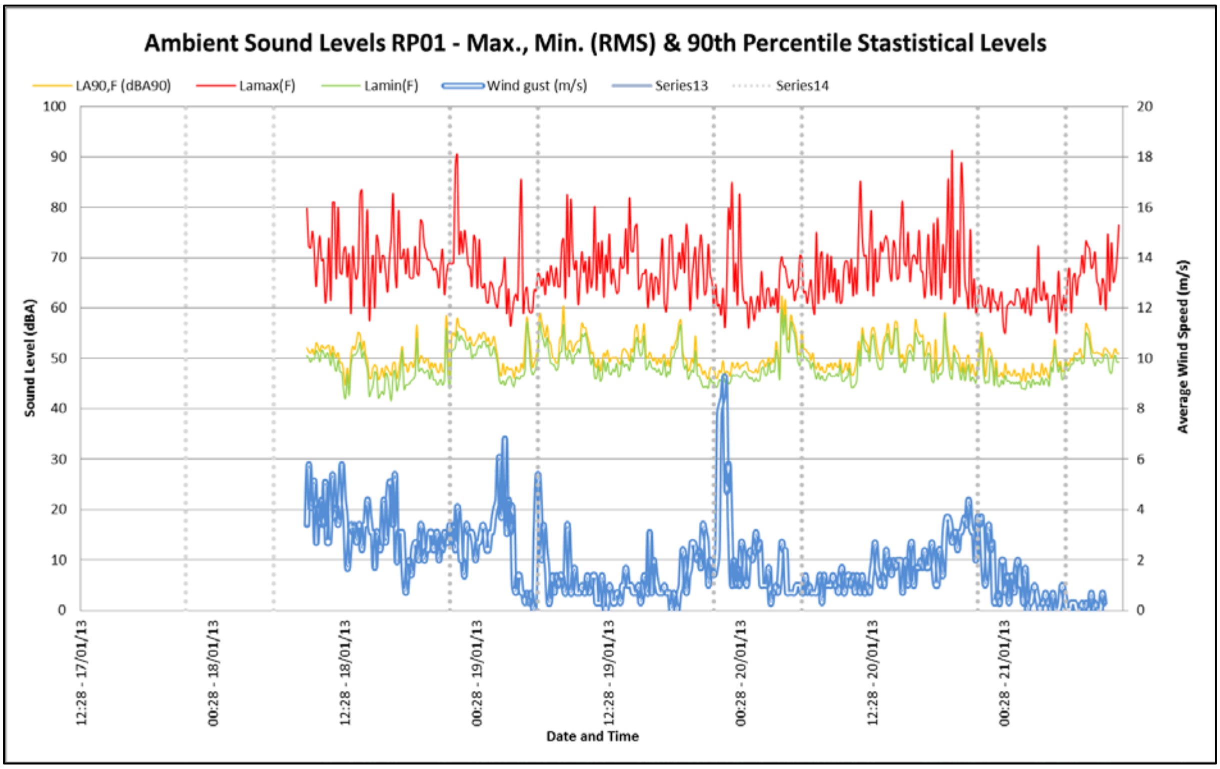

Figure 3-3: Maximum, minimum and statistical values at RP01

Third octave spectral analysis (Figure 3-4 and Figure 3-10):

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

Lower frequencies (20 – 250 Hz, although low frequency is 100 Hz or below): This frequency band is generally dominated by noises originating from anthropogenic activities (vehicles idling and driving, pumps and motors, etc.) as well as certain natural phenomena (wind shear, ocean surf splash etc.). Motor vehicle engine revolutions per minute (1000 - 6000 rpm[21]) mostly convert to this range of frequency (not considering other motor car acoustical sources e.g. tyre to road interaction pumping and "horn effect")[22]. Faunal communication may contribute to this level, although faunal (smaller species i.e. insecta family) generally communicate with dominant frequencies at much higher levels (see further below). Lower frequencies (above infrasound etc.) also have the potential to propagate much further than the higher frequencies.

The daytime and night-time 10 min. measurement illustrates a mishmash of peaks and troughs throughout this entire lower range, with no dominant peak evident from data. Certain 10 min. data illustrated a smoother and linear regression character that could be similar to pink or even white noise.

Third octave surrounding 1,000 Hz: This range contains energy mostly associated with dominant frequencies of human speech (dominant frequencies mostly between 350 Hz – 2,000 Hz, other voice frequencies can range between 20 – 16,000 Hz), dwelling related sounds, dogs barking, and road to tyre interaction from road traffic[23].

The frequency band surrounding 500 Hz had moderate energy in measured data, with most mid-range data indicating moderate energy levels.

Higher frequencies (2,000 Hz upwards until ultrasound range): Most smaller faunal species, including animals, birds, frogs, crickets and cicada would use this range as the dominant frequency to communicate, hunt with etc. [24] 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.

During measurements there were moderate predominant peaks in and around the 6,300, 8,000 and 12,500 with some energy near the ultrasound range.

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[21] Mechanical Engineering Conversion Factors, Dr. K. Clark Midkiff
[22] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed. P.g 19.
[23] SILVIA. "Guidance Manual for the Implementation of Low Noise Road Surface". 2nd ed. P.g 19.
[24] A Paradoxical Problem. Can bush crickets discriminate frequency?, J.C Hartley, University of Nottingham. An Automatic Monitoring System for Recording Bat Activity, Colin O' Donnel and J Sedgeley.Short Communication. The Scaling of song Frequency in Cicadas, H.C Bennet-Clark (1994).

Summary: Spectral Analysis (Figure 3-4 and Figure 3-10):
Refer to the inserts in the mentioned figures (in red) 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.

Measured higher frequency peaks are likely song/faunal communication. Energy in the higher frequencies was more dominating during the morning and evening hours. "Natural" contributors could include your native suburban bird species calls such as Weaver Finches, doves, crows etc. as well as other faunal communication such as cicada, frogs, crickets etc. (measurements conducted during summertime). Many higher frequency data almost had a duel frequency harmonic, although did have tones that would likely be associated with the bird song and other faunal communication.[25] The higher frequency at 20,000 Hz could almost be comparable to a high pitch squeal and is relatively close to the ultrasound range. The contributors to these high frequencies were most likely due to faunal echolocation such as that can be found from bats etc.

The spectral contributors to the mid and low frequencies were from local road traffic movement near measurement location. The area surrounding the 500 Hz range did have a peak to it. This is likely due to the low-medium speed at which local road traffic were travelling on the roads. The lower frequency contribution would be from engine revolutions as vehicles passed measured locations. At speeds below 60 km/h engine noise (fan belt, piston revolutions etc.) would be more dominant over road tyre interaction noise which contributes to 1,000 Hz peaks. Aerodynamics would only be audible at much higher speeds than can be attained on these public routes. On certain occasions metrological conditions could contribute to data. This is evident in the more linear regression data compared to times when there was rain, wind (above 4 m/s) etc. Energy in the mid to low frequencies would also be influenced by the water fountain near monitoring location.

[25] Panatcha Anusasananan, Suksan Suwanarat, Nipon Thangprasert. Acoustic Characteristics of Zebra Dove in Thailand. Pg. 4.

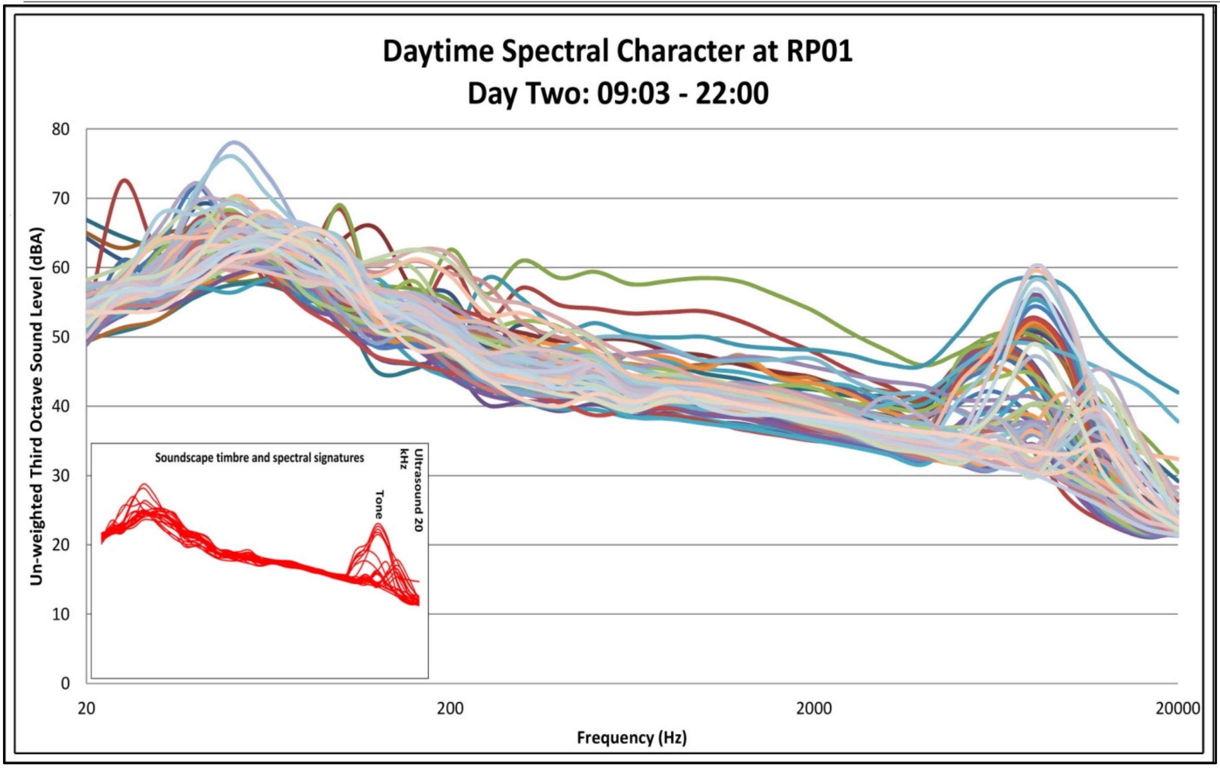

Figure 3-4: Daytime spectral frequency distribution at RP01, 2nd day

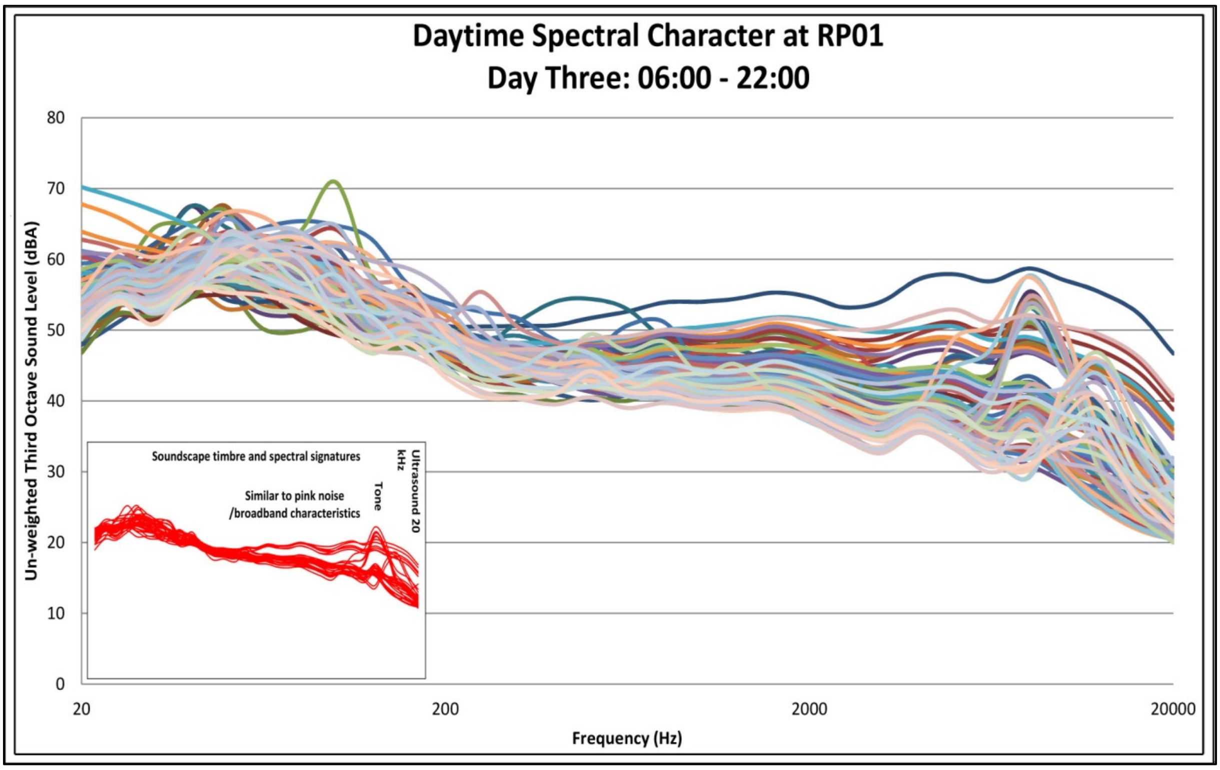

Figure 3-5: Daytime spectral frequency distribution at RP01, 3rd day

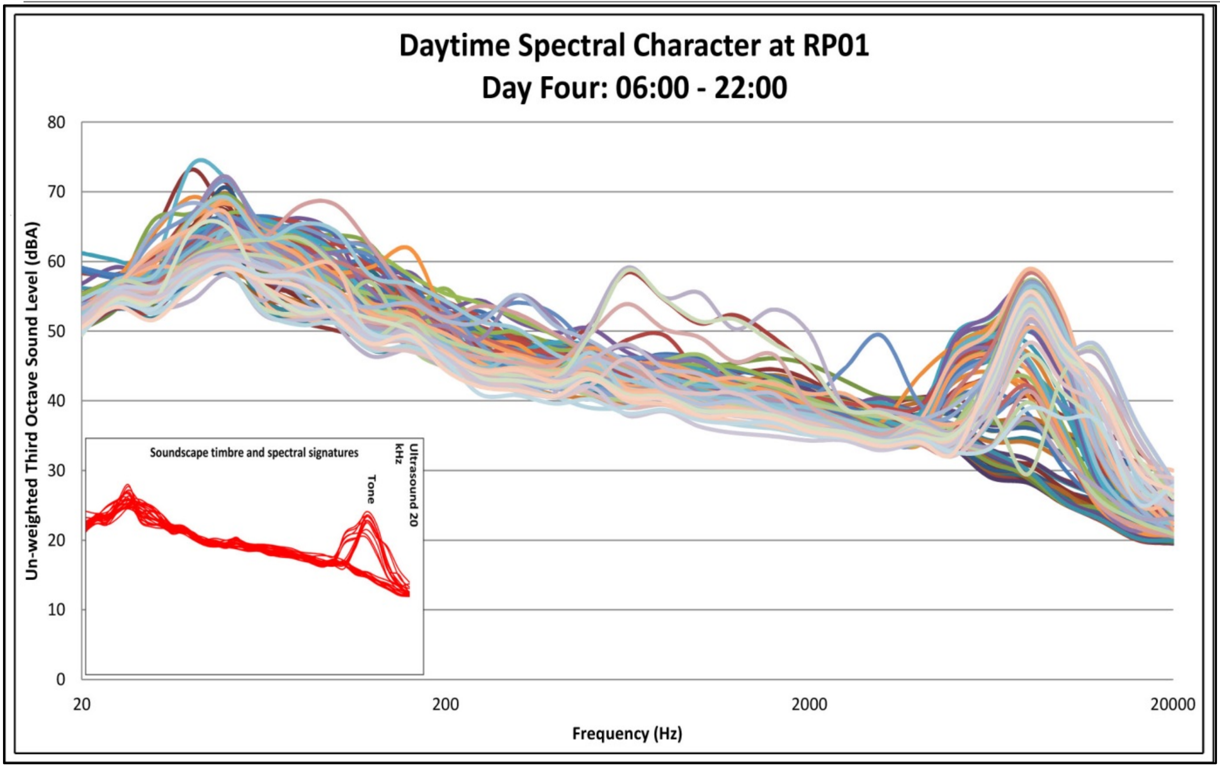

Figure 3-6: Daytime spectral frequency distribution at RP01, 4th day

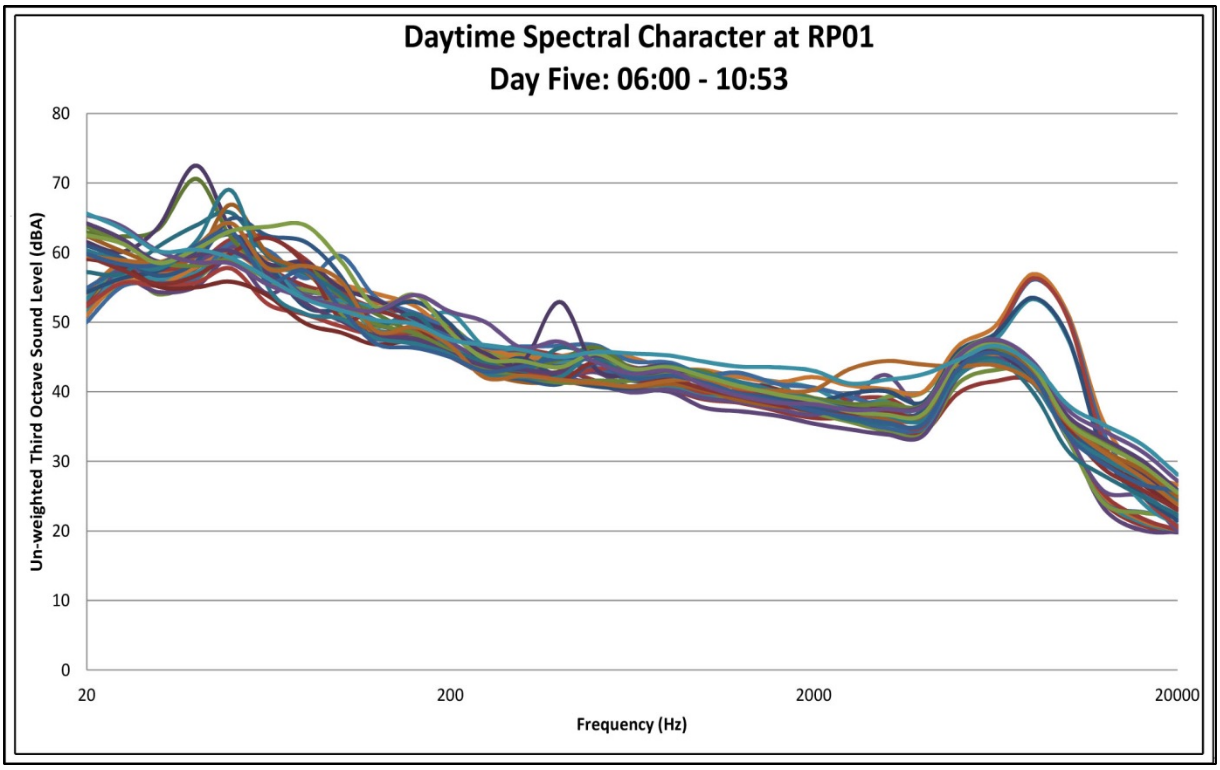

Figure 3-7: Daytime spectral frequency distribution at RP01, 5th day

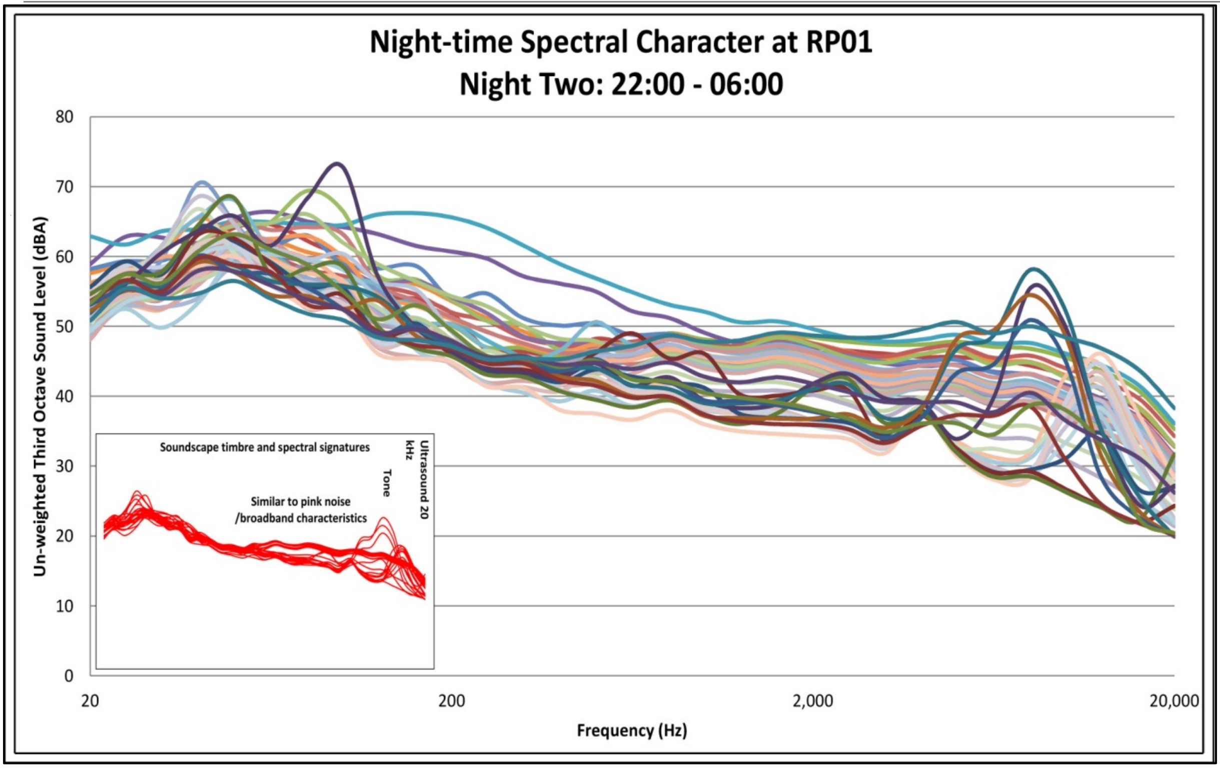

Figure 3-8: Night-time spectral frequency distribution at RP01, 2nd night

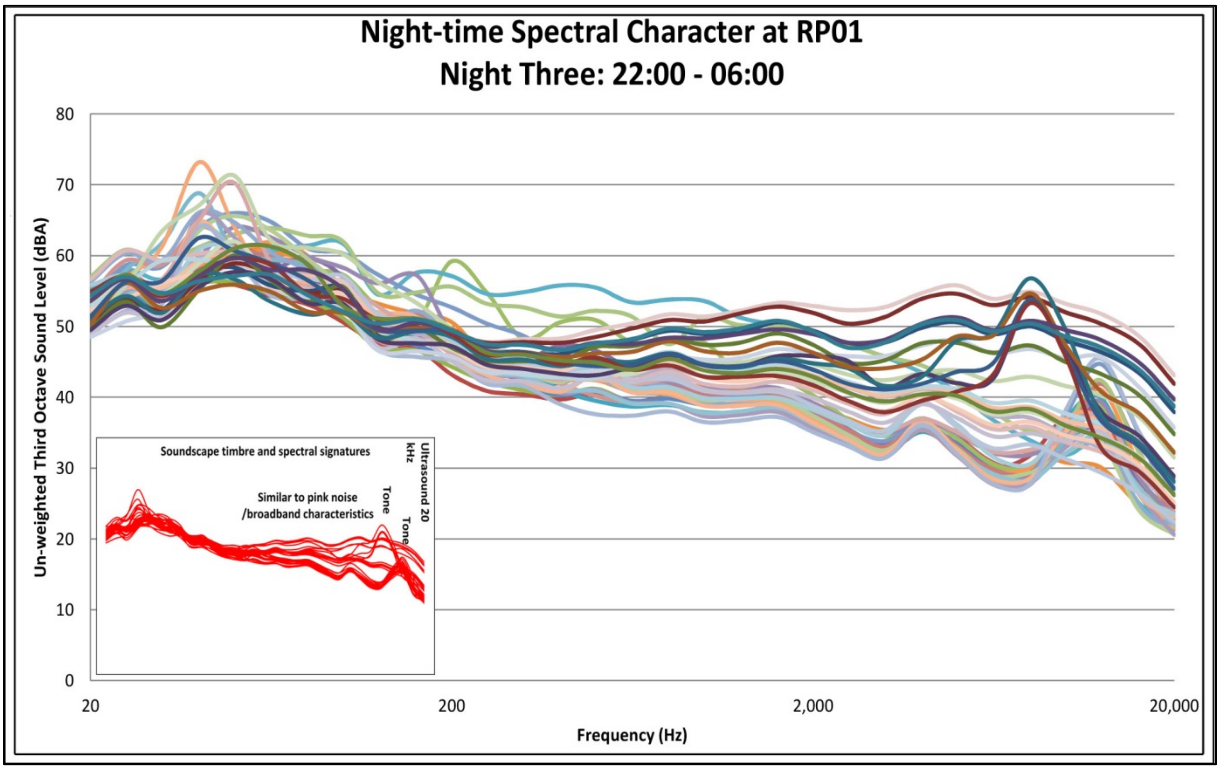

Figure 3-9: Night-time spectral frequency distribution at RP01, 3rd night

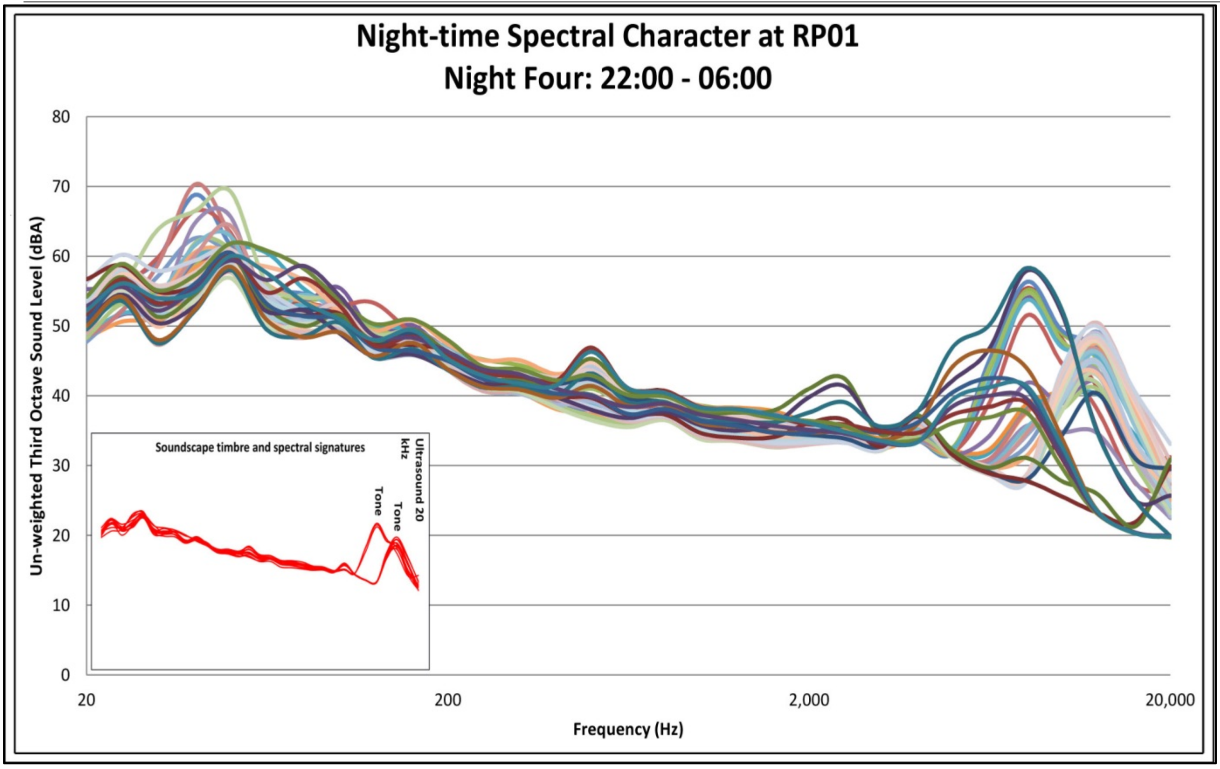

Figure 3-10: Night-time spectral frequency distribution at RP01, 4th night

Metrological conditions: The highest measured wind speed was classified as "strong breeze" on the Beaufort Scale[26].

SANS 10103:2008 Rating Level: Considering the $L_{Aeq,I}$ measured daytime data, ambient sound indicated many sound levels slightly higher than a urban district, yet lower than a busy urban district. Night-time data indicating many sound levels slightly higher than a busy urban district, yet lower than a central business district. Refer to **Table 3-6** comparing each measured $L_{Req,T}$ based on $L_{Aeq,I}$ measurements. Most 10 minute night-time $L_{Aeq.F}$ levels measured conformed to the recommendation of 55 and 45 dBA respectively set out by the World Health Organization (**Section 2.8.1**), World Bank (**Section 2.8.3**) and International Finance Corporation (**Section 2.8.4**) for a residential area.

3.3.2 Measurement Point RP02: Receptor NSD02 – Mzingazi Waterfront Village Estate

A number of 10 minute measurements were taken over a day/night period from 18th – 21st January 2013. The equipment defined in **Table 3-3** was used for gathering data. Measured sound levels are presented in **Figure 3-11** and **Figure 3-12**.

[26] Met Office, "National Meteorological Library and Archive Fact sheet 6 – The Beaufort Scale", Version 1, Crown copyright 2010, p.4.

Table 3-3: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Rion NA-28	00901489	1 June 2012
Microphone*	Rion UC-59	02087	1 June 2012
Calibrator	Rion NC-74	34494286	24 February 2012
Weather Station	WH3081PC	-	-

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

The measurement location was selected to be reflective of the typical sound levels within close proximity of the Waterways Residential Estate. As a result a SLM was erected in a similar locality to pervious measurement point RP01.

Refer to Appendix B.2 for a photo of this measured location. **Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-4** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-4: Noises/sounds heard during site visits at RP02

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural** Bird song.
	Residential and other Anthropogenic Conversation from community members.
	Industries, Commercial and Road Traffic Vehicle movement on adjacent road (during passing event(s)).

Impulse equivalent sound levels (South African legislation): Figure 3-11 illustrates the impulse 10 minute equivalent (average) sound levels for the day and night-time periods. During the daytime $L_{Aeq,I}$ values ranged between 45.0 to 67.6 dBA. The night-time $L_{Aeq,I}$ values ranged between 43.2 to 72.2 dBA. The average value of the 323 10-minute equivalent daytime sound level measurements were calculated at 55.3 dBA, while the average for the 170 night-time measurements were calculated at 51.4 dBA. Calculated 16 hour day $L_{Aeq,16\,h}$ values were calculated each day in chronological order as 56.5, 56.0, 56.1 and 56.3 dBA. Calculated 8 hour night $L_{Aeq,8\,h}$ values were calculated as 51.4, 57.3 and 53.0 dBA.

Fast equivalent sound levels (International guidelines): Figure 3-11 illustrates the fast 10 minute equivalent (average) sound levels for the day and night-time periods. During the daytime $L_{Aeq,F}$ values ranged between 44.1 to 61.0 dBA. The night-time $L_{Aeq,F}$

values ranged between 42.1 to 63.1 dBA. The average value of the 323 10 min. equivalent daytime measurements were calculated at 52.4 dBA, while the average for the 170 night-time measurements were calculated at 48.7 dBA. $L_{Aeq,F}$ values are illustrated in this document for reference purpose.

The day/night 10 minute values ($L_{Aeq,F}$) remained below the impulse ($L_{Aeq,I}$) correspondent values, at times very closely mimicking its contours. Night-time hours generally indicated times when the fast and impulse setting were further in value (less impulsive noise events). Calculated 16 hour day $L_{Aeq,16\ h}$ values were calculated each day in chronological order as 53.5, 52.6, 51.5 and 52.9 dBA. Calculated 8 hour night $L_{Aeq,8\ h}$ values were calculated as 47.8, 54.7 and 47.9 dBA.

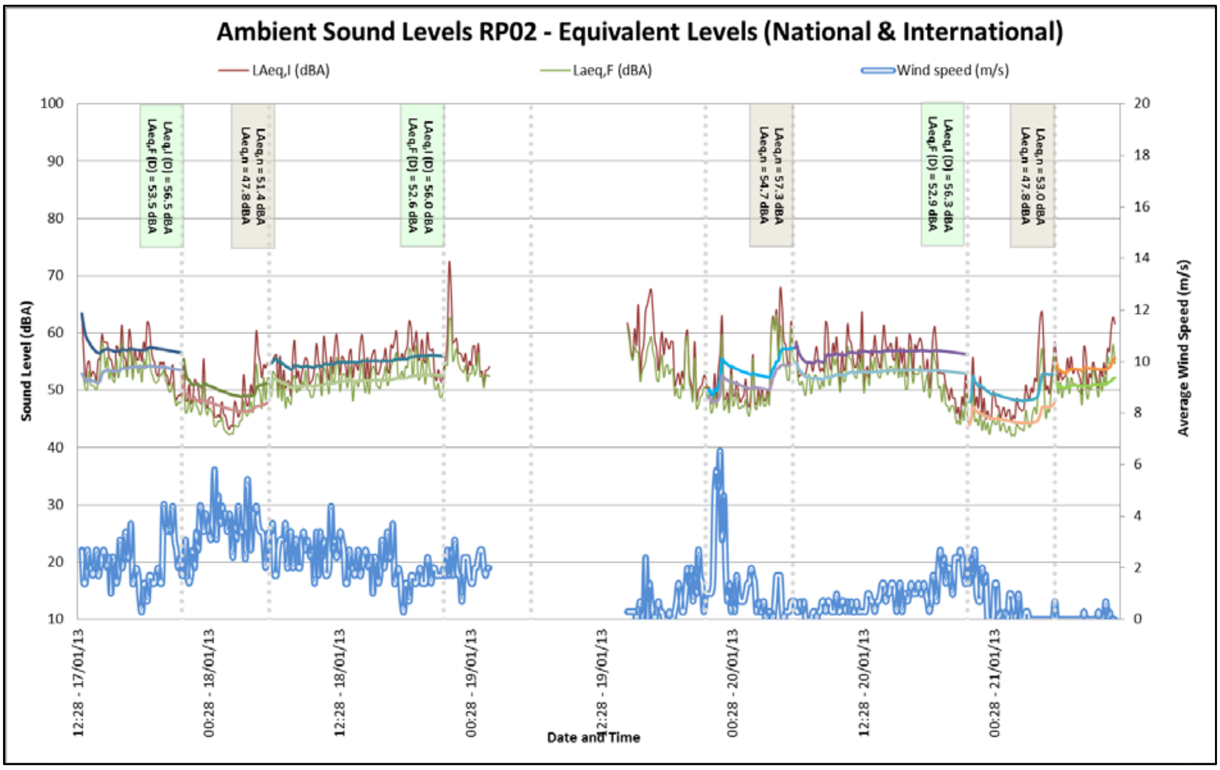

Figure 3-11: Ambient Sound Levels at RP02

Statistical sound levels ($L_{A90,f}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the “background sound level”, or the sound level that can be expected it there were little single events (loud transient sounds) that impacts on the average sound level. It is illustrated on **Figure 3-12**. $L_{A90,f}$ daytime values ranged from 42.8 to 58.1 dBA90. The night-time $L_{A90,f}$ values ranged from 40.8 to 60.0 dBA90.

Measured $L_{A90,f}$ data indicated an area that never became really quiet, even during the night-times. Generally the ambient soundscape had consistent continuous night sounds in the area, only pierced on occasion by higher magnitude noise events ($L_{Amax.F}$). The L_{A90} statistical value was consistently above 40 dBA90, even during the dead of the night. L_{A90} data also increased at roughly 05:30 – 06:00 on the mornings, and would most likely be attributed to the surrounding area awakening during the dawn period preparing for their daily routine (bird dawn chorus, increased traffic flow on roads etc.).

Maximum noise levels ($L_{Amax,F}$) RMS: Maximum sound levels are illustrated on **Figure 3-12** with the loudest day sound measured at 87.9 dBA (averaged 69.2 dBA), while night-time loudest sound measured at 91.7 dB (averaged 63.4 dBA). L_{Amax} levels exceeded 55 dBA on many occasions during the night-times (during the 10 minute measurements) where noise events may become an annoyance.[27]

Maximum sound events were of sufficient duration (or a number of short events) and/or magnitude to impact on certain periods of the L_{Aeq} graphs and 90th percentile statistical values.

Minimum noise levels ($L_{Amin,F}$) RMS: Minimum noise levels are illustrated on **Figure 3-12** with the quietest sounds measured during the day at 41.0 dBA (averaged 43.7 dBA), while night-time quietest was measured at 39.8 dBA (averaged 43.2 dBA).

It illustrates an area that rarely becomes quiet with both the $L_{Amin,I}$ and L_{A90} values remaining above the 39 dBA plain. L_{A90} statistical and L_{AMin} values illustrated simultaneously as seen in **Figure 3-3** indicated that the measured ambient 90th percentile statistical equivalent values almost mimicked the RMS (root mean square) minimum values.

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

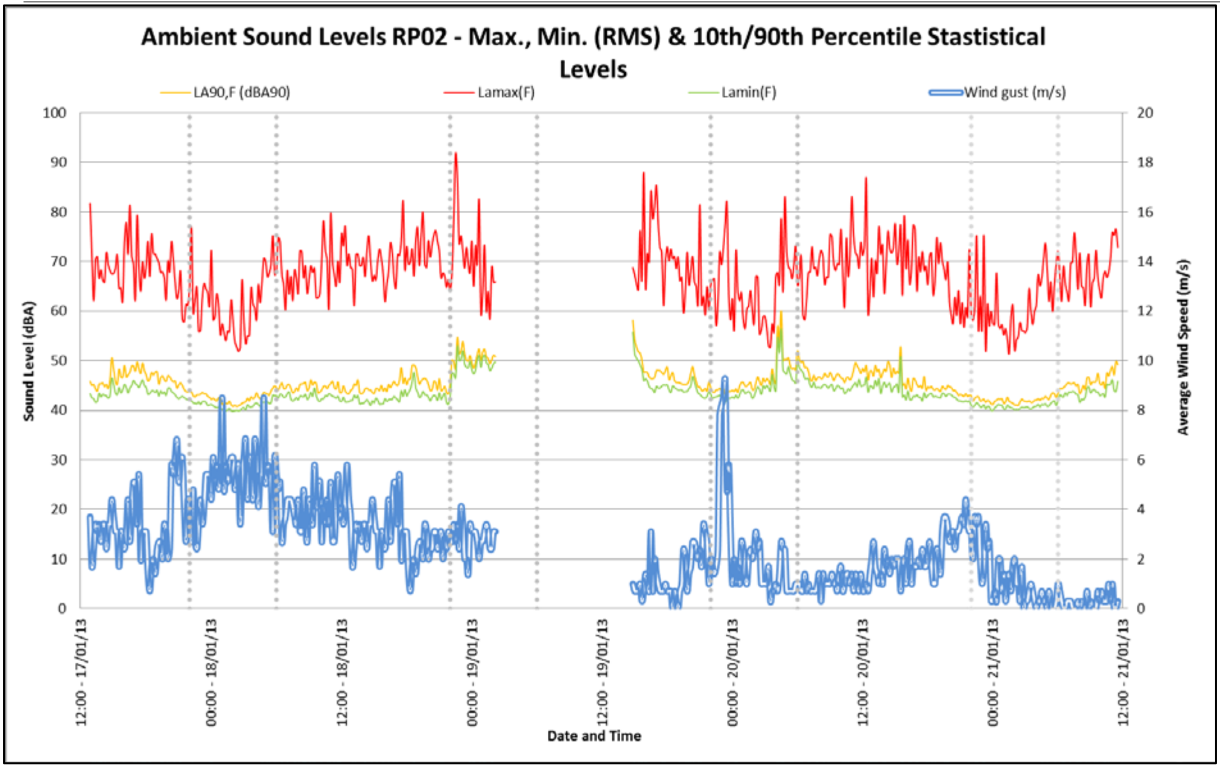

Figure 3-12: Maximum, minimum and statistical values at RP02

Third octave spectral analysis (Figure 3-13 to Figure 3-21):

Refer to previous sections spectral analysis defining characteristics of various ranges (**Section 3.3.1**).

<u>Lower frequencies (20 – 250 Hz, although low frequency is 100 Hz or below):</u> The daytime and night-time 10 min. measurement illustrates a mishmash of peaks and troughs throughout this entire lower range, with no dominant peak evident from data. Certain 10 min. data illustrated a smoother and linear regression character that could be similar to pink or even white noise.

<u>Third octave surrounding 1,000 Hz</u>: The frequency band surrounding 1,000 Hz had moderate energy in measured data, with most mid-range data indicating moderate energy levels.

<u>Higher frequencies (2,000 Hz upwards until ultrasound range)</u>: During measurements there were moderate predominant peaks in and around the 5,000 – 6,000 and 12,500 Hz range.

Summary: Spectral Analysis (Figure 3-13 to Figure 3-21):

Refer to the inserts in the mentioned figures (in red) 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.

Measured higher frequency peaks are likely song/faunal communication. Energy in the higher frequencies was more dominating during the morning and evening hours. "Natural" contributors could include your native suburban bird species calls such as Weaver Finches, doves, crows etc. as well as other faunal communication such as cicada, frogs, crickets etc. (measurements conducted during summertime). Many higher frequency data had a duel frequency harmonic and tones that would likely be associated with the bird song and other faunal communication.[28]

The spectral contributors to the mid and low frequencies were from local road traffic movement near measurement location. The area surrounding the 1,000 Hz range did have some peaks to it. This is likely due to the low-medium speed at which local road traffic were travelling on the roads. The lower frequency contribution would be from engine revolutions as vehicles passed measured locations. At speeds below 60 km/h engine noise (fan belt, piston revolutions etc.) would be more dominant over road tyre interaction noise which contributes to 1,000 Hz peaks. Aerodynamics would only be audible at much higher speeds than can be attained on these public routes. On certain occasions metrological conditions could contribute to data. This is evident in the more linear regression data compared to times when there was rain, wind (above 4 m/s) etc. Energy in the mid to low frequencies would also be influenced by the water fountain near monitoring location.

[28] Panatcha Anusasananan, Suksan Suwanarat, Nipon Thangprasert. Acoustic Characteristics of Zebra Dove in Thailand. Pg. 4.

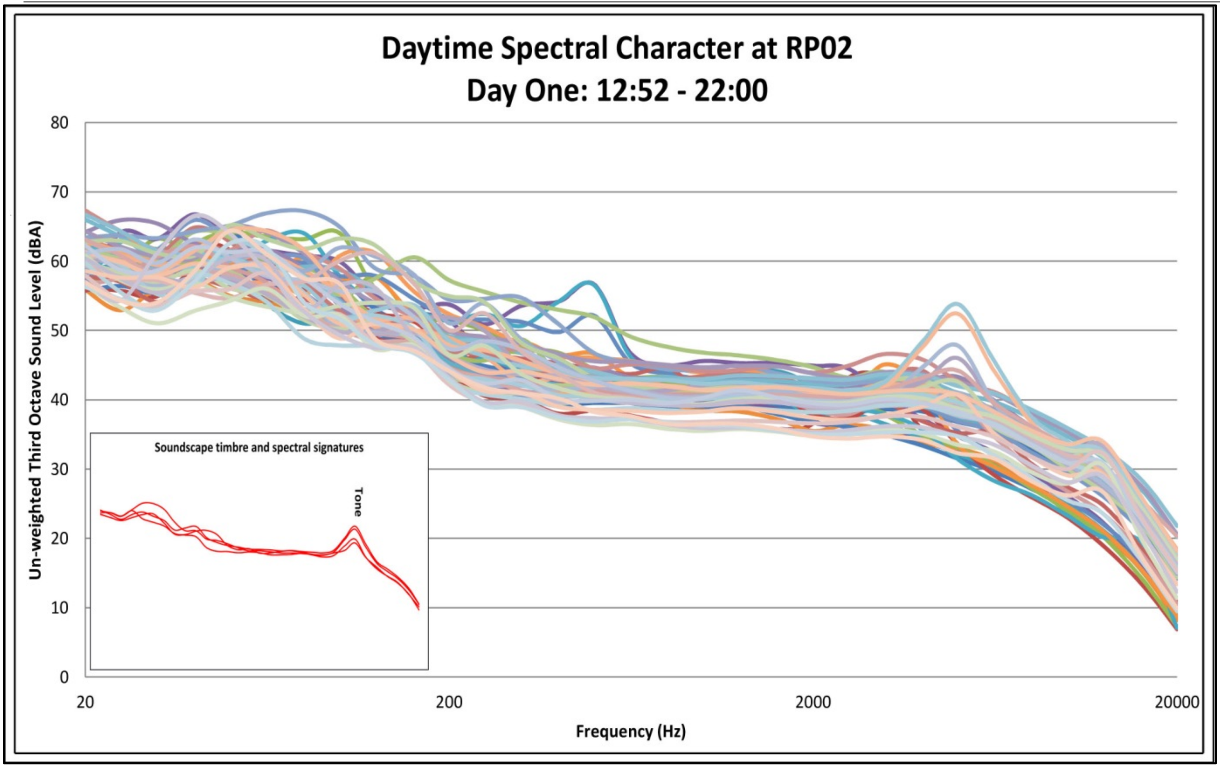

Figure 3-13: Daytime spectral frequency distribution at RP02, 1st day

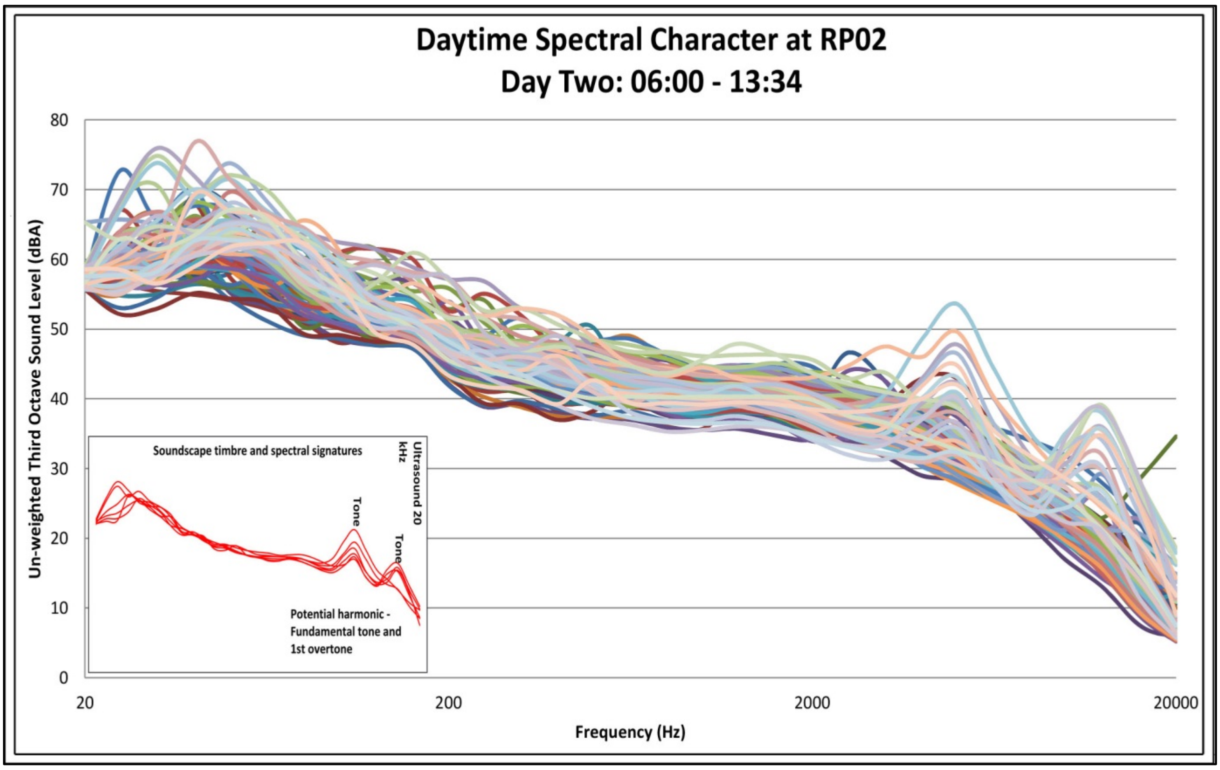

Figure 3-14: Daytime spectral frequency distribution at RP02, 2nd day

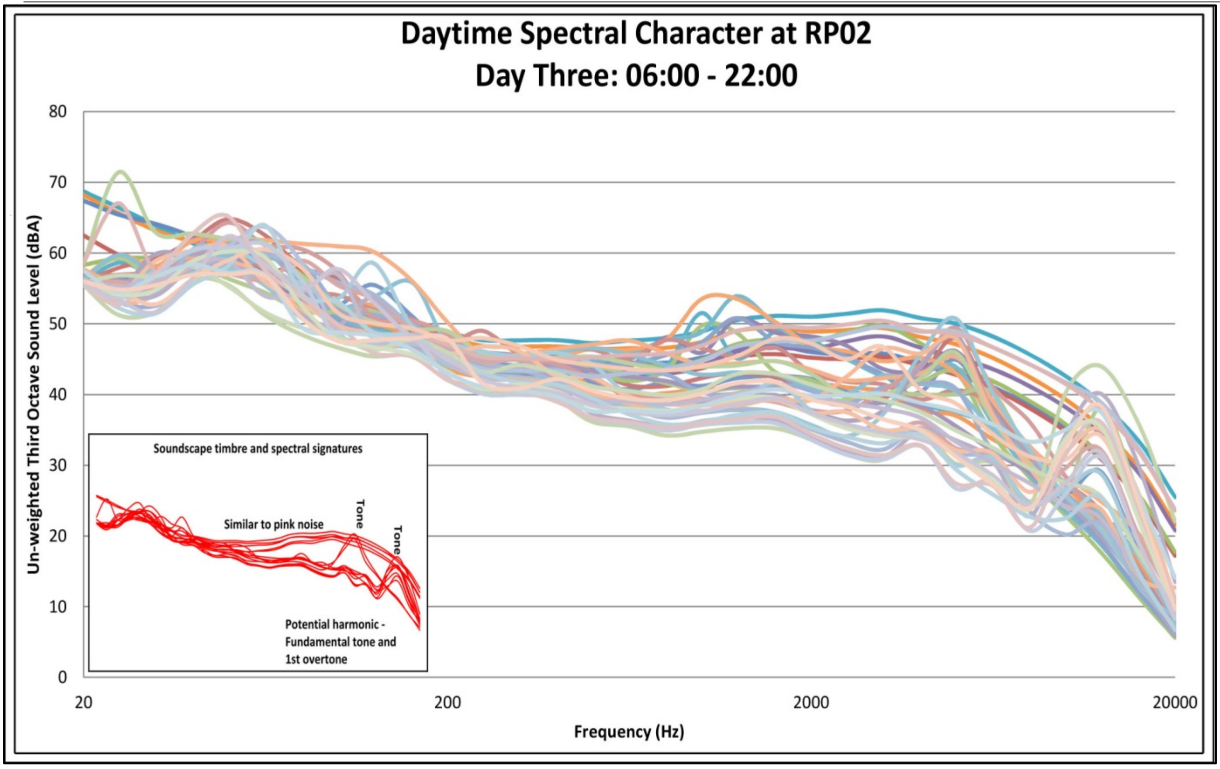

Figure 3-15: Daytime spectral frequency distribution at RP02, 3rd day

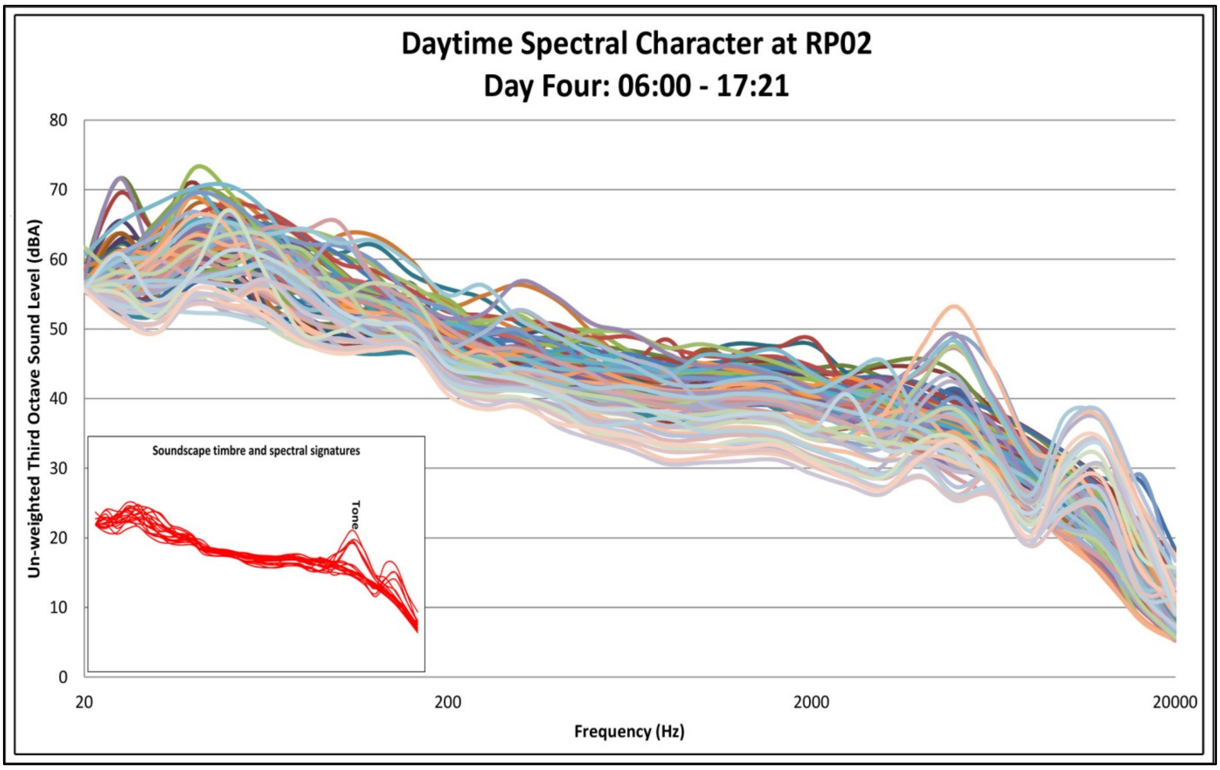

Figure 3-16: Daytime spectral frequency distribution at RP02, 4th day

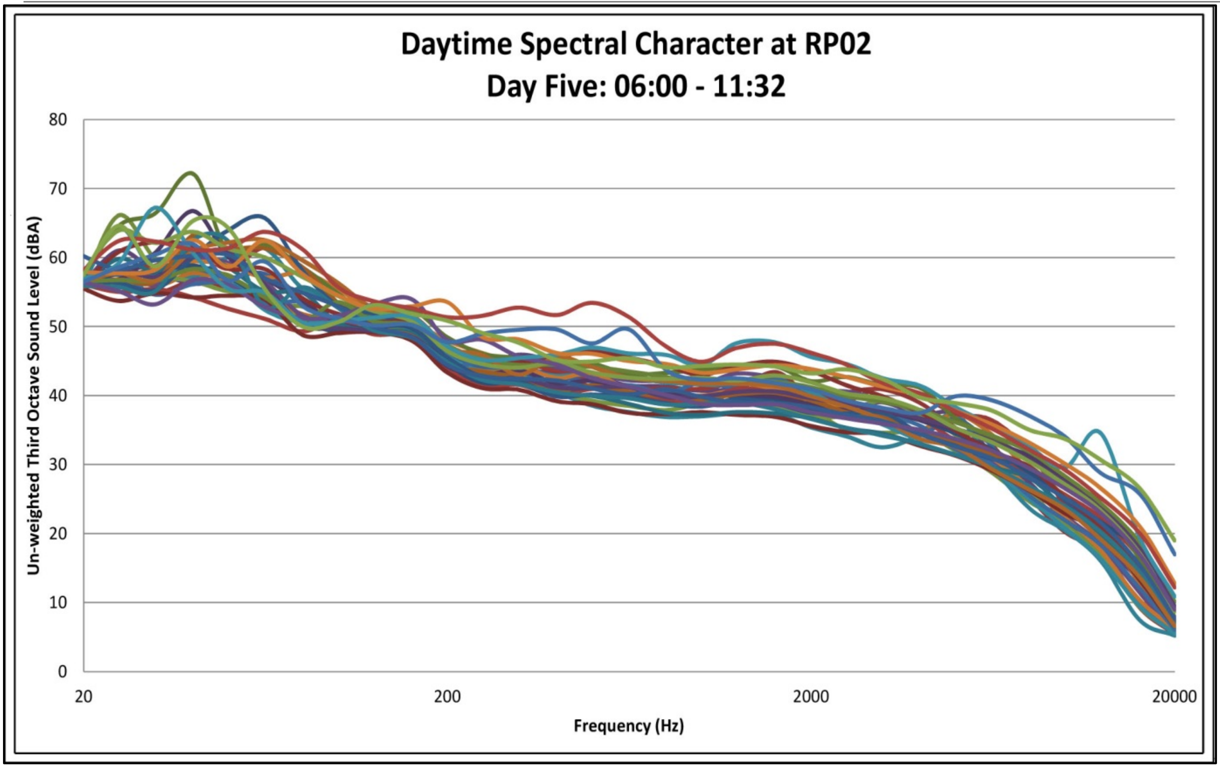

Figure 3-17: Daytime spectral frequency distribution at RP02, 5th day

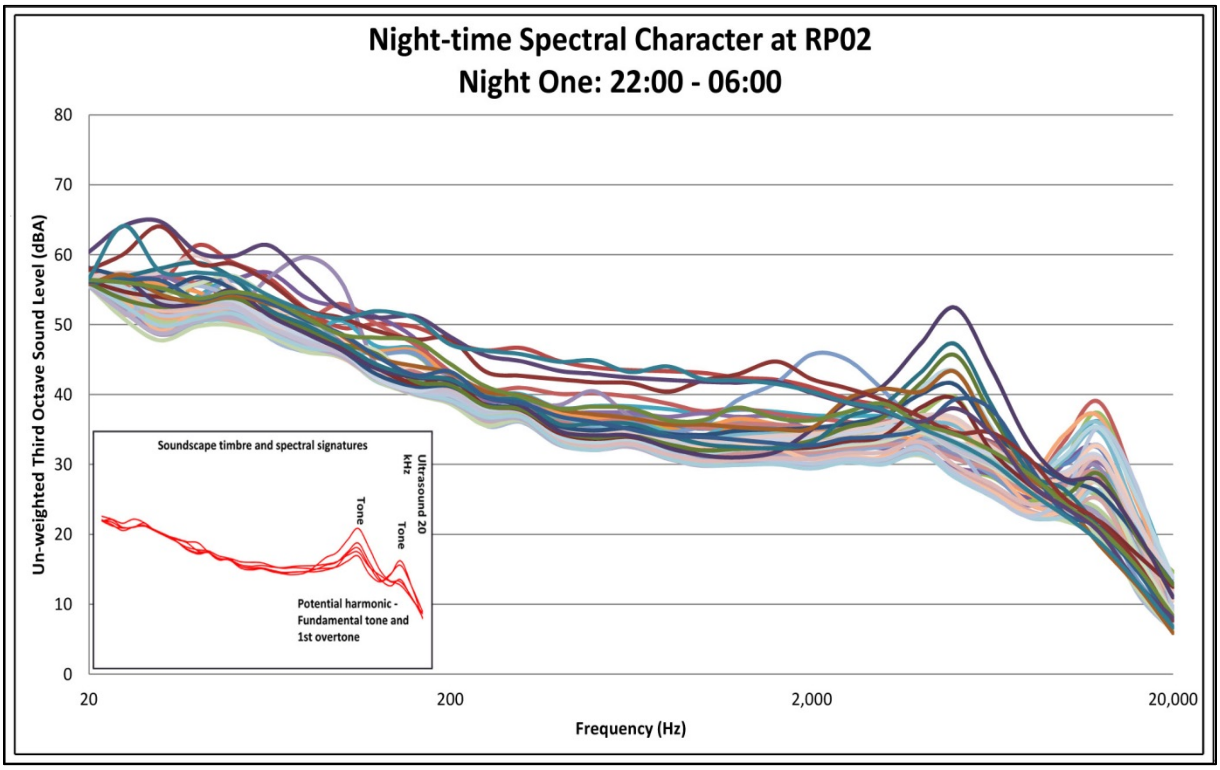

Figure 3-18: Night-time spectral frequency distribution at RP02, 1st night

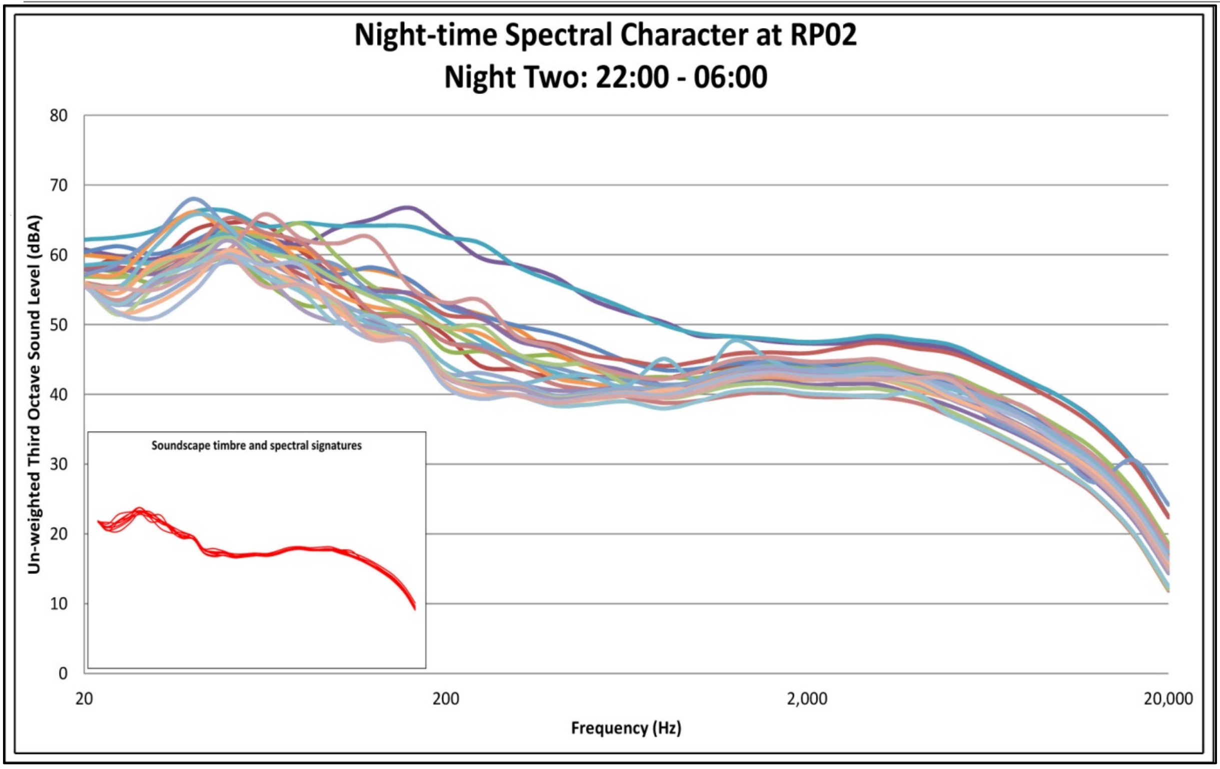

Figure 3-19: Night-time spectral frequency distribution at RP02, 2nd night

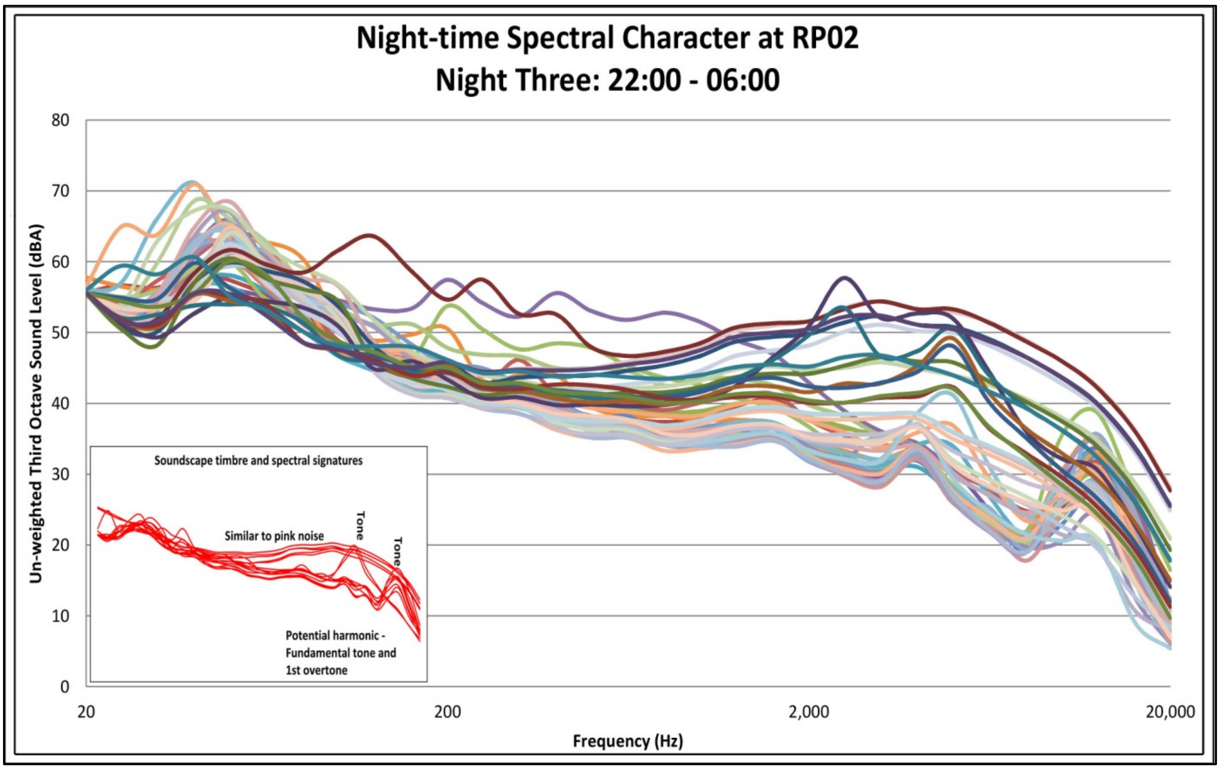

Figure 3-20: Night-time spectral frequency distribution at RP02, 3rd night

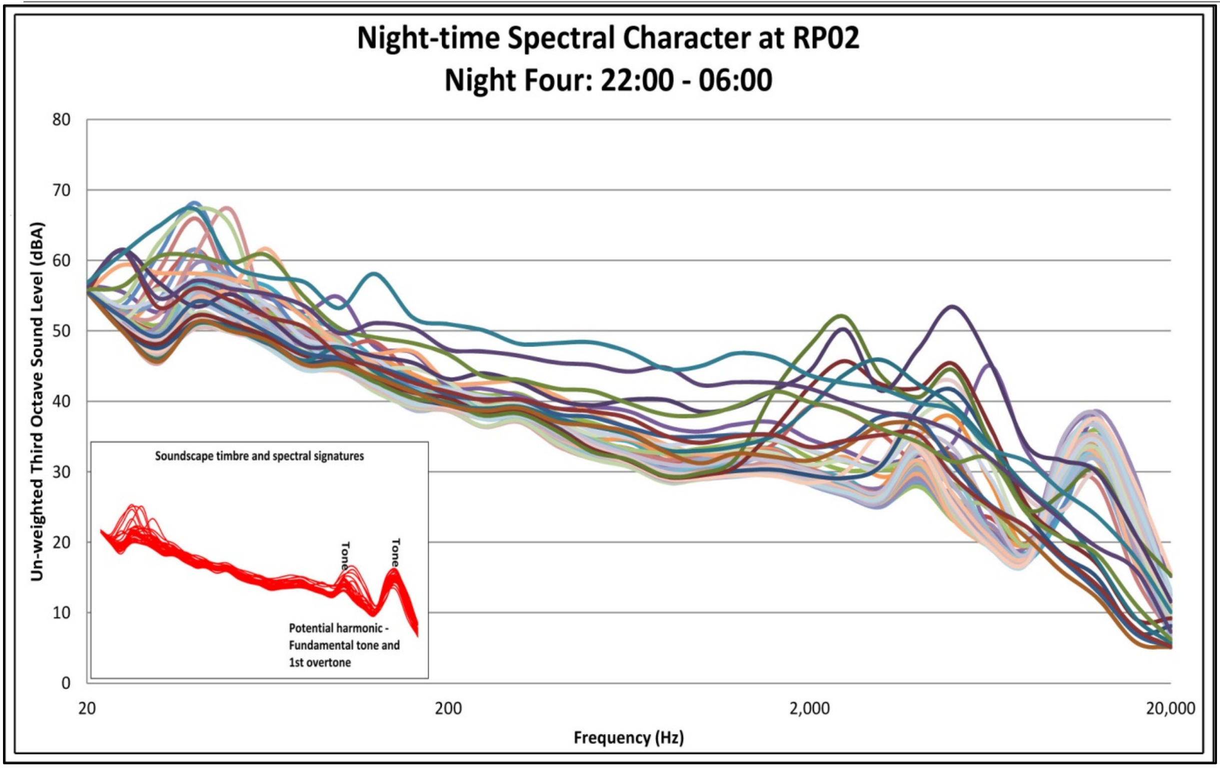

Figure 3-21: Night-time spectral frequency distribution at RP02, 4th night

Metrological conditions: The highest measured wind speed was classified as "strong breeze" on the Beaufort Scale[29].

SANS 10103:2008 Rating Level: Considering the $L_{Aeq,I}$ measured daytime data, ambient sound indicated many sound levels slightly higher than a urban district, yet lower than a busy urban district. Night-time data indicating many sound levels slightly higher than a busy urban district, yet lower than a central business district. Refer to **Table 3-6** comparing each measured $L_{Req,T}$ based on $L_{Aeq,I}$ measurements. Most 10 minute night-time $L_{Aeq.F}$ levels measured conformed to the recommendation of 55 and 45 dBA respectively set out by the World Health Organization (**Section 2.8.1**), World Bank (**Section 2.8.3**) and International Finance Corporation (**Section 2.8.4**) for a residential area.

3.3.3 Measurement point RP03: Ridge Town Road

Four sound level measurements were obtained in this area to determine road traffic noise and conditions from the Ridge Town Road. Traffic volumes were also counted during the period that measurements were collected (approximately 30 minutes in total). Results of road traffic sound measurements are presented in **Table 3-5**.

[29] Met Office, "National Meteorological Library and Archive Fact sheet 6 – The Beaufort Scale", Version 1, Crown copyright 2010, p.4.

Measurements were taken of the road traffic noise as it is the only and/or main noise source of significance in the study area.

Table 3-5: Results of singular ten minute bin sound level measurements (Datum type: Latitude, Longitude)

Point Name	Latitude, Longitude	Time	L_{AIeq} (dBA)	L_{A90} (dBA)	L_{A10} (dBA)	$L_{A,max}$ (dBA)	$L_{A,min}$ (dBA)	Ave. Wind (m/s)
RP03	28°47'25.27"S 32° 4'48.39"E	10:19	60.4	55.1	61.9	73.9	53.4	3.4
		10:29	57.3	54.1	59.2	68.5	52.1	2.7
		10:39	61.3	55.6	61.7	75.5	54	2.4

Note: SLM fitted at all times with appropriate windshield

3.4 AMBIENT SOUND LEVELS – SUMMARY

A summary of the SANS 10103:2008 Rating Levels for noise in districts is provided in **Table 3-6** below.

Both longer-term monitoring locations reflected an area slightly higher than an urban setting, but at times with a busy urban/central business district character. Although it is always likely that a degree of over-engineering or precautionary principals are adhered to in environmental assessments, there is a high confidence in ambient sound levels measured and the subsequent Rating Levels determined.

There is a high confidence level in L_{Aeq} measured data and subsequently the Rating Levels determined. The Noise Control Regulations for an industrial zone would be the applicable South African Legislation. It is also recommended that the project also consider the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas. Seasonal changes in ambient sound levels must be considered, and measured data may change depending on season.

Table 3-6: Summary of Noise district Rating Levels

Point name	Noise district rating based on $L_{Aeq,I}$ 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)
RP01	Urban – busy urban/busy urban – central business district	Urban – busy urban	At times
RP02	Urban – busy urban/busy urban – central business district	Urban – busy urban	At times

3.5 ASSESSED EXISTING AMBIENT SOUNDSCAPE

3.5.1 Representation of Rating Levels

Existing Rating Level will be calculated in this report using the appropriate sound propagation models as defined in the preceding **Section 4**. It is therefore important to understand the difference between sounds 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 level to which various corrections and adjustments was added. This Noise Rating Level is further processed into a 3D map illustrating the ambient soundscape contours of constant rating levels or noise isopleths. In this project it illustrate the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time. Based on the information in this study, the outcome of the Noise Rating Level is presented in the preceding chapters.

3.5.2 Daytime Ambient Soundscape for Assessment Purpose

Night-time (22:00 – 06:00) operations will assessed as this is the most critical investigational times when a quiet environment is desired (at night for sleeping, weekends etc.).

3.5.3 Night-time Ambient Soundscape for Assessment Purpose

The existing night-time ambient soundscape is designed from available information (**Section 1.3**). The most distinguishable noise contributors of significance to the environmental ambient soundscape were identified as the existing R34 and Ridge Town road traffic (refer to **Section 1.3.3**).

With all available information, the daytime calculated major ambient soundscape designed representation includes:

- An existing consistent equivalent background ambient sound level of 40.8 dBA. This value is based on the lower L_{A90} values measured during site investigation dates (refer to **Section 3.3**);
- R34 Road traffic volumes calculated from annual average daily traffic (AADT) data as monitored/calculated on the roads (data courtesy of Yolan Pillay. Traffic Impact Assessment: Proposed Upgrade of Mondi, Richards Bay. Royal Haskoning DHV. September 2012 [30]). Roads considered as a (single-lane alternative direction) continuous paved route (non-porous i.e. semi dense air void of 9 – 14 %[31] or less,

[30] Yolan Pillay. Traffic Impact Assessment: Proposed Upgrade of Mondi, Richards Bay. Royal HaskoningDHV. September 2012
[31] SILVIA. *Guidance Manual for the Implementation of Low Noise Road Surface 2nd ed.* FEHRL Report

chip sealed e.g. cape seal[32] etc.). Traffic calculated at constant mean traffic speed of 80 km/h[33] as per speed limits on regional main roads, and as viewed during site investigational dates. Annual Average Daily Truck Traffic (AADTT or heavy vehicles) calculated at 1 % of AADT volumes. The Ridge Town Road traffic conditions made use of information from the Baseline Report (**Section 1.4**);

- Intervening ground conditions of a medium ground nature, i.e. some flora etc. (50 75% hard ground conditions). Refer to **Section 1.3.6**;
- Activities assessed functioned during wind-still conditions, in good sound propagation conditions (20^{o}C and 80% humidity);
- Calculations are more indicative of Rating Levels of houses with a direct line of sight from the receptors to noise sources (i.e. no screening corrections considered); and
- No building façade corrections were considered.

Figure 3-22 illustrates the resulting representation of the night-time ambient soundscape climate. This figure rating contours are illustrated from 45 dBA upwards (IFC table Residential - Equator Principle referencing), with contours illustrated in 5 dBA intervals. These figures indicate a $L_{Req,1\ h}$ value with no tone or impulse corrections. Contours are more indicative of Rating Levels at dwellings with a direct line of sight from the assessed scenario to the receptors closest to the noise source. This is mostly relevant for dwellings on the outer edge of a township, that would likely screen Rating Levels at dwellings (or row of dwellings) directly behind and adjacent to it.

[32] R.A Clayton. *"Experience with Cape Seals on Heavily Trafficked Roads Leading to Improved Design and Larger Aggregate Utilisation"*. GHD House, Western Australia. P.g 1.
[33] No. 93 of 1996. *National Road Traffic Act*. 1996.

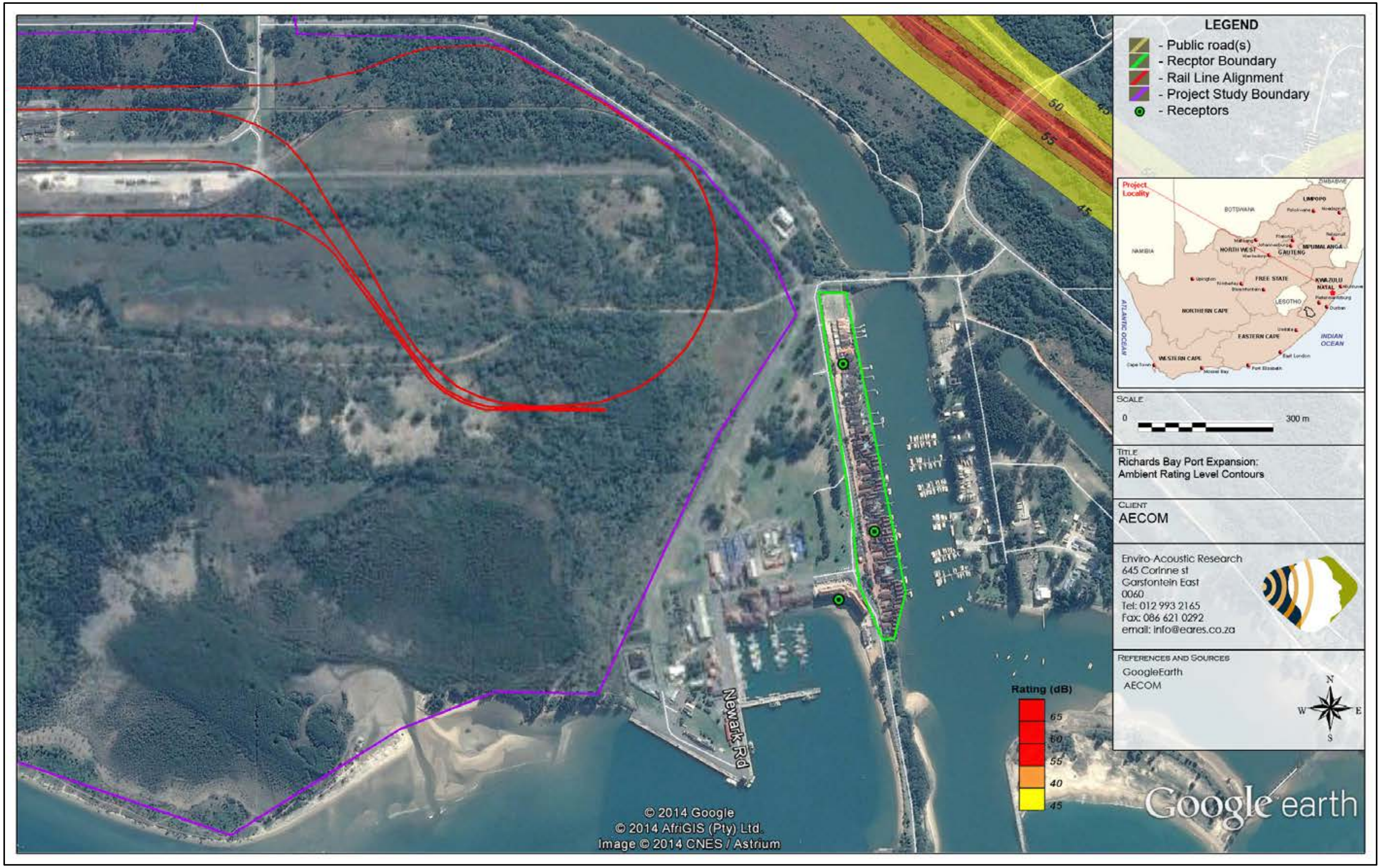

Figure 3-22: Night-time ambient contours representation

4 POTENTIAL NOISE SOURCES

Increased sound levels are directly linked with the various activities associated with the construction, as well as the operational phase of the activity. Refer to **Appendix E.1** indicating the layout as received by the main consultant and used for assessment purposes. The existing ambient soundscape sound sources are also briefly discussed here, as they may act as a buffer or cumulate with sound levels from the development.

4.1 POTENTIAL NOISE SOURCES – EXISTING AMBIENT SOUNDSCAPE

4.1.1 Existing Linear Noise Sources

The R34 and Ridge Town Road was the only existing ambient soundscape sound sources investigated. Noise propagation due to road traffic depends on various acoustical factors. The most important are briefly discussed below.

4.1.1.1 Road tyre interaction/road vehicle speeds[34]

The most significant noise contributor above 60 km p/h is the tyre interaction with the road surface. Tyre road impacts and shocks as well as tyre to road pumping (during standard rolling conditions, pumping is the compression of air under tyre tread) can contribute mainly below and above 1,000 Hz respectively (up to 2,000 Hz for pumping). The horn effect created by the geometry of the tyre and road surface can amplify up to frequencies of 10,000 Hz[35]. At speeds below 60 km/h engine noise (fan belt, piston revolutions etc.) would be more dominant over road tyre interaction noise which contributes to 1,000 Hz peaks.

Tyre design also plays a role in the creation and propagation of noise when tyre interacts with road surface at different speeds. Tyre manufacturers and designs are abundant and have to consider a whole host of other factors besides acoustics, including handling, braking, acceleration, off-road abilities, durability to environmental factors (heat, stresses etc.), load index, aspect ratios, speed ratings etc. Test conducted by independent acoustical consultants have indicated various effective means of reducing Noise, Vibration and Harshness (NVH) due to tyre design selection. Such designs include exterior fibre wheel arch liners that help reduce tire noise in the wheel well area[36]. Although wheel

[34] Milieu. *Inventory of Potential Measures for a Better Control of Environmental Noise.* DG Environment of the European Commission. 2010.

[35] *FEHRL Report 2006/02, Guidance manual for the implementation of low-noise road surfaces*

[36] Barry R. Wyerman. Gabriella Cerrato Jay. "Tire Noise Reduction with Fiber Exteriro Wheel Arch Liners". SAE International. 2007.

archers are mostly designed for noise reduction of vehicle cabin interior, implementation of archers will help reduce air-borne noise as well.

4.1.1.2 Road vehicle type

Vehicles noise emissions at speed vary from vehicle to vehicle. For acoustical purposes the classification of vehicles are considered as light or heavy. Heavy vehicles could be considered as articulated, tanker or other industrial freight trucks or any vehicle with heavy axle loads.

4.1.1.3 Road traffic volume

Road traffic with the volume and type of traffic generated may vary from day to day. Noise levels due to traffic volumes from the haul/existing roads will be estimated using the methods stipulated in SANS 10210:2004 (Calculating and predicting road traffic noise).

4.1.1.4 Other road noise contributors

Other noise sources associated with motor vehicles include the exhaust outlet, engine motor and associated engine components such as fan belt (mostly audible below 60 km p/h). Many motor engine revs per minute (rpm) convert to a low range of frequency below the 100 Hz range. Wind shear noise can contribute to vehicle movement although mostly at very high speeds only.

4.2 POTENTIAL NOISE SOURCES - CONSTRUCTION PHASE

The construction of the project was not investigated as the implementation or construction of equipment is relatively quick in relation to operations of the facility, and equipment is less likely to be established during the more critical investigational night-time hours. For reference purpose, potential maximum noise levels generated by construction equipment as well as the potential extent are presented in **Table 4-1.** The potential extent depends on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral character of the noise and the ambient surroundings.

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

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

Equipment Description[37]	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 modeling 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)	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

[37] 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	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

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

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Bulldozer CAT D10	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D11	113.3	88.4	82.3	76.3	68.4	62.3	58.8	56.3	52.8	48.4	44.8	42.3	36.3
Bulldozer CAT D9	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D6	108.2	83.3	77.3	71.2	63.3	57.3	53.7	51.2	47.7	43.3	39.8	37.3	31.2
Bulldozer CAT D5	107.4	82.4	76.4	70.4	62.4	56.4	52.9	50.4	46.9	42.4	38.9	36.4	30.4
Bulldozer Komatsu 375	114.0	89.0	83.0	77.0	69.0	63.0	59.5	57.0	53.4	49.0	45.5	43.0	37.0
Bulldozer Komatsu 65	109.5	84.5	78.5	72.4	64.5	58.5	54.9	52.4	48.9	44.5	41.0	38.5	32.4
Diesel Generator (Large - mobile)	106.1	81.2	75.1	69.1	61.2	55.1	51.6	49.1	45.6	41.2	37.6	35.1	29.1
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
Dumper/Haul truck - Bell 25 ton (B25D)	108.4	83.5	77.5	71.4	63.5	57.5	53.9	51.4	47.9	43.5	40.0	37.5	31.4
Excavator - Cat 416D	103.9	78.9	72.9	66.8	58.9	52.9	49.3	46.8	43.3	38.9	35.4	32.9	26.8
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
Excavator - Hitachi 270 (30 t)	104.5	79.6	73.5	67.5	59.6	53.5	50.0	47.5	44.0	39.6	36.0	33.5	27.5
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
JBL TLB	108.8	83.8	77.8	71.8	63.8	57.8	54.3	51.8	48.3	43.8	40.3	37.8	31.8
Road Transport Reversing/Idling	108.2	83.3	77.2	71.2	63.3	57.2	53.7	51.2	47.7	43.3	39.7	37.2	31.2
Road Truck average	109.6	84.7	78.7	72.6	64.7	58.7	55.1	52.6	49.1	44.7	41.1	38.7	32.6
Vibrating roller	106.3	81.3	75.3	69.3	61.3	55.3	51.8	49.3	45.8	41.3	37.8	35.3	29.3
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

4.3 Potential Noise Sources - Operational Phase

4.3.1 Train movement

Train specifications, routine and capacity made use of information from **Section 1.4,** with project capacity presented in **Appendix E.2.** Rail traffic is considered as a line source of noise with a continuous area of impact both sides of and parallel to the railway line. Railway related noise is general acoustically characterised by high noise levels of relatively short duration.

The wayside noise radiated into a community is the function of a number of different factors, namely:

- Interaction of wheels and rails. This includes the type of railway and wheel design, wheel diameter and "roughness". The main cause of wheel roughness is due to the use of cast iron brakes[38]. Most worldwide railway lines consist of flat-bottom steel rails supported on timber or pre-stressed concrete sleepers. These are usually laid on crushed stone ballast. Railway lines with heavy traffic use continuous welded rails (CWR) attached to sleepers via baseplates which spread the load. Certain railway lines make use of the jointed track, leaving (over time) small spacing between tracks. Jointed tracks are also used when a railway line breaks and repairs need to be made;
- Amount of axels per carriage. Transnet intends on running CCL/CCR wagon carriages on the line. These carriages consist of 4 axels per carriage. An example of a CCL – 8 carriages is illustrated in **Figure 4-1**.
- The vehicle or locomotive propulsion system. Transnet proposes the use of between 4 and 6 class 43 diesel locomotives (example in **Figure 4-2**);
- Type of locomotive and wagons. Refer to points above for locomotive and wagon specifications;
- Amount of trains per day/night. The initial trains per day are indicated at 8 per day while future operations are indicated at 16 trains per day. As SANS1010:2008 defines day and night as 16 and 8 hours (over 24 hours) day and night operations will be split 66 % and 33 % i.e. constant homogenous operations;
- Braking technology employed on the wagons and locomotives. All trains will have to be fitted with electronic controlled pneumatic brakes (ENP). It is assumed that the brakes will be cast iron. Railway braking is also associated with brake squeal which may have an acoustical tonal element to it;

[38] European Commission Directorate General Energy and Transport. Impact Assessment Study on Rail Noise Abatement Measures addressing the Existing Fleets. Reference Tren/A1/46-2005. December 10 2007.

- Railway alignment, in particular the design radius of curves and turns. The minimum railway curve radius has an important bearing on construction costs and operating costs;
- Auxiliary equipment;
- Noise radiated from vibrating structures;
- Train speed. Transnet intends on running trains on the balloon at 15 km/h;
- The length/amount of carriages. The envisaged maximum amount of carriages is intended to be 200. Carriage amounts can vary from 160 to 200 wagons (**Appendix E.2.**);
- Aerodynamics (for higher speed operations above 200 km/h); and
- Locomotive warning devices or horn noise.

Figure 4-1: CCL – 8 Wagon

Figure 4-2: Class 43 diesel locomotives

Train speed is a major influence parameter for noise emission. The noise due to traction and auxiliary systems (diesel units, electrically driven powertrains, cooling equipment, compressors), if present, tends to be predominant at low speeds, up to around 60 km/h. The relationship with speed is illustrated in **Figure 4-3**.

Wheel-rail rolling noise is dominant up to speeds around 200-300 km/h, after which aerodynamic noise takes over as dominant factor. The transition speeds from traction noise to rolling noise and from rolling noise to aerodynamics noise depend entirely on the relative strength of these sources. The rolling noise, for example, depends strongly on the surface condition (roughness) of wheels and rails, whereas aerodynamic noise depends on the streamlining of the vehicle.

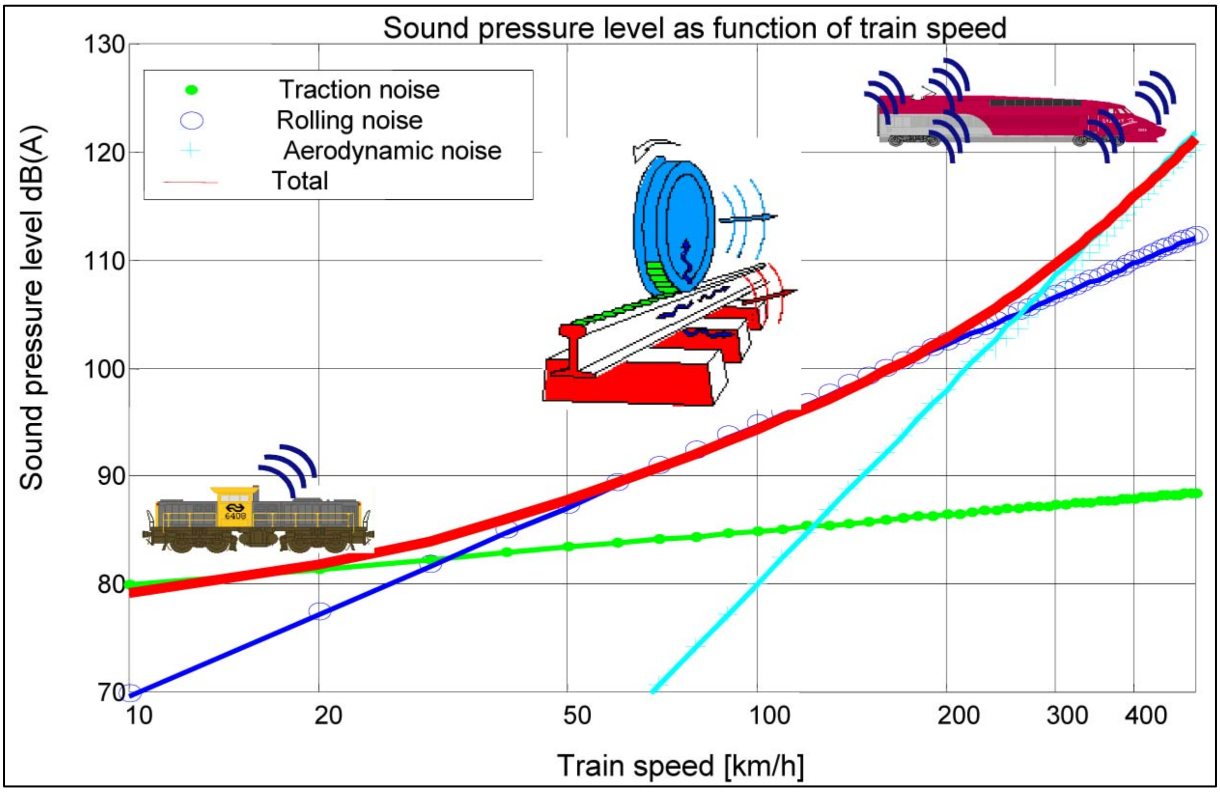

Figure 4-3: Railway exterior sound sources and typical dependence on train speed

Unfortunately there is no standard or guideline in South Africa stipulating the requirements to calculate or model the potential noise impacts from a railway operation. For this purpose it was selected to make use of the United Kingdom Department of Transport document, "Calculation of Railway Noise, 1995" (CRN).

4.3.2 Other railway infrastructure and potential noise sources

Although not significantly and generally far less than sources of noise mentioned above, other sources noises include:

- Ancillary equipment at rail passing loops (substations, compressors, refuelling, etc.);
- Railway maintenance operations; and
- Workshops and other equipment maintenance.

4.3.3 Single maximum noise events - magnitude and occurrences (L_{Amax})

Several railway activities, including train pass-bys, emit repetitive noises of a significant level for brief periods of time that can interfere with sleep, communications, and the wellbeing of the residents of neighbouring properties (WHO 1999). International Standards relating to L_{Amax} singular maximum events is briefly discussed in **Section 2.9**.

4.3.4 Impulse or tone corrections[39]

Curve squeal and brake squeal are common noise sources for railways in urban areas and light rail networks. Both are considered annoying due to the high levels and the tonal content. Curve squeal is known as the tonal noise that occurs during turning either at curves or at points. [40]

Noise levels due to brake squeal as trains approach the rail loop could range between the 90 to more than 105 dBA (peak). It can be audible for more than 2,000 meters. The character of this noise can be considered tonal and could also increase annoyance levels with receptors.

4.3.5 Low Frequency Noise[41]

4.3.5.1 Background and Information

Low frequency sound is the term used to describe sound energy in the region below ~200Hz. The rumble of thunder and the throb of a diesel engine are both examples of sounds with most of their energy in this low frequency range. Infrasound is often used to describe sound energy in the region below 20Hz.

Almost all noise in the environment has components in this region although they are of such a low level that they are not significant (wind, ocean, thunder). See also **Figure 4-4**, which indicates the sound power levels in the different octave bands from measurements taken at different wind speeds with no other audible noise sources. Sound that has most of its energy in the 'infrasound' range is only significant if it is at a very high level, far above normal environmental levels.

4.3.5.2 The generation of Low Frequency Sounds

Low frequency oscillation may occur in the lower frequency of railway grids. Internet resources are abundant regarding low frequency

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[39] SANS 10103:2008
[40] Micheal Dittrich and Erwin Jansen. Virtual certification of acoustic performance for freight and passenger trains, 11/04/2013

[41] Renewable Energy Research Laboratory, 2006; DELTA, 2008; DEFRA, 2003; HGC Engineering, 2006; Whitford, Jacques, 2008; Noise-con, 2008; Minnesota DoH, 2009; Kamperman, 2008, Van den Berg, 2004

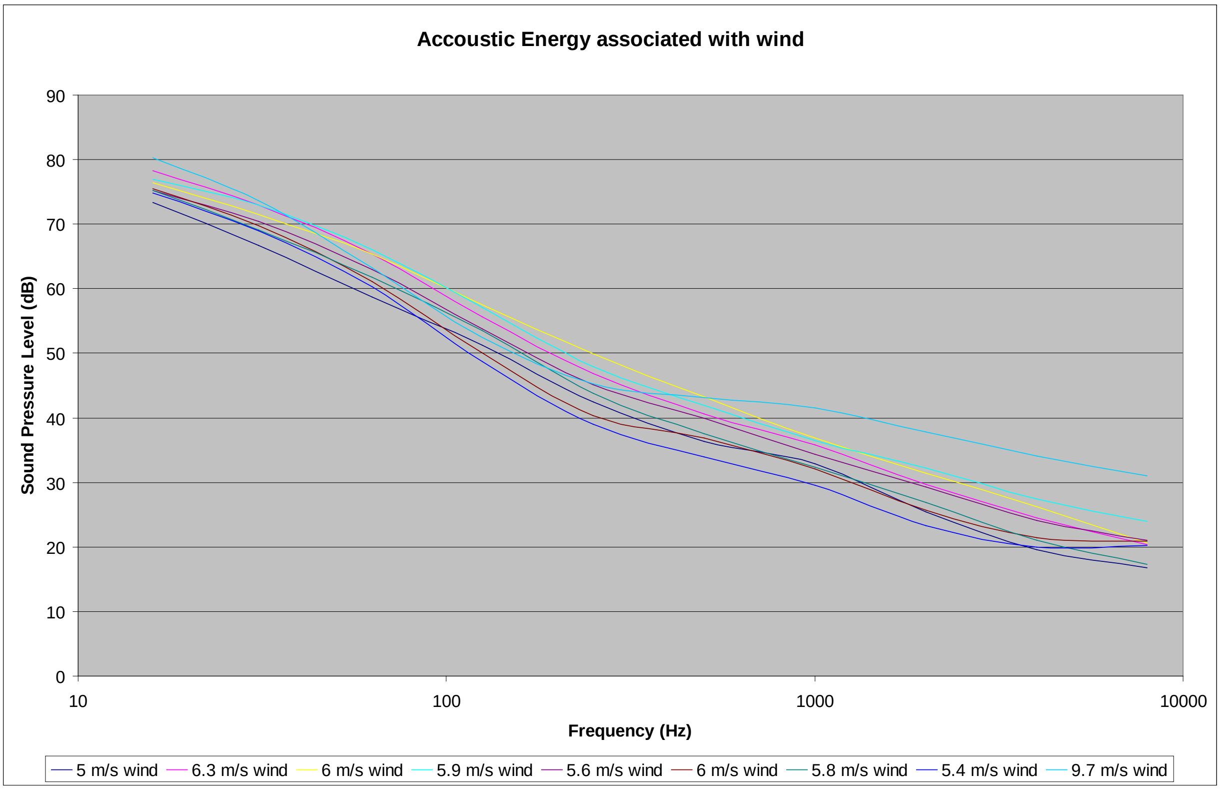

Figure 4-4: Third octave band sound power levels at various wind speeds

4.3.5.3 Measurement, Isolation and Assessment of Low Frequency Sounds

There isn't a standardised test, nor an assessment procedure available for the assessment of low frequency sounds, neither is there an accepted methodology on how low frequency sounds can be modelled or predicted. This is because low frequency sound can travel large distances, and are present all around us, with a significant component generated by nature itself (ocean, wind, etc.). SANS 10103 proposes a method to identify whether low frequency noise could be an issue. It proposes that if the difference between the A-frequency weighted and the C-frequency weighted equivalent continuous ($L_{Aeq}>>L_{Ceq}$) sound pressure levels is greater than 10 dB, a predominant low frequency component **may** be present.

4.4 POTENTIAL NOISE SOURCES - CLOSURE PHASE

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

- Closure activities are generally less intense than construction and operational activities. Noise levels are lower and frequently limited to daylight hours. This reduces the significance of the noise impact;

- Most rehabilitation takes place con-currently with mining. It is therefore just another activity generating noise that could be considered as part of the operational phase; and
- A closure EMP must be developed by the mining operation at the end of the mining operation, which is more specific and accurate. If required, noise could be addressed in this document.

5 METHODS: NOISE IMPACT ASSESSMENT

5.1 POTENTIAL NOISE IMPACTS ON ANIMALS[42]

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

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

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

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

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

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

From these and other studies the following can be concluded:

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

[42] USEPA, 1971: *"Effects of Noise on Wildlife and other animals"*.

As such various South African/International guidelines existing very briefly mentioning potential noise impacts on wildlife from industrial and commercial industries, it has the issue where no acoustical criteria is defined[43]. Faunal guidelines exists regarding the protection of an animal's surrounding environment, with "physical" impacts such as water, vegetation etc. a far more critical impact than that of acoustics.

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

5.1.1 Effects of Noise on Wildlife

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

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

Many natural based acoustics themselves may be loud or impulsive. Examples include thunder, wind induced noises that could easily exceed 35 dBA ($L_{A90,fast}$) above wind speeds averaging 6 m/s (wind conditions of a moderate breeze on the Beaufort Scale[44]), 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)[45&46]. The high noise

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

levels may see negative influences on animals cardiovascular systems and behaviour, and may damaging to the hearing of dogs in the kennel facility[47].

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. A change in the heart rate, renal blood flow and blood pressure of study subjects were noted in the above studies.

5.1.3 Laboratory Animal Studies

Although many laboratory animals have wild counterparts (rats, mice) the laboratory test subjects differ in many aspects (genetics, behaviour etc.). Also noise levels of studies are conducted at generally very high levels at over 100 dB, much more than what would be experienced in environmental settings around industrial, commercial or transportation activities.[48] Other dissimilarities to laboratory tests and a natural environment include the time exposure (duration of noise), the spectral and noise character (impulsive noise vs. constant noise) etc. Although there exists dissimilarities in tests conducted and noise levels around commercial and industrial environments, laboratory rodents exposed to high noise levels did indicated physiological, behavioural changes, hearing loss and other such effects[49].

5.2 WHY NOISE CONCERNS COMMUNITIES[50]

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.

[47] Wei, B. L. (1969). Physiological effects of audible sound. AAAS Symposium Science, 166(3904), 533-535.
[48] USEPA, 1971: *"Effects of Noise on Wildlife and other animals"*.
[49] Ann Linda Baldwin. *"Effect of Noise on Rodent Physiology"*. 2007.
[50] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

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

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

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

Severity of the annoyance depends on factors such as:

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

5.2.1 Annoyance associated with Industrial Processes

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

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

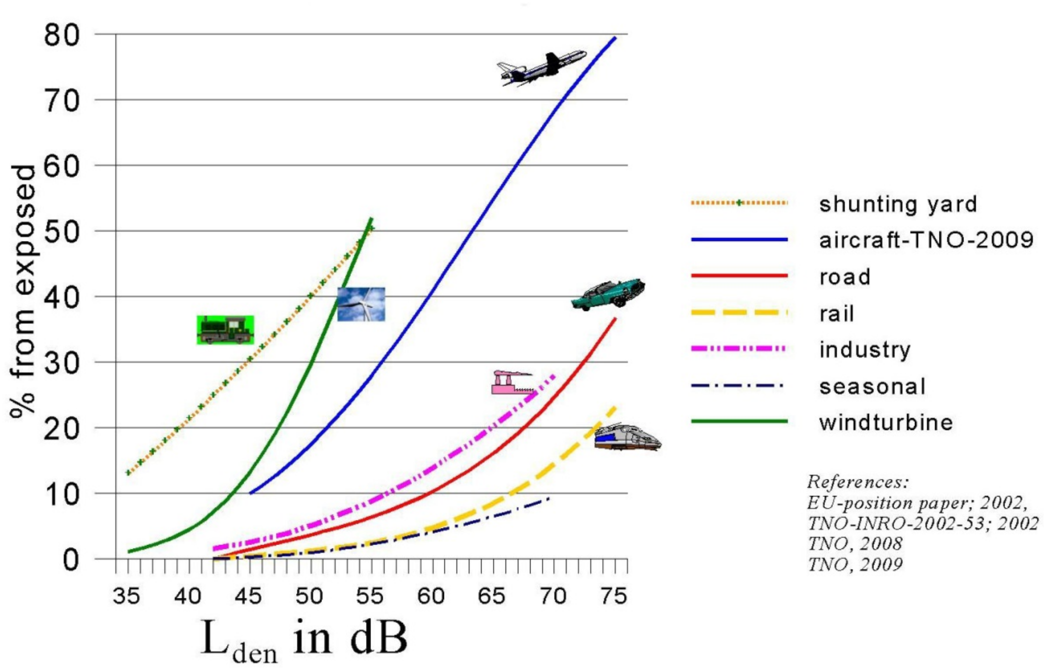

Figure 5-1: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling

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

5.3 IMPACT ASSESSMENT CRITERIA

5.3.1 Overview: The Common Characteristics

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

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

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

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

5.3.2 Noise criteria of concern

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

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

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

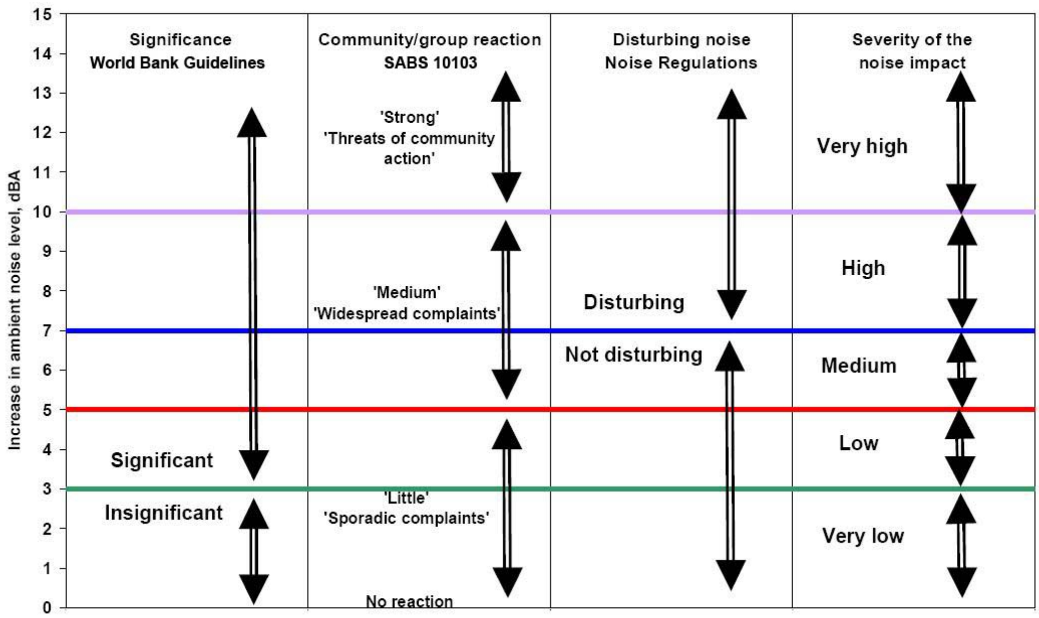

Figure 5-2: Criteria to assess the significance of impacts stemming from noise

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.

During site measurements (**Section 3.3**) $L_{Aeq.I}$ ranged between Urban to Central Business District. By considering other measured variables and by taking a precautious stance (due to seasonal faunal sounds, unwanted noises from dwellings etc.) the following SANS 10103:2008 rating levels will be considered for the surrounding areas:

- Urban district $L_{Req,D}$ of 55 dBA; and
- Urban district $L_{Req,N}$ of 45 dBA.

The zoning of the land use as set out by the local authorities needs to be considered. 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-

iii. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or

iv. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

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

- Use of $L_{Req,D}$ of 55 dBA during the daytimes; and
- Use of $L_{Req,N}$ of 45 dBA during the night-times.

SANS 10103:2008 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in sound level, the following criteria are of relevance:

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

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

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

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

1	2	3	4	5	6	7
Type of district	Equivalent continuous rating level ($L_{Req.T}$) for noise dBA					
	Outdoors			Indoors, with open windows		
	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

It must be noted that SANS10103:2008 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"*

5.3.3 Other noise sources of significance

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

At night, sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from a variety of appliances (magnetostriction) drawing standby power, freezers and fridges. **Figure 5-3** illustrates the sound levels associated with some equipment or in certain rooms. This is however more for illustrative purposes, as there are many manufacturers with different equipment, each with a different noise emission character.

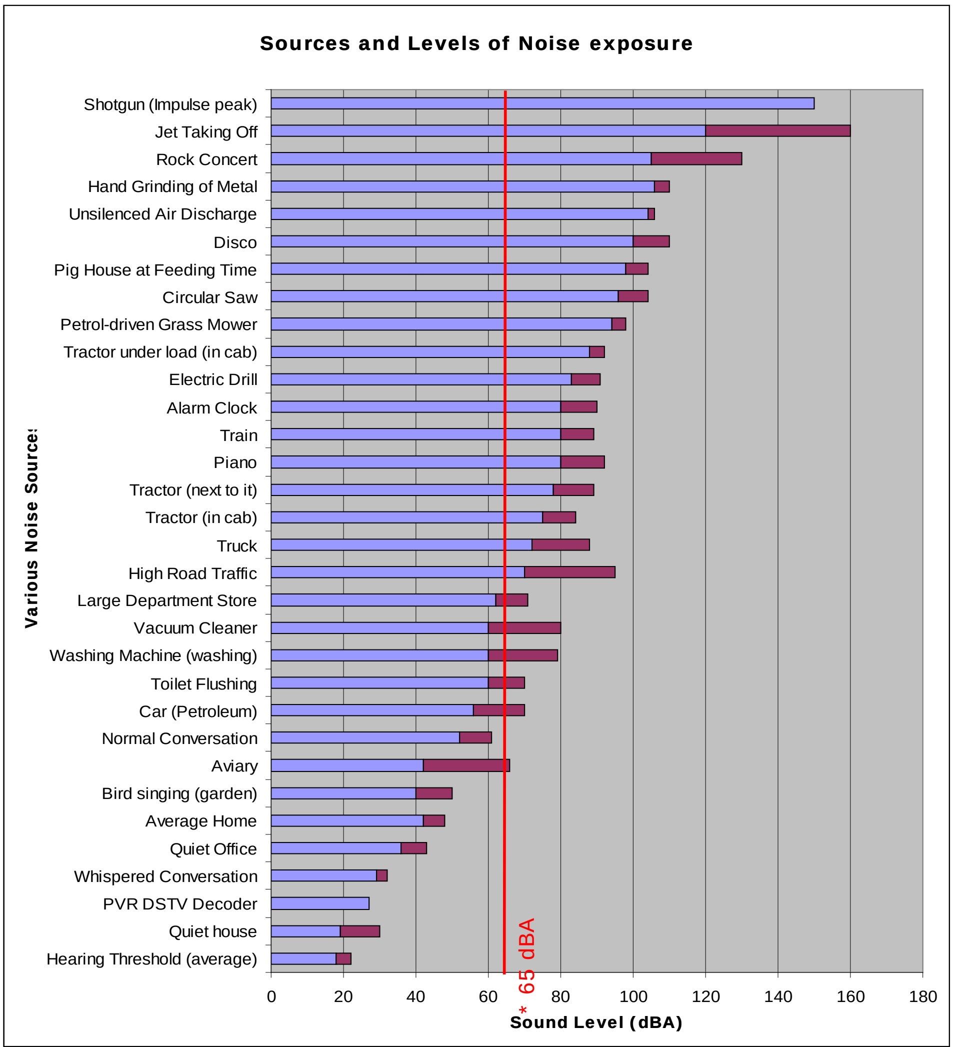

Figure 5-3: Typical Noise Sources and associated Sound Pressure Level

5.3.4 Determining the Significance of the Noise Impact

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

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

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

Table 5-2: Impact Assessment Criteria - Magnitude

This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species.		
Rating	**Description**	**Score**
Low	Increase in average sound pressure levels between 0 and 3 dB from the expected ambient sound levels. Ambient sound levels are defined by the lower of the measured $L_{Aleq,8\ h}$ or $L_{Aleq,16\ h}$ during measurement dates (**Section 3.3**). Total projected noise level is less than the Zone Sound Level and/or Equator Principle in wind-still conditions.	2
Low Medium	Increase in average sound pressure levels between 3 and 5 dB from the expected ambient sound levels. Total projected noise levels between 3 and 5 above the Zone Sound Level and/or Equator Principle (wind-less conditions).	4
Medium	Increase in average sound pressure levels between 5 and 7 dB from the ambient sound levels. Increase in sound pressure levels between 5 and 7 above the Zone Sound Level and/or Equator Principle (wind less conditions). Sporadic complaints expected.	6
High	Increase in average sound pressure levels between 7 and 10 from the ambient sound level. Total projected noise levels between 7 and 10 dBA above the Zone Sound Level and/or Equator Principle (wind-less condition). Medium to widespread complaints expected.	8
Very High	Increase in average ambient sound pressure levels higher than 10 dBA. Total projected noise levels higher than 10 dB above the Zone Sound Level and/or Equator Principle (wind less-conditions). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action. Any point at a receptor where 24 hr. measured value exceeds 61 dBA for an Industrial zoned or controlled area.	10

Table 5-3: Impact Assessment Criteria - Duration

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

Table 5-4: Impact Assessment Criteria – Spatial extent

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

Table 5-5: Impact Assessment Criteria - Probability

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

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

Table 5-6: Assessment Criteria: Ranking Scales

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

5.3.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

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

Significance without mitigation is rated on the following scale:

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

5.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

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

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

5.4 Representation of Noise Levels

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

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

6 METHODS: CALCULATION OF NOISE CLIMATE

6.1 NOISE CLIMATE ON THE SURROUNDING ENVIRONMENT

6.1.1 Linear Sources – Roads Traffic

The noise emission into the environment due to road traffic will be calculated using the sound propagation model described in SANS 10210. Calculated corrections such as the following will be considered:

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

6.1.2 Linear Sources – Railway traffic

There is no standard or guideline in South Africa stipulating the requirements to calculate or model the potential noise impacts from a railway operation. Various International propagation models do exist. These include the German Schall 03, Dutch SRM II, Nordic TemaNor:1996 and NMPB-FER French acoustical models. Based on the measured scenario from conducted by Enviro-Acoustics Research (refer to **Section 1.4** for document title) the comparison of two predictive models namely the Calculation of Railway Noise (CRN) and Schall 03 highlighted the following:

- The results indicate that the CRN model uses the 3 dB per doubling of distance algorithm;
- The CRN model generally under-estimates the noise levels at 10 meters (out with an average of 4.3 dB);
- Considering the predicted values at 40 and 80 meters, the calculated levels on average is out with less than 2 dB from the measured values. This value is an over-estimation;
- Due to the 3 dB reduction with doubling of distance equation, the CRN model could likely over-estimate the noise rating levels at 160 meters;
- From a predictive environment the use of the CRN model is acceptable and provides results that is comparative with the measured data;
- The Schall 03 model is based on the ISO 9613-2 model that uses a point source algorithm (± 6 dB per doubling of distance reduction). The resulting noise rating levels indicate that the Schall 03 model consider a reduction of approximately 5 dB (reduction per doubling in distance) in the near field that reduced to approximately

4 dB at 80 and 160 meters. This is closer than the 5 dB (reduction per doubling in distance) measured in the field;

- The Schall 03 model provides a more accurate noise level at 10 meters;
- The Schall 03 model provides under-estimates the predicted values at 40 and 80 meters;
- Due to the 5 dB reduction with doubling of distance equation, the Schall model could likely under-estimate the noise rating levels at a distance of 160 m; and
- From a predictive environment the use of the Schall 03 model might under-estimate the noise levels.

As receptors are based at over 200 m from the railway line for this study, it was selected to make use of the United Kingdom Department of Transport document, "Calculation of Railway Noise, 1995". The methodology proposed in this document is illustrated in **Figure 6-1**.

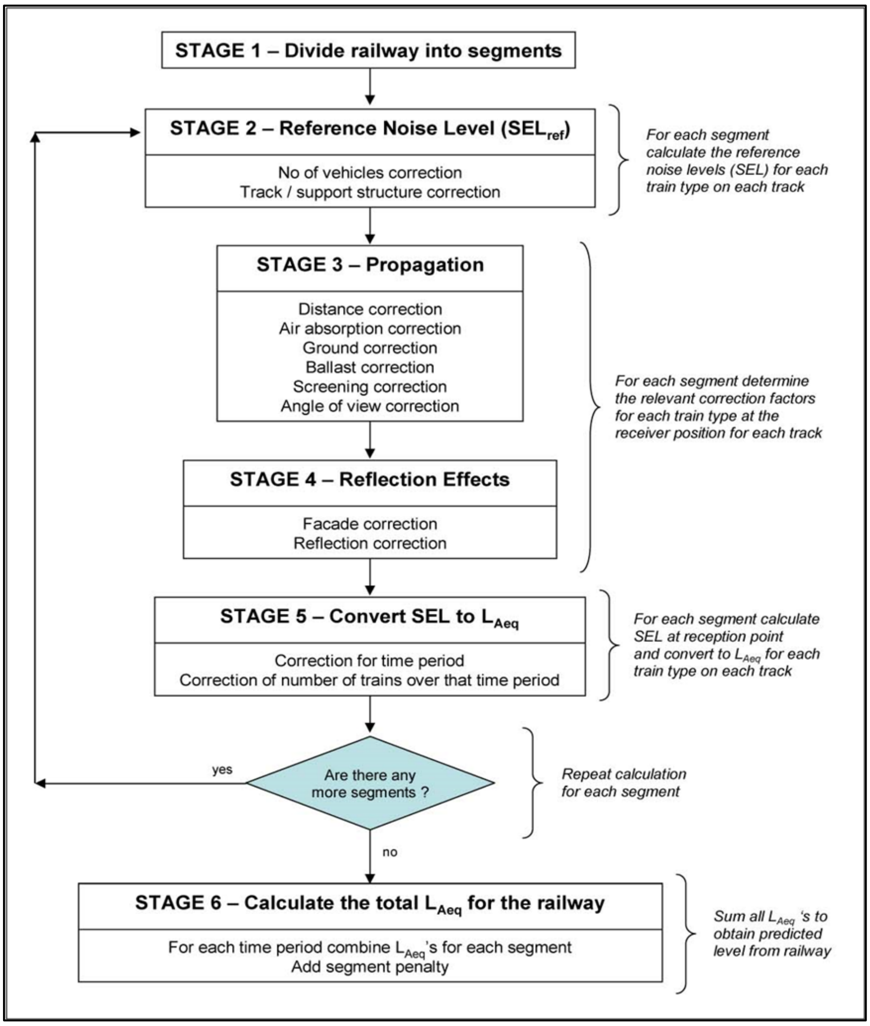

Figure 6-1: Flow diagram illustrating the methodology to calculate the noise from railways

6.2 SOUND PROPAGATION - CALCULATION LIMITATIONS

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. These include intrusive sounds or amplitude modulation;
- Many sound propagation models do not calculate the increase of the ambient soundscape due to wind shear (masking noise);
- Most sound propagation models do not consider refraction through the various temperature layers (specifically relevant during the night-times);
- Most sound propagation models do not consider the low frequency range (third octave 16 – 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 change depending on the load the process and equipment is subject too. While the octave sound power 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 worse-case scenario;
- As it is unknown which processes and equipment will be operational, modelling considers a scenario where all processes and equipment are under full load 100% of the time. The result is that projected noise levels would likely over-estimate 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 $\leq$ 5 dBA is more common in practice.

7 SCENARIO: NOISE CLIMATE

7.1 INVESTIGATED SCENARIOS

Initial daytime (06:00 – 22:00) and night-time (22:00 – 06:00) operations will be assessed in this section. Most critical investigational times would be the night-time hours when a quiet environment is desired (at night for sleeping, weekends etc.).

Calculations in this section are based on a worst-case scenario and will not be relevant for all times of the operation phase (not a moment in time, but the potential extent of noise Rating Levels during the operational phase). The operational phase *modus operandi* is discussed in more detail in **Section 4**, with potential noise source localities illustrated in **Figure 7-1**.

7.1.1 Investigated Worst-Case Scenarios - Initial Day and Night-time

7.1.1.1 Railway traffic

Based on available information (**Section 4**) the future operations (maximum capacity) will be assessed taking into account the following:

- The daytime operations of 6 x Class 43 electric locomotives and 200 x 4-axle tread braked wagons per train with 22 (11 delivery, 11 return). Trains can travel at 40 km/h in and around sensitive areas, this speed will be investigated around the loop;
- The night-time mainline operations of 6 x Class 43 electric locomotives and 200 x 4-axle tread braked wagons per train with 10 trains per night (5 delivery, 5 return) travelling at 40 km/h;
- Ballast correction (acoustics attenuation due to ballast effect) was considered;
- Intervening ground conditions of a medium ground nature, i.e. (50 75% medium ground conditions);
- Continuous welded rail (CWR) corrections were considered; and
- Assessment does not consider façade corrections or the row of houses acting as a screen when obstructing a direct line of sight to the railway line. Assessed calculations better illustrate potential noise levels at with a direct line of sight to railway lines.

7.1.1.2 Impulse or tone corrections[51]

A + 5 dBA correction can be implemented for train brake squeal at areas where momentum needs to be reduced or trains make periodic stops (reference as per SANS 10103:2008 methodology). The SANS 10103:2008 methodology indicates a + 5 dBA (tone, *C*t) in the calculation of the Rating level in the formulae $L_{Req,T} = L_{Aeq,T} + Ci + Ct$.

[51] SANS 10103:2008

Note that the correction is considered in the assessment section in **Appendix D.1** and **Appendix D.2**. +5 dBA corrections are not illustrated in maps i.e. **Figure 7-1**.

7.1.1.3 Existing Ambient Contributors and Acoustical Factors

The following ambient soundscape factors were considered:

- Intervening ground conditions of a medium ground nature, i.e. some flora etc. (50 - 75% hard ground conditions). Refer to **Section 1.3** for more information;
- The existing ambient soundscape as investigated in **Section 3.5**;
- Activities assessed functioned during wind-still conditions, in good sound propagation conditions (20^{o}C and 80% humidity).

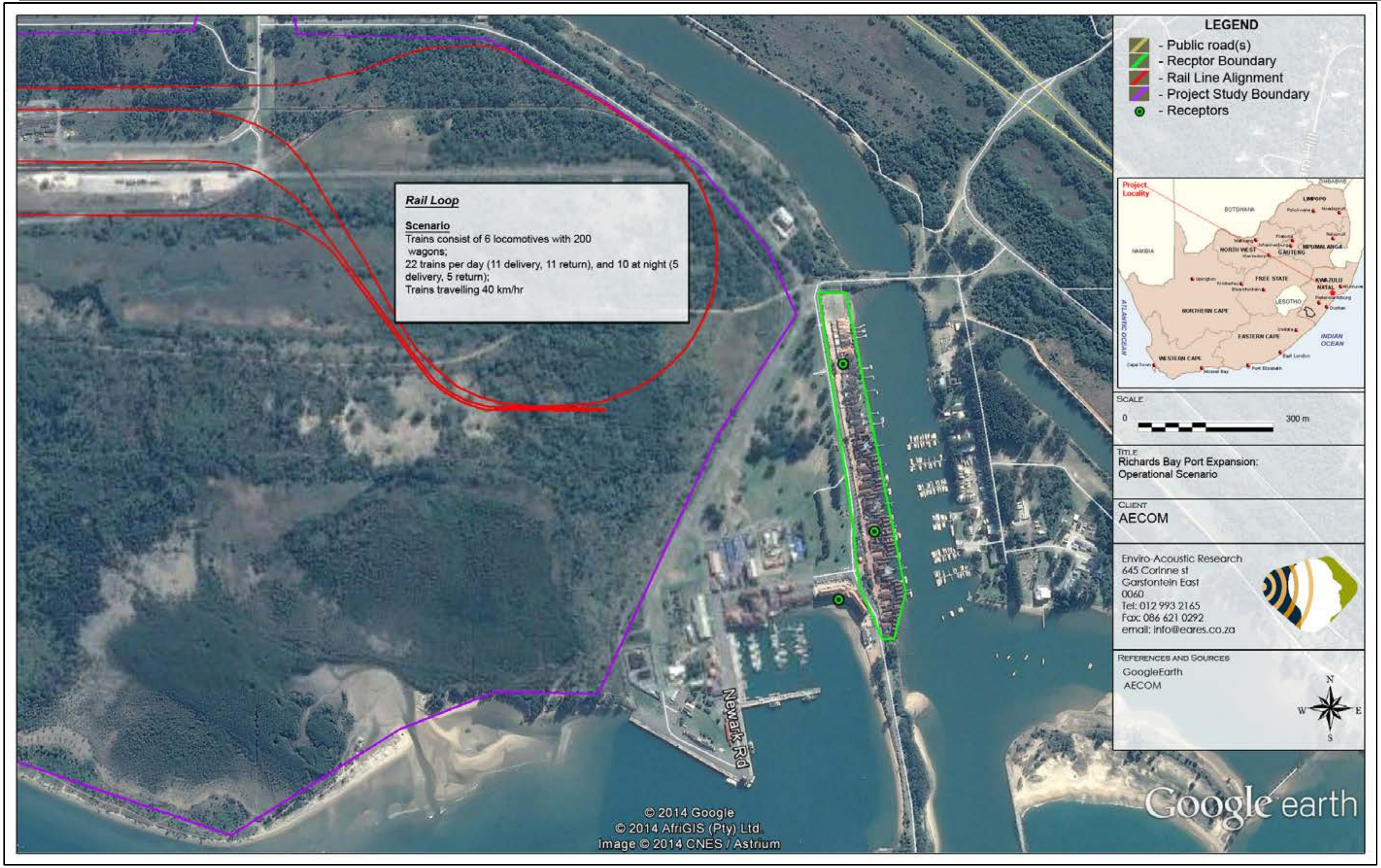

Figure 7-1: Future scenario as modelled for the day / night time period – Worst case peak noise climate

8 MODELLING RESULTS AND IMPACT ASSESSMENT

8.1 OPERATIONAL SCENARIO – WORST-CASE REPRESENTATION: PEAK NOISE CLIMATE

This impact assessment is quite precautious and a worst-case representation of potential maximum equivalent (average) noise climate ($L_{Req,1\ h}$) the receptors could be exposed to at some time during the operational phase.

A representation of the day and night-time operational noise climate at receptors is presented in **Appendix D.1** and **Appendix D.2** respectively. Both day and night-times will be assessed as the proposed development will operate during the entire 24 hour day/night period. **Figure 8-1** illustrates the resulting representation of the night-time worst-case peak noise climate around the proposed development. This figures Rating Level contours are illustrated from 45 dBA upwards (IFC table Residential - Equator Principle referencing), with contours illustrated in 5 dBA intervals. The mentioned figures indicate a $L_{Req,1\ h}$ value with no tone or impulse corrections.

It was selected to use the lowest $L_{Aleq,8h}$ and $L_{Aleq,16h}$ to define the existing daytime and night-time ambient soundscape respectively around the development (see **Section 3**). The values will be used in conjunction with the Rating Level and/or Noise Control Regulations in this assessment for comparison with the calculated $L_{Req,T}$ of the noise sources under investigation. This will help identify any potential noise concerns, impacts (according to legislation and/or guidelines) or requirements for further investigations (refinement of model coefficients, corrections etc.).

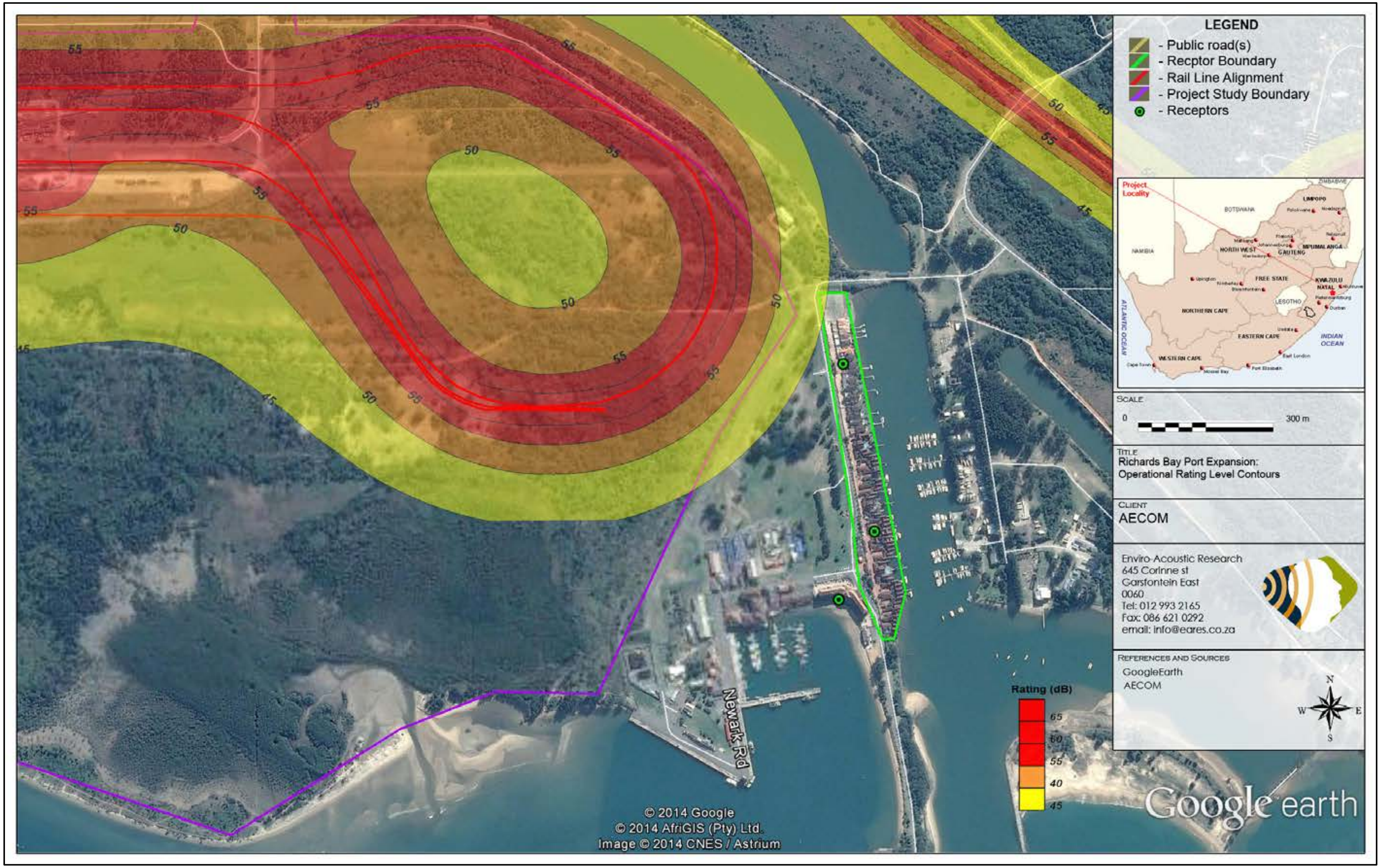

Figure 8-1: Projected night-time operational noise Rating Levels (no tone correction)

8.2 Impact Assessment – Operational Phase Representation

The impact significance as assessment for potential receptors when the project operates is presented in **Table 8-1** and **Table 8-2** below.

Table 8-1: Impact Assessment: Daytime scenario – peak hours

Nature:	Operations that take place during the daytime hours of (06:00 – 22:00).
Acceptable Rating Level	National Noise Control Regulations (GN R154 1992) - any point at a receptor where 24 hr. measured value exceeds 61 dB for an Industrial zoned or controlled area. Daytime Rating Level of 55 dBA – Urban Rating. Use of $L_{Req,D}$ of 55 dBA. IFC table (Equator Principle) for Residential; institutional and educational. Use of $L_{Req,D}$ of 55 dBA.
Extent	**Local (2)** – The impact could affect the local area (within 1,000 m from site).
Duration	**Long term (4)** – Impacts that will continue for the life of the Project, but ceases when the Project stops operating.
Magnitude-($L_{Req,D}$) > Rating Level/Equator Principal or measured $L_{Aleq,\ 16\ h}$ (Noise Control Regulations for a controlled area)	**Medium (6)** – NSD01; and **Low (2)** – NSD02 0 NSD03. • Equivalent calculated rating levels ($L_{Aeq,1hr}$) will not exceed the SANS10103:2008 Rating; • Equivalent calculated rating levels ($L_{Aeq,1hr}$) will not exceed the IFC table (Equator Principle) for Residential; • Equivalent calculated rating levels ($L_{Aeq,1hr}$) will exceed the existing ambient soundscape measured levels; and • The calculated 16 hr. scenario did not exceed 61 dB at receptors.
Probability	**Improbable (1) –** All receptors. • Engagements at a receptors dwelling may screen noise levels during the daytimes; and • The potential operation near buildings and facilities where a natural or quiet period is required. E.g. religious, educational, health care and hospitality facilities (game lodges).
Significance	**8 - 12 (low)** – for all NSD's. Refer to **Appendix D.1**.
Status	Negative.
Reversibility	Not relevant.
Comments	Refer to **Section 10** for mitigation options for further consideration.
Can impacts be mitigated?	Not relevant.

Based on the preceding data it is obvious that the risk of a noise impact developing during the daytime operational hours is of a low significance. Mitigation measures are supplied in **Section 10** to ensure that this assessed scenario significances is kept to a low value.

Table 8-2: Impact Assessment: Night-time scenario – peak hours

Nature:	Operations that takes place during the night-time hours of (22:00 – 06:00).
Acceptable Rating Level	National Noise Control Regulations (GN R154 1992) - any point at a receptor where 24 hr. measured value exceeds 61 dBA for an Industrial zoned or controlled area. Night-time Rating Level of 45 dBA – Urban Rating. Use of $L_{Req,D}$ of 45 dBA. IFC table (Equator Principle) for Residential; institutional and educational. Use of $L_{Req,D}$ of 45 dBA.
Extent	**Local (2)** – The impact could affect the local area (within 1,000 m from site).
Duration	**Long term (4)** – Impacts that will continue for the life of the Project, but

	ceases when the Project stops operating.
Magnitude-($L_{Req,N}$) > Rating Level/Equator Principal or measured $L_{Aleq, 8 h}$ (Noise Control Regulations for a controlled area)	**Medium (6)** – NSD01; and **Low (2)** – NSD02 0 NSD03. • Equivalent calculated rating levels ($L_{Aeq,1hr}$) will slightly exceed the SANS10103:2008 Rating; • Equivalent calculated rating levels ($L_{Aeq,1hr}$) will slightly exceed the IFC table (Equator Principle) for Residential; • Equivalent calculated rating levels ($L_{Aeq,1hr}$) will exceed the existing ambient soundscape measured levels; and • The calculated 8 hr. scenario did not exceed 61 dB at receptors.
Probability	**Possible (2)** – NSD01. **Improbable (1) –** All other receptors. • The increased likelihood of a noise impact to occur due to the $L_{Req,N}$ night-time rating; • Single noise events ($L_{max,}$ **Section 2.8.2**) due to train pass-bys will likely exceeded the recommended international guidelines; • The calculated 8 hr. scenario did not exceed 61 dB at receptors; and • The potential operation near buildings and facilities where a natural or quiet period is required. E.g. religious, health care and hospitality facilities (game lodges).
Significance	**8 - 24 (low)** – for all NSD's. Refer to **Appendix D.2.**
Status	Negative.
Reversibility	Not relevant.
Comments	Mitigation during the night-time operations is recommended. Refer to **Section 10** for mitigation options for further consideration.
Can impacts be mitigated?	Not relevant.

Based on the preceding data it is obvious that the risk of a noise impact developing during the night-time operational hours is of a low significance. Mitigation measures are supplied in **Section 10** for further consideration.

9 ENVIRONMENTAL MANAGEMENT PLAN

Commercial railway line activities are exempted from certain requirements of Government Notice R154 of 1992 (Noise Control Regulations) – Regulation 2.(c) - *"Provided that the provisions of this paragraph* (in reference to noise emanating from a development) *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"*. Furthermore the locomotive horns is exempted from the 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".* As such mitigation options are supplied for the Transnet's consideration only, with no Environmental Management Programme supplied due to the clause above.

9.1 OPERATIONAL PHASE

The following objectives and targets are recommended to define the performance of the development, this is not mandatory (due to exemption from above clause).

Objective	**Control potential noise pollution stemming from the operation of the development**
Project Component(s)	Development operations.
Potential Impact	• Increased noise levels (disturbing noise) at potentially sensitive receptors; • Changing ambient sound levels could change the acceptable land use capability; • Changing ambient sound levels could increase annoyance and potential complaints; • Disturbing character of sound.
Activity/Risk source	• Numerous simultaneous operational activities
Mitigation Target/Objective	• Ensure equivalent A-weighted noise levels below 55 dBA at potentially noise-sensitive receptors (daytime). • Ensure equivalent A-weighted noise levels below 45 dBA at potentially noise-sensitive receptors (night-time). • Define industrial boundaries as set out by municipality industrial zoning. Ensuring that equivalent A-weighted noise levels at this boundary does not exceed 61 dBA (over a 24 hour period); • Ensure that maximum noise events at potentially noise-sensitive receptors are less than 55 dBA eight times per night (RMS value); • Ensure that the change in Rating Level as experienced by Potentially Sensitive Receptors is less than 7 dBA; • Ensuring compliance with the National Noise Control Regulations and SANS10103:2008 guidelines. The referencing of the International Finance Corporation (World Bank) guidelines for an acceptable sound level in a residential area was also considered.

10 MITIGATION OPTIONS

With a risk of a noise impact developing during the night-time hours of low significance, mitigation options are recommended to be evaluated by the Transnet to ensure a low rating. The Rating Level for the area must consider the land use as proclaimed by local authorities, as well as acoustical legislation and guidelines. With the local authority demarcating the project footprint as industrial (see **Section 2.2.1**), the corresponding Rating Level as per GN R154 and SANS10103:2008 would likely be high (industrial rating level). This may not be relevant with the surrounding properties in relation to the project, however such situations could pose problems when a receptor/dwelling or community is based adjacent/ bordering or within close approximation to industrial land zoning.

The mitigation of noise from railway lines is difficult and potentially expensive to implement. Mitigation discussed below is optional and not mandatory for Transnet due to the exemptions from regulations. Mitigation options should also be considered near potential sensitive areas such as places of worship (religious), at educational and health care facilities and at business that cater for hospitality (game lodges).

10.1 MITIGATION OPTIONS: MITIGATION OF NOISE SOURCE – RAILWAY LINE

Possibly the best mitigation options when considering acoustics is the design and specifications of railway lines and operations. These include:

- Continuous welded rails and ballast is indicated to be implemented by Transnet which will result in a noise reduction factor. Cracked, corrugated or damaged rails should be mended or replace immediately to reduce noise and vibrations;
- Transnet can consider the implementation of composite material with added rubber (or similar) brake shoes ("K or LL Blocks") as cast-iron brakes cause wheel roughness (and more friction and noise). These wheel dampers will produce the lowest peak noise levels, but may not prevent tyre squeal fully[52]. The LL brake block system has the potential to reduce rolling and braking noise the most over cast iron brakes as well as K blocks. LL block systems does not require the adaption of cast-iron brake systems and also damage the train wheels far less than a conventional cast-iron brake[53]. Note that it has been indicated Transnet (during meetings) that cast-iron brake shoes have been phased out, and that composite brakes are just as loud as cast-iron;

[52] E.H.W Jansen, M.G Ditrrich and E.L Sima. TNO Science and Industry, Brake noise measurements on mixed freight trains with composite brakes, 2008
[53] UIC SET 01, Usage guidelines for composite (LL) brake blocks, 10th edition, 2013.

- Transnet should consider ensuring that rail head grinding and rail head maintenance is conducted regularly to ensure that the correct rail head profile is maintained and the elimination of corrugated rails. Defect or wheels with flat spots must be mended or replace to minimise wheel interaction sounds;
- Transnet could consider rail dampers on the rail line or wheels and at sections of rail near receptors dwellings. Sharp curves could be lubricated to reduce break squeal;
- Transnet can consider berms and barriers in order to screen the railway line operations to receptors dwellings. From a technical perspective it would seem easiest to consider a berm or single/double brick wall. A less feasible option (from a technical perspective) is to design the railway balloon and railway line to be at a lower elevation than a receptors dwelling (sufficient height difference to obscure line of sight). Advancement in barriers designed specifically for sound insulation has improved drastically over the years. Although a more expensive option than single/double brick/concrete wall or an aggregate berm, acoustic barriers are specifically designed as a buffer for noises. Such barriers could be implemented along the railway line where there is a potential for a high noise impact or at sensitive areas. Examples of barriers designed specifically for acoustics is illustrated below in **Figure 10-1** with examples of national and international suppliers supplied in the footer and reference section of this document[54].

[54] Acoustical Barriers: http://eng.clima.org.cn/Machine/Nosie-Barrier-Wall/Nosie-barrier-wall.html, www.isover.co.za and http://www.heringinternational.com/en/products-services/noise-protection-4859.htm

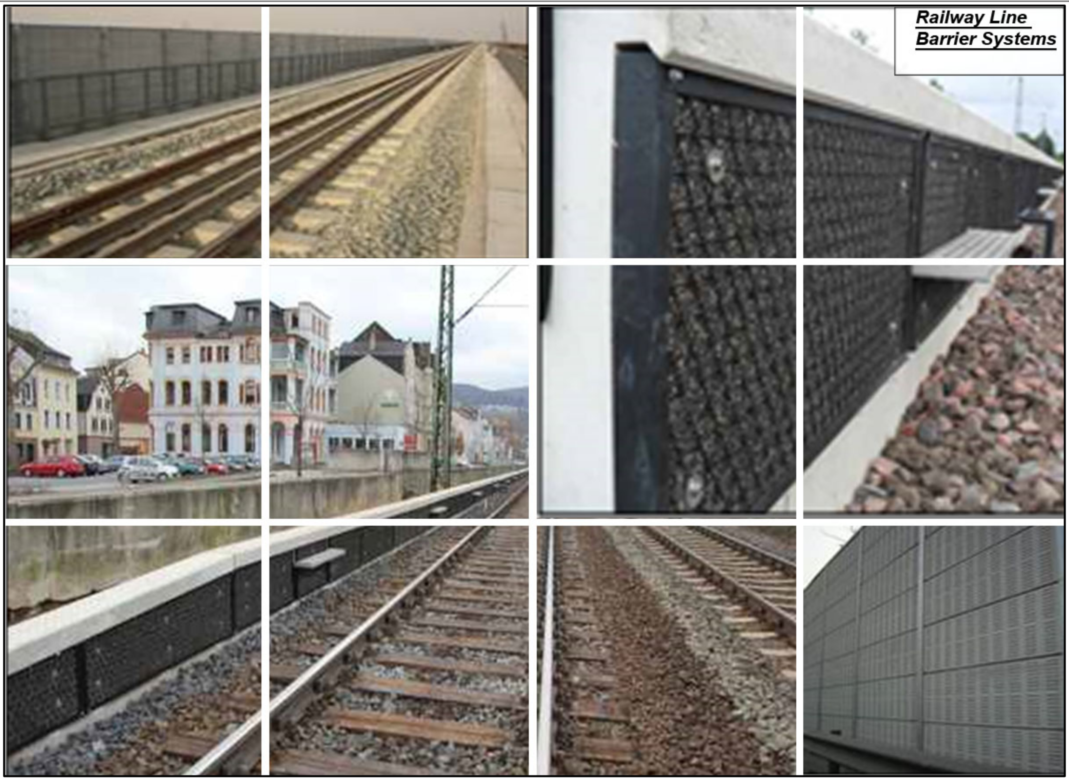

Figure 10-1: Acoustical Barriers

- The following factors/specifications should be considered when implementing as berm as an acoustical screen:
  - It is recommended that the barrier be built as close as feasibly possible to the railway line or receptor;
  - 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 the railway line, although the higher the berm/barrier the better acoustical screen tool it will be[55]. Certain locomotives 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) [56] and sufficient in thickness. A brick wall provides a surface density of 244 kg/m^2 at thickness of 150 mm[57] 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 the railway line 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[58];

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

- The barrier should be sufficiently long to block the line of sight from receptors to the sides of the development; and
- No apertures (gaps, entrances) should be implemented at berms and facing a receptors dwelling.

10.2 MITIGATION OPTIONS: MITIGATION AT RECEPTORS

Mitigation options at receptors would likely only be management mitigation options, as listed below.

10.3 MITIGATION OPTIONS: MANAGEMENT MITIGATION

Public relations are important throughout the entire planning, construction and development of the project. Transnet could consider the following:

- Good public relations are essential, and at all stages surrounding receptors should be educated with respect to the potential sounds that could be generated by the railway activity. The information presented to stakeholders should be factual and should not set unrealistic expectations. It is counterproductive to suggest that the mining operation will be inaudible, or to use vague terms like "quiet";
- Community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. The Port Expansion could offer a benefit to the community and local economy. A positive community attitude throughout the greater area should be fostered, particularly with those residents near the Port operation, to ensure they do not feel taken advantage of;
- Transnet must implement a line of communication where complaints could be lodged/registered. All potentially sensitive receptors should be made aware of this line of communication. Transnet should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop. For example, sudden and sharp increases in sound levels could result from mechanical malfunctions, changes in operators, equipment and even operating protocols. Problems of this nature can be corrected quickly, and it may be in the mine's interest to do so; and
- Religious, health, educational buildings, nature reserves and hospitality facilities – Transnet could consider identifying these facilities near the mine and co-ordinating any operational times that may be sensitive to these receptors.

11 CONCLUSIONS

The resulting future noise projections indicated that the operations of the project as modelled for representation would comply with the Noise Control Regulations (GN R154), SANS 10103:2008 guideline and International Finance Corporation. Subsequently a low significance for a noise impact to occur during operations is identified. There is always the likelihood that a degree of over-engineering or precautionary principals are adhered to in environmental assessments. However there is a high confidence level in the consecutive calculated Rating Level and assessment. It should be noted, while a low significance of a noise impact was identified, it is definite that the train operations will be audible during quiet times. This may cause a noise annoyance and people may complain about these sounds at times.

The Noise Rating Level for the area must consider the land use as proclaimed by local authorities, as well as acoustical legislation and guidelines. With the local authority demarcating the project footprint as industrial, the corresponding Rating Level as per GN R154 and SANS10103:2008 would likely be high (industrial rating level). This may not be relevant with the surrounding properties in relation to the project, however such situations could pose problems when a receptor/dwelling or community is based adjacent/ bordering or within close approximation to industrial land zoning.

With a risk of a noise impact developing during the night-time hours of low significance, mitigation options are included to be evaluated by Transnet. As such mitigation options are supplied for Transnet consideration only, with no Environmental Management Programme supplied.

Commercial railway line activities are also exempted from certain requirements of Government Notice R154 of 1992 (Noise Control Regulations) – Regulation 2.(c) - *"Provided that the provisions of this paragraph* (in reference to noise emanating from a development) *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"*. Furthermore the locomotive horns is exempted from the 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".*

Due to economic advantages, railway systems do provide valuable employment, local taxes and foreign currency. It must be noted when Railway projects are near to potential noise-sensitive receptors, consideration must be given to ensuring a compatible co-existence. It should be noted that this does not suggest that the sound from the development should not be inaudible under all circumstances - this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source, but rather that the sound due to the railway activities should be at a reasonable level in relation to the ambient sound levels as per regulations.

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

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

12 THE AUTHOR

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

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

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

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

Road and Railway	*K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane), Swaziland Rail Link – Assessment of 4 Schools in Swaziland (Aurecon), Extension of Atterbury Road, City of Tshwane (Bokomoso)*
Airport	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping*
Noise monitoring	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional, Sephaku Delmas (AGES), Amakhala Emoyeni WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF (Cennergi and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon), Unica Iron and Steels's Babelgi Plant Operations (Unica), Sephaku Cement Aganang Quarterly Monitoring Report (Exigo), Sephaku Cement Delmas Quarterly Monitoring Report (Exigo)*
Small Noise Impact Assessment s	*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)*

The author and co-author are independent consultants to the project, the Transnet as well as the main consultant. They,

- does not and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations;
- have and will not have no vested interest in the activity proceeding;

- have no and will not engage in conflicting interests in the undertaking of the activity;
- undertake to disclose all material information collected, calculated and/or findings, whether favourable to the mine or not; and
- will ensure that all information containing all relevant facts be included in this report.

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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 (LAeq,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 (LReq,T)	The Equivalent continuous A-weighted sound exposure level (LAeq,T) to which various adjustments has been added. More commonly used as (LReq,d) over a time interval 06:00 – 22:00 (T=16 hours) and (LReq,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).
LAMin and LAMax	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) rural districts, suburban districts with little road traffic, urban districts, urban districts with some workshops, with business premises, and with main roads, central business districts, and industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Overburden	In mining and in archaeology, overburden (also called waste or spoil) is the material that lies above an area of economic or scientific interest. In mining, it is most commonly the rock, soil, and ecosystem that lies above a coal seam or ore body
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Rail head	The bulbous part at the top of the rail.
Rolling Stock	Rolling stock comprises all the vehicles that move on a railway. It usually includes both powered and unpowered vehicles, for example locomotives, railroad cars, coaches, and wagons.
ROM	The coal delivered from the mine that reports to the coal preparation plant is called run-of-mine, or ROM, coal. This is the raw material for the CPP, and consists of coal, rocks, middlings, minerals and contamination

Shunting	Shunting, in railway operations, is the process of sorting items of rolling stock into complete train sets.
Railway Sidings	A siding, in rail terminology, is a low-speed track section distinct from a running line or through route such as a main line or branch line or spur. It may connect to through track or to other sidings at either end.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as Lp 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

Photo B.1: Measurement location RP01

Photo B.2: Measurement location RP02

Annexure B: Site Investigation Photos

APPENDIX C

Potential Noise-Sensitive Developments and Measurement Locations

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

Noise-sensitive development	Location latitude	Location longitude
1	-28.788637°	32.080786°
2	-28.791983°	32.081494°
3	-28.793341°	32.080678°

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

Point name	Location latitude	Location longitude
RP01	-28.789177°	32.080719°
RP02	-28.790809°	32.080997°
RP03	-28.790354°	32.080109°

APPENDIX D

Impact Assessment

Table D.1: Modelling results and assessment - day operational – peak hours

Noise-sensitive development	Measured Ambient Sound Level ($L_{Aeq,16\ h}$)	Calculated Continuous Rating Level + 5 dB Tone correction ($L_{Req,1\ h}$)	Change from measured Ambient Sound Level (dB)*	Above Equator Principle IFC guideline 55 dB*	Any point at a receptor where 24 hr. measured value exceeds 61 dBA for an Industrial zoned or controlled area*
1	40.8	45.9	5.1	0	No
2	40.8	40.0	0	0	No
3	40.8	40.0	0	0	No
Defining Significance of Noise Impact (See Section 5)					
Noise-sensitive development	Magnitude	Duration	Scale	Probability	Significance
1	6	4	2	1	12
2	2	4	2	1	8
3	2	4	2	1	8

***+ 5 dB Tone correction implemented due to brake squeal from train.**

Table D.2: Modelling results and assessment - night operational – peak hours

Noise-sensitive development	Measured Ambient Sound Level ($L_{Aeq,8\ h}$)	Calculated Continuous Rating Level + 5 dB Tone correction ($L_{Req,1\ h}$)	Change from measured Ambient Sound Level + 5 dB Tone correction (dB) *	Above Equator Principle IFC guideline + 5 dB Tone correction – 45 dB*	Any point at a receptor where 24 hr. measured value exceeds 61 dBA for an Industrial zoned or controlled area*
1	40.8	47.0	6.2	2.0	No
2	40.8	41.1	0.3	0	No
3	40.8	41.1	0.3	0	No
Defining Significance of Noise Impact (See Section 5)					
Noise-sensitive development	Magnitude	Duration	Scale	Probability	Significance
1	6	4	2	2	24
2	2	4	2	1	8
3	2	4	2	1	8

***+ 5 dB Tone correction implemented due to brake squeal from train.**

APPENDIX E

Project Layout and Capacity

Figure E.1: Project layout

End or Report

Annexure E: Project Layout and Capacity

Table 20-11: Potential and Enabled capacity data - Work Packages and Sequencing

SECTION: Davel to Phuzumoya

Work Package Number	Work Execution Sequence	Project Capability Enabled	Daily Train Slots	Axle Load	Max. Number Wagons	Tonnage (Mtpa): Enabled Practical[1]	Tonnage (Mtpa): Potential[2]	Tonnage (Mtpa): Aspirational Potential[2]	Tonnage (Mtpa): % Enabled[4]
1, 3B	1	Through traffic from Mpumalanga/ Coal Line to Nsese/ Beluluane	6	18.5	50	5.4	5.4	45.2	12%
5	2	Increase slot capacity to Nsese	6	18.5	50	5.4	5.4	45.2	12%
4	3	Increase train slot capacity and axle loads on Breyten to Phuzumoya section	8	20	50	8.1	8.1	45.2	18%
6, 2A, 3A	4	Longer and heavier trains from Davel to Nsese via direct connection to Link Line	8	26	100 /80	20.2	22.6	45.2	50%
2B	5	Consolidation/ distribution of 160/200 wagon trains to/ from Nsese	8	26	200 /160	40.3	45.2	45.2	100%
7, PHASE 2	6	Running of 160/200 wagon trains at 20/26 t/a to Beluluane	16	26	200 /160	80.6	90.3	90.3	100%

SECTION: Phuzumoya to Nsese

Work Package Number	Work Execution Sequence	Daily Train Slots	Axle Load	Max. Number Wagons	Tonnage (Mtpa): Enabled Practical[1]	Tonnage (Mtpa): Existing (Approx.)[3]	Tonnage (Mtpa): Potential[2]	Tonnage (Mtpa): Aspirational Potential[2]	Tonnage (Mtpa): % Enabled[4]
1, 3B	1	12	20	50	4.3	5.5	12.1	90.3	13%
5	2	16	20	50	5.4	5.5	16.1	90.3	18%
4	3	16	20	50	8.1	5.5	16.1	90.3	18%
6, 2A, 3A	4	16	26	200 /160	20.2	5.5	90.3	90.3	100%
2B	5	16	26	200 /160	40.3	5.5	90.3	90.3	100%
7, PHASE 2	6	16	26	200 /160	40.3	5.5	90.3	90.3	100%

SECTION: Phuzumoya to Beluluane

Work Package Number	Work Execution Sequence	Daily Train Slots	Axle Load	Max. Number Wagons	Tonnage (Mtpa): Enabled Practical[1]	Tonnage (Mtpa): Existing (Approx.)[3]	Tonnage (Mtpa): Potential[2]	Tonnage (Mtpa): Aspirational Potential[2]	Tonnage (Mtpa): % Enabled[4]
1, 3B	1	5	20	50	1.1	1.3	5.0	28.2	18%
5	2	5	20	50	0.0	1.3	5.0	28.2	18%
4	3	5	20	50	0.0	1.3	5.0	28.2	18%
6, 2A, 3A	4	5	20	50	0.0	1.3	5.0	28.2	18%
2B	5	5	20	50	0.0	1.3	5.0	28.2	18%
7, PHASE 2	6	5	26	200 /160	25.2	1.3	28.2	28.2	100%

Table E.2: Project capacity