LIMPOPO ECONOMIC DEVELOPMENT AGENCY

REPORT NO: GC/EAR/2019-04

NOISE IMPACT ASSESSMENT FOR THE PROPOSED MUSINA-MAKHADO SPECIAL ECONOMIC ZONE (SEZ) DEVELOPMENT WITHIN THE VHEMBE DISTRICT MUNICIPALITY, LIMPOPO PROVINCE

PREPARED BY

gudaniconsulting
ENVIRONMENTAL & SOCIAL SCIENTISTS

P.O. Box 714 Faunapark,
Polokwane, 0787
37A Voortrekker Street,
Polokwane, 0699
Tel: 015 – 291 3620 / 5669
Fax: 015 – 291 4932 / 086 235 9820
setenane@gudaniconsulting.co.za
www.gudaniconsulting.co.za

EAR Enviro Acoustic Research

P.O. Box 2047, Garsfontein East, 0060
Tel: 012 004 0362 | Fax: 086 621 0292
Email: info@eares.co.za

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LEDA
LIMPOPO ECONOMIC DEVELOPMENT AGENCY
AN AGENCY OF THE LIMPOPO PROVINCIAL GOVERNMENT REPUBLIC OF SOUTH AFRICA

ROOTED IN THE FUTURE

Authors: Setenane Nkopane, Morné de Jager

Status of Report: FINAL

Consultants:
Approved for Consultants:

…………………………………………
Setenane Nkopane
Gudani Consulting - Project Lead

Client:

Approved for Limpopo Economic Development Agency(LEDA)

……………………………………………………………..
Ronaldo Retief (012 - 368 1850)
Lead Consultant (DELTA BEC)

EXECUTIVE SUMMARY

INTRODUCTION

Gudani Consulting and Enviro-Acoustic Research cc (GC/EARES) have undertaken the study to determine the potential noise impact on the surrounding environment due to the development of the proposed Musina-Makhado Energy and Metallurgy Special Economic Zone (SEZ) under the auspices of Limpopo Economic Development Agency (LEDA).

The proposed Musina-Makhado SEZ is located across the Musina and Makhado Local Municipalities which fall under the Vhembe District Municipality in the Limpopo Province. The nearest towns are Makhado (located 31 km south) and Musina (located 36 km north) of the proposed SEZ site.

PROJECT DESCRIPTION

The Musina-Makhado SEZ will comprise an offering of mixed land uses and infrastructure provision to ensure the optimal manufacturing operations in the energy and metallurgical complex. It is envisaged that the energy and metallurgical complex shall comprise the manufacturing plants:

PROJECTS	AREA (ha)	WATER (million m^3)	TYPICAL ILLUSTRATION OF AN ENERGY AND METALLURGICAL SEZ
Power Plant	300	39	
Coke Plant	500	11	
Ferrochromium Plant	500	30	
Ferromanganese Plant	100	10	
Pig Iron Plant	600	12	
Carbon steel plant	200	2	
Stainless steel plant	500	8	
Lime plant	500	5	
Silicon-manganese plant	100	0.5	
Metal silicon plant	50	0.3	
Calcium carbide plant	50	0.3	
Infrastructure	2600	5	
Total	**6000**	**123**	

Ancillary uses to complement and support the energy and metallurgical complex include:

- Light industrial activities and developments (various service industries, steel product industries, workshops and yards, building materials factory, light industrial plants, packaging materials factory, warehouses);
- Intermodal facilities (transport terminus, diesel fuel station, mechanical repair plant, automobile logistics centre);
- Retail (shopping centre, farmers market, supermarket/neighbourhood centre, commercial banks);
- Business uses (administration buildings and offices, hotels);
- Staff facilities (hospital, government uses, library, crèche, religious facilities, community facilities, recreational areas); &
- Telecommunication masts.

BASELINE ASSESSMENT

Ambient (background) sound levels were measured during the day and night of 7 March 2019, augmented with the results of longer-term ambient sound level measurements collected during previous site visits. Measurements were sufficient to characterise the ambient sound level character and, together with measurements done in the area for other projects there is a very high confidence in the typical rating level determined for the area.

Considering the ambient sound levels measured onsite as well as the developmental character of the area, the acceptable zone rating level would be typical of a **rural area** (35 dBA at night and 45 dBA during the day) as defined in SANS 10103:2008 for most of the area.

Rating levels will be higher in an area up to 500m from the N1, mainly due to traffic noises from the national road. This will be relevant to NSDs 03 and 14, located very close to the N1 road. Night-time ambient sound levels may also be higher at NSD02.

Similarly will the rating levels be higher in the town of Mopane, due to the activities of the existing Syferfontein Dolomite quarry.

NOISE IMPACT DETERMINATION AND FINDINGS

No specific layout or activities were available at this planning phase of the project and conceptual scenarios were developed to assist in the identification of potential noise impacts. The conceptual scenarios used the output from a basic sound propagation model (based on geometric spreading of sound waves only) to calculate the potential extent of noise levels. These conceptual scenarios highlighted the potential of a noise impact of high significance on all NSD for an unmitigated situation.

RECOMMENDATIONS (MANAGEMENT AND MITIGATION)

However, these potential noise impacts can be managed to reduce the potential impact to a low significance. The main mitigation recommended that:

i. Future land uses in the SEZ must be planned to ensure that the noise-generating activities does not impact on potential noise-sensitive land uses with certain noise limits as defined in Table 1 of SANS 10103:2008. This include:
    a. Locating the industrial areas as far as possible from existing NSD (if not relocated) and areas that may be used in the future for potential noise-sensitive activities;
    b. The placement of light industrial areas between commercial / retail areas and heavy industrial areas. The commercial / retail areas to be planned as buffer between industrial areas and potential noise-sensitive areas (NSD);
    c. Using available space to ensure a buffer of at least 500m between industrial activities and potential NSDs, though a buffer of at least 1,000m is recommended.

ii. Should a heavy industry (with cooling/exhaust/intake/induced draft fans or exhaust stacks higher than 20m) be developed within 2,000m from an NSD, or an area that may in the future be used for residential purposes, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact for the specific development.

iii. Should an industry be planned or proposed within 1,000m from a NSD, or an area that may in the future be used for residential purposes, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact for the specific development.

iv. Should a NSD be planned within 500m from the N1 or similar busy road, or a new road are proposed within 200m from an NSD, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact.

It is the opinion of the Author that the increase in noise levels does not constitute a fatal flaw, as the increases can be managed to a low significance. It is therefore the recommendation that the development of the SEZ be authorized (from a noise impact perspective).

CONTENTS OF THE SPECIALIST REPORT – CHECKLIST

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6 (as amended 2017)		Relevant Section in Specialist study
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of-	
	(i) the specialist who prepared the report; and	Section 1
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Section 1
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 2 *(also separate document to this report)*
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 3.1
(cA)	an indication of the quality and age of base data used for the specialist report;	Section 5.1 and 5.2
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 3.3, 5.2 and 6.3
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 5.1 and 5.2
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 3.7
(f)	details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Sections 5.2 and 6.3
(g)	an identification of any areas to be avoided, including buffers;	Figure 9-2
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figure 9-2
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 8
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Sections 9 and 10

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6 (as amended 2017)		Relevant Section in Specialist study
(k)	any mitigation measures for inclusion in the EMPr;	Sections 11.3
(l)	any conditions for inclusion in the environmental authorisation;	Sections 11.3
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Not required for this project.
(n)	a reasoned opinion -	Section 12
	whether the proposed activity, activities or portions thereof should be authorised;	Section 12
	regarding the acceptability of the proposed activity or activities; and	Section 12
	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Sections 11.3
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	See Section 3.5
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	See Section 3.5
(q)	any other information requested by the competent authority.	None

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GLOSSARY OF ABBREVIATIONS

ADT	Articulated Dump Trucks
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
EARES	Enviro Acoustic Research cc
ECA	Environment Conservation Act
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
ENIA	Environmental Noise Impact Assessment
ENM	Environmental Noise Monitoring
ENPAT	Environmental Potential Atlas for South Africa
EPs	Equator Principles
EPFIs	Equator Principles Financial Institutions
FEL	Front-end Loader
GN	Government Notice
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Organization for Standardization
METI	Ministry of Economy, Trade, and Industry
NASA	National Aeronautical and Space Administration
NCR	Noise Control Regulations
NSD	Noise-sensitive Development
PWL	Sound Power Level
SABS	South African Bureau of Standards
SANS	South African National Standards
SPL	Sound Power Level
TPA	Tonnes per annum
UTM	Universal Transverse Mercator
WHO	World Health Organization

GLOSSARY OF UNITS

dB	Decibel (expression of the relative loudness of the un-weighted sound level in air)
dBA	Decibel (expression of the relative loudness of the A-weighted sound level in air)
Hz	Hertz (measurement of frequency)
kg/m^2	Surface density (measurement of surface density)
km	kilometre (measurement of distance)
m	Meter (measurement of distance)
m^2	Square meter (measurement of area)
m^3	Cubic meter (measurement of volume)
mamsl	Meters above mean sea level
m/s	Meter per second (measurement for velocity)
^oC	Degrees Celsius (measurement of temperature)
μPa	Micro pascal (measurement of pressure – in air in this document)

1 THE AUTHOR

The Author started his career in the mining industry as a bursar Learner Official (JCI, Randfontein), working in the mining industry, doing various mining related courses (Rock Mechanics, Surveying, Sampling, Safety and Health [Ventilation, noise, illumination etc.] and Metallurgy. He did work in both underground (Coal, Gold and Platinum) as well as opencast (Coal) for 4 years. He changed course from Mining Engineering to Chemical Engineering after his second year of his studies at the University of Pretoria.

After graduation he worked as a Water Pollution Control Officer at the Department of Water Affairs and Forestry for two years (first year seconded from Wates, Meiring and Barnard), where duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents (such as EMPR's, Water Licence Applications and EIA's), auditing of licence conditions as well as the compilation of Technical Documents.

Since leaving the Department of Water Affairs, Morné has been in private consulting for the last 15 years, managing various projects for the mining and industrial sector, private developers, business, other environmental consulting firms as well as the Department of Water Affairs. During that period he has been involved in various projects, either as specialist, consultant, trainer or project manager, successfully completing these projects within budget and timeframe. During that period he gradually moved towards environmental acoustics, focusing on this field exclusively since 2007.

He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. He has been doing work in this field for the past 8 years, and was involved with the following projects in the last few years:

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), AmakhalaEmoyeni (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), EvrazVametco 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), Stuart Coal – Weltevreden (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)
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)*
Airport	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping*
Noise monitoring	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), DoxaDeo (DoxaDeo), Harties Dredging (Rand Water), Xstrata Coal - Witbank Regional, SephakuDelmas (AGES), AmakhalaEmoyeni 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)*
Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (NomanShaikh), 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), SafikaLadium (AGES), Safika Cement Isando (AGES), Natref (NEMAI), RareCo (SE), Struisbaai WEF (SE)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma (Cennergi), AmakhalaEmoyeni (Windlab), Spreeukloof (Savannah), Spinning Head (Savannah), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy)*

2 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent specialist in this application
- I will perform the specialist work in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental noise impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2014, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014.

____________________________ **Gudani/Enviro-Acoustic Research**

Signature of the environmental practitioner: Name of company:

2019 – 05 - 20

Date:

3 INTRODUCTION

3.1 INTRODUCTION AND PURPOSE

Gudani Consulting and Enviro-Acoustic Research cc (GC/EARES) have undertaken the study to determine the potential noise impact on the surrounding environment due to the development of the proposed Musina-Makhado Energy and Metallurgy Special Economic Zone (SEZ) under the auspices of Limpopo Economic Development Agency (LEDA).

This report describes ambient sound levels in the area, potential noise rating levels and the potential noise impact that the development of the SEZ may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. It should be noted that specific information is not available, and this assessment is a high level document to assist in the identification of potential concerns with recommendations.

3.2 BRIEF PROJECT DESCRIPTION

The proposed Musina-Makhado SEZ is located across the Musina and Makhado Local Municipalities which fall under the Vhembe District Municipality in the Limpopo Province. The nearest towns are Makhado (located 31 km south) and Musina (located 36 km north) of the proposed SEZ site (see also **Figure 3-1**).

The Musina-Makhado SEZ will comprise an offering of mixed land uses and infrastructure provision to ensure the optimal manufacturing operations in the energy and metallurgical complex. It is envisaged that the energy and metallurgical complex shall comprise a number of main land uses as well as ancillary uses.

The main land uses include a number of different heavy industrial manufacturing plants, as well as roads, waste management, substations, water treatment works, bulk water supply, water reservoirs and water distribution systems.

Ancillary uses to complement and support the energy and metallurgical complex include:

- Light industrial activities and developments (various service industries, steel product industries, workshops and yards, building materials factory, light industrial plants, packaging materials factory, warehouses);
- Intermodal facilities (transport terminus, diesel fuel station, mechanical repair plant, automobile logistics centre);
- Retail (shopping centre, farmers market, supermarket/neighbourhood centre, commercial banks);
- Business uses (administration buildings and offices, hotels);
- Staff facilities (hospital, government uses, library, crèche, religious facilities, community facilities, recreational areas); &

- Telecommunication masts.

The latest development plan indicates the following proposed operations, like:

- Coal washery;
- Coking Plan;
- Heat recovery power generation;
- Thermal power plant;
- Ferrochrome Plant;
- Ferromanganese Plant;
- Silicomanganese Plant;
- Vanadium – titanium magnetite project;
- High Manganese steel;
- High - vanadium steel;
- Stainless steel Plant;
- Lime Plant;
- Cement Plant;
- Refractories Factory;
- Sewage Treatment Plant;
- Industrial domestic water Plant;
- Light Industrial Processing Zone;
- Machining Zone;
- Commercial residential area;
- Living area;
- Administrative Centre;
- Bonded area; and
- logistics Centre.

3.3 STUDY AREA

The proposed project is located approximately 40 km south-west of Musina, lying north of Makhado (Louis Trichardt). The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

3.3.1 Topography

ENPAT (1998) describes the topography as Extremely Irregular Plains. There are no local topographical features that will limit the propagation of noises.

3.3.2 Surrounding Land Use

The area in the vicinity of the proposed development is currently classified as Vacant or Unspecified. Previous site visits revealed that the area is mainly wilderness with game ranches forming a large part of the agricultural activities (game and cattle farming). Some of the farms focus on the tourism and hunting industry.

3.3.3 Roads

The focus area is roughly enclosed by the N1 Musina - Makhado, the D1021 on the south, the Musina – Makhado Railway Line and the D744 road (running parallel to the railway line) to the west and the R525 to the north. The railway line is aligned in a north-south direction and reported to carry 4 trains per day.

3.3.4 Residential areas

The small town of Mopane is located to the north-west on the border of the focus area.

3.3.5 Other industrial and commercial processes

The Syferfontein Dolomite operates a quarry just south of Mopane, north-west of the focus area. The site visit indicated that this quarry operates also at night.

3.3.6 Ground conditions and vegetation

The area falls within the Savannah biome with the vegetation types being Limpopo Ridge Bushveld and Musina Mopane Bushveld. The natural veldt has been significantly disturbed in areas due to agriculture and game farming. The ground surface is generally covered with grasses, shrubs and trees. It is the opinion of the author that the ground surface is sufficiently covered to assume 50% soft ground conditions for modelling purposes. It should be noted that this factor is only relevant for sound waves being reflected from the ground surface, with certain frequencies slightly absorbed by the vegetation.

3.3.7 Existing Ambient Sound Levels

Onsite measurements were collected on 7 March 2019 with the resulting sound levels discussed in more detail in **Section 5**. The data was augmented with longer-term measurements collected in the area during previous site visits.

The soundscape is complex, with elevated sound levels around the Syferfontein Dolomite activity as well as close to the N1 national road. Excluding the activities mentioned above, most of the site is undeveloped with the ambient sound levels more typical of a rural noise district with natural sound (wind and faunal) being the dominant source of noise. Sound levels will be briefly elevated along the gravel roads in the area during the passing of vehicles.

3.4 POTENTIAL NOISE-SENSITIVE RECEPTORS (DEVELOPMENTS) AND NO-GO AREAS

Potentially noise-sensitive developments (NSDs), located within or close to the focus area was identified using Google Earth®. The identified NSDs are depicted in **Figure 3-2**. See also the definition of an NSD in Appendix A.

3.5 COMMENTS REGARDING NOISE RECEIVED DURING THIS PROJECT

No comments concerning noise were raised during the compilation of this report.

3.6 AVAILABLE INFORMATION

The Author has completed Environmental Noise Impact Assessments for the following projects in the area:

- Development of the proposed Greater Soutpansberg Mopane Project, Limpopo;
- Development of the proposed Generaal and Mount Stuart Collieries, Limpopo;
- Development of the proposed Chapudi, Chapudi West and Wildebeesthoek Collieries, Limpopo; &
- Development for the proposed Mutsho Power Project North of Makhado, Limpopo Province.

Figure 3-1: Locality map indicating the location of the proposed SEZ area

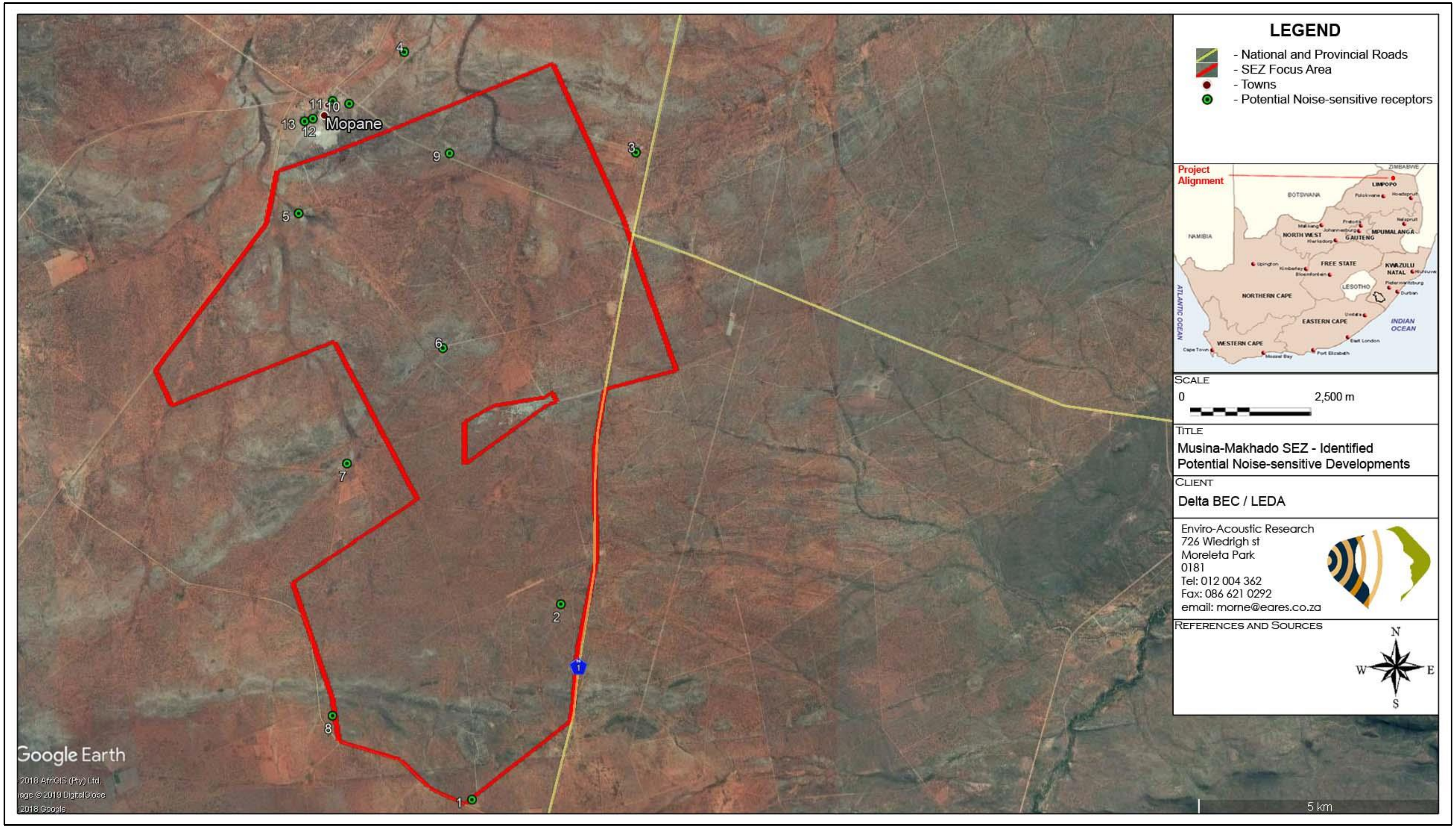

Figure 3-2: Aerial image indicating potentially noise-sensitive receptors close to SEZ Focus Area

3.7 TERMS OF REFERENCE

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

- If a noise-sensitive development is to be established within 500 m (or, in the case of a busy throughway, 1 000 m) of a road or railway line (SANS 10328:2008 [5.4 (d)]) *or visa-versa*;
- If a noise sensitive development is to be established within 1,000 m from a an industry (SANS 10328:2008 [5.4 (g)]) *or visa-versa*;
- If an industry is to be established within 1,000 m from a potential noise sensitive development (SANS 10328:2008 [5.4 (h)]) *or visa-versa*;
- If a wind farm (wind turbines - SANS 10328:2008 [5.4 (i)]) or a source of low-frequency noise (such as large cooling fans - SANS 10328:2008 [5.4 (l)]) is to be established within 2,000 m from a potential noise sensitive development *or visa-versa*;
- It is a controlled activity in terms of the NEMA regulations and an ENIA is required, because:
    - It may cause a disturbing noise that is prohibited in terms of section 18(1) of the Government Notice 579 of 2010;
- It is generally required by the local or district authority as part of the environmental authorization or planning approval in terms of Regulation 2(d) of GN R154 of 1992; &
- If noise is raised as a potential concern by interested and affected parties during the Environmental Impact Assessment (EIA) process.

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

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

This standard specifies the methodology to assess the potential noise impacts on the environment due to a proposed activity that might impact on the environment. This standard also stipulates the minimum requirements to be investigated, including:

1. The purpose of the investigation;
2. A brief description of the planned development or the changes that are being considered;
3. A brief description of the existing environment;

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

4 LEGAL CONTEXT, POLICIES AND GUIDELINES

4.1 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 under the particular circumstances. The subjectivity of this approach can be problematic, which has led to the development of noise standards (see **Section 4.3**).

"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.

4.2 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 Environmental Affairs") to make regulations regarding noise, among other concerns. See also **section 4.2.1**.

4.2.1 Noise Control Regulations (GN R154 of 1992)

In terms of section 25 of the ECA, the national Noise Control Regulations (NCRs) (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 exist in the Free State, Gauteng and Western Cape provinces but not in Limpopo and the National Regulations will be in effect.

The National Noise Control Regulations (GN R154 1992) defines:

"**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".

4.3 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 10328:2008. 'Methods for environmental noise impact assessments'.

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*.

4.4 INTERNATIONAL GUIDELINES

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

4.4.1 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.

Guidance on the health effects of noise exposure of the population has already been given in an early publication of the series of Environmental Health Criteria. The health risk to humans from exposure to environmental noise was evaluated and guidelines values derived. The issue of noise control and health protection was briefly addressed.

The document uses the L_{Aeq} and $L_{A,max}$ noise descriptors to define noise levels. It should be noted that a follow-up document focusing on Night-time Noise Guidelines for Europe (WHO, 2009).

4.4.2 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 30dB inside at night (which equals 45-50dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40dB to avoid sleep disturbance and its related health effects. The report notes that only below 30dB (outside annual average) are "*no significant biological effects observed*," and that between 30 and 40dB, 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 40dB, "*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".

4.4.3 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 and the social policies of the International Finance Corporation (IFC). 67 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.

4.4.4 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 a project facility or 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 propose 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 causing 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; &
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 4-1**) 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 4-1: IFC Table 7.1-Noise Level Guidelines

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

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

5 CURRENT ENVIRONMENTAL SOUND CHARACTER

5.1 EFFECT OF SEASON ON SOUND LEVELS

Natural sounds are a part of the environmental noise surrounding humans. In rural areas the sounds from insects and birds would dominate the ambient sound character, with noises such as wind flowing through vegetation increasing as wind speed increase. Work by Fégeant (2002) stressed the importance of wind speed and turbulence causing variations in the level of vegetation generated noise. In addition, factors such as the season (e.g. dry or no leaves versus green leaves), the type of vegetation (e.g. grass, conifers, deciduous), the vegetation density and the total vegetation surface all determine both the sound level as well as spectral characteristics.

Ambient sound levels are significantly affected by the area where the sound measurement location is situated. When the sound measurement location is situated within an urban area, close to industrial plants or areas with a constant sound source (ocean, rivers, etc.), seasons and even increased wind speeds could have a significant impact on ambient sound levels.

Sound levels in undeveloped rural areas (away from occupied dwellings) however are impacted by changes in season for a number of complex reasons. The two main reasons are:

- Faunal communication during the warmer spring and summer months as various species communicate in an effort to find mates; &
- Seasonal changes in weather patterns, mainly wind (also see **section 5.1.1**).

For environmental noise, weather plays an important role; the greater the separation distance, the greater the influence of the weather conditions; so, from day to day, a road 1,000 m away can sound very loud or can be completely inaudible.

Other, environmental factors that impact on sound propagation includes wind, temperature and humidity, as discussed in the following sections.

5.1.1 Environmental factors that influence the propagation of sound

Sound is a sequence of waves of pressure that propagate through a compressible medium such as air. In air, there are three main properties that can affect the behaviour of sound propagation, namely:

1. The motion of the medium itself, e.g. wind in air. In the case of wind, if the air movement is in the direction of the sound wave, the sound can be transported further;
2. The relationship between density and pressure. This relationship, affected by temperature, determines the speed of sound within the medium; &
3. The viscosity of the medium. This determines the rate at which sound is attenuated.

During this propagation, the sound waves can be reflected, refracted or attenuated by this medium. Atmospheric absorption depends on frequency, relative humidity, temperature and atmospheric pressure.

5.1.2 Effect of wind on ambient sound levels

Wind speed can be a significant factor for ambient sound levels at most rural locations. With no wind, there is little vegetation movement that could generate noises, however, as wind speeds increase, the rustling of leaves increases which subsequently can increase sound levels. This directly depends on the type of vegetation in a certain area. The impact of increased wind speeds on sound levels depends on the vegetation type (deciduous versus conifers), the density of vegetation in an area, seasonal changes (in winter deciduous trees are bare) as well as the height of this vegetation. This excludes the effect of faunal communication as vegetation may create suitable habitats and food sources for fauna, attracting more animals in number and species diversity as may be found in the natural veldt.

5.1.3 Effect of wind on sound propagation

Excluding wind-induced noises relating to increased wind speeds, wind alters sound propagation by the mechanism of refraction; that is, wind bends sound waves. Wind nearer to the ground moves more slowly than wind at higher altitudes, due to surface characteristics such as hills, trees, and man-made structures that interfere with the wind. This wind gradient, with faster wind at higher elevation and slower wind at lower elevation, causes sound waves to bend downward when they are traveling to a location downwind of the source and to bend upward when traveling toward a location upwind of the source. Waves bending downward means that a listener standing downwind of the source will hear louder noise levels than the listener standing upwind of the source. This phenomenon can significantly impact sound propagation over long distances and when wind speeds are high.

5.1.4 Effect of temperature on sound propagation

On a typical sunny afternoon, air is warmest near the ground and temperature decreases at higher altitudes. This temperature gradient causes sound waves to refract upward, away from the ground and results in lower noise levels being heard at a measurement location. In the evening, this temperature gradient will reverse, resulting in cooler temperatures near the ground. This condition, often referred to as a temperature inversion will cause sound to bend downward toward the ground and results in louder noise levels at the listener’s position. Like wind gradients, temperature gradients can influence sound propagation over long distances and can significantly complicate noise propagation modelling.

5.2 AMBIENT SOUND LEVEL AND CHARACTER MEASUREMENTS

Ambient (background) sound levels were measured during the day and night of 7 March 2019, augmented with the results of longer-term ambient sound level measurements collected during previous site visits. Measurements were sufficient to characterise the ambient sound level character and, together with measurements done in the area for other projects (see Available Information, section 3.6) there is a very high confidence in the typical rating level determined for the area.

The measurements were completed 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;
- minimum duration of measurement;
- microphone positions;
- calibration procedures and instrument checks; &
- weather conditions.

The sound measurement locations are illustrated in **Figure 5-1** as a blue square, with a summary of the sound levels determined.

The sound level measuring equipment was referenced at 1,000 Hz directly before and after the measurements were taken. In all cases drift was less than 0.2 dBA. Instruments used to measure the longer-term sound levels would measure "average" sound levels over 10 minute periods, save the data and start with a new 10 minute measurement till the instrument was stopped.

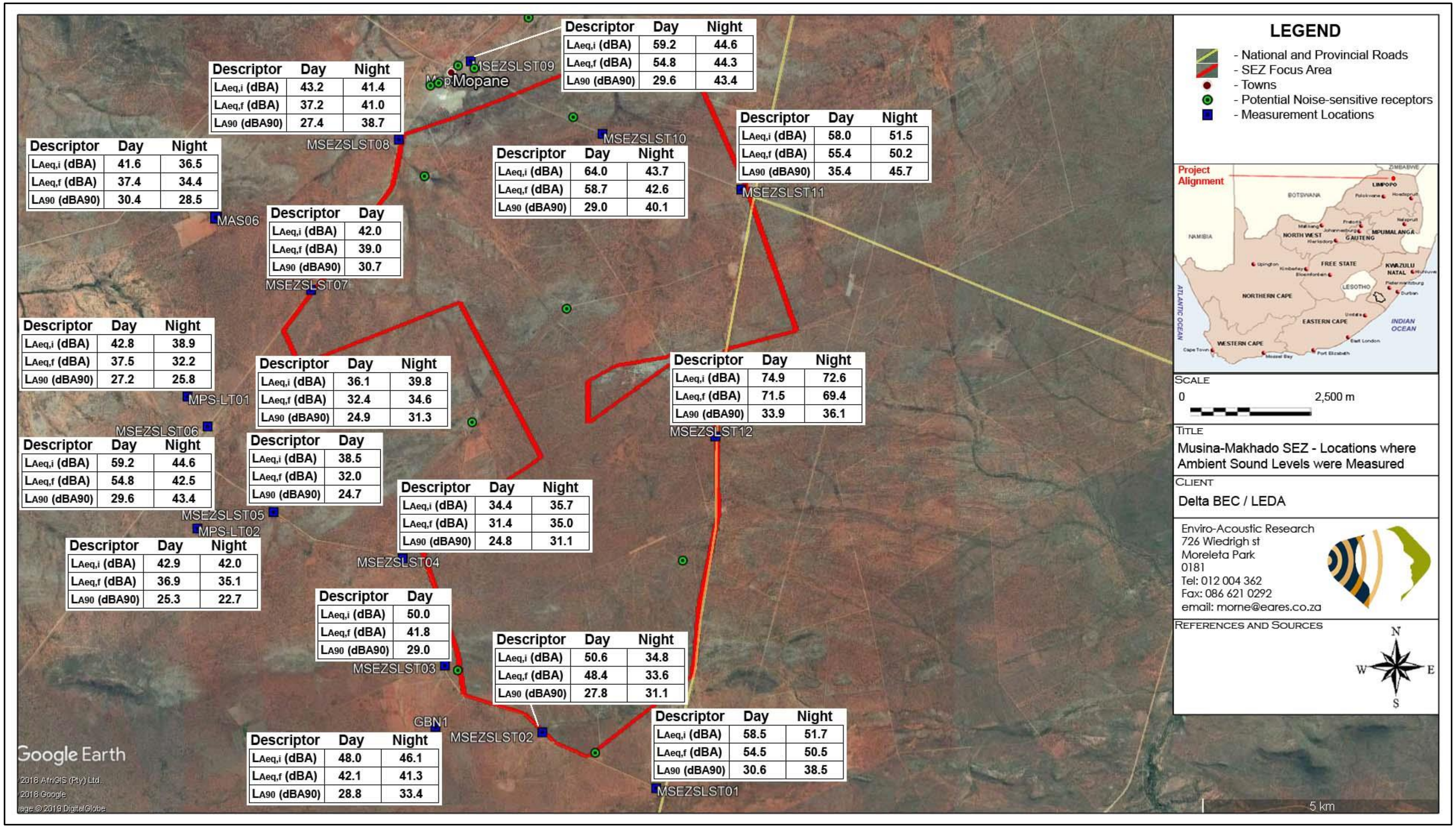

Figure 5-1: Localities of where ambient sound levels were measured

5.2.1 Ambient Sound Measurements at MPS-LT01

Measurements were collected from the afternoon of 23rd of January 2018 to the morning of 25th January 2018 (late summer). The microphone was deployed close to a location used by the resident to relax in the afternoon. Ambient sounds were dominated with wind-induced noises and bird song. There were no large trees within 20m from the microphone. A photo of the measurement location is presented in Appendix B. The equipment defined in **Table 5-1** were used to measure the sound levels.

Table 5-1: Equipment used to gather data at MPS-LT01

Equipment	Model	Serial no	Calibration
SLM	SVAN 977	36176	December 2017
Microphone	ACO Pacific 7052E	49596	December 2017
Calibrator	Quest CA-22	J 2080094	July 2018
Weather Station	WH3081PC	-	-

- Microphone fitted with the appropriate windshield.

Impulse equivalent sound levels (South African legislation): Figure 5-2 illustrates how the impulse-weighted 10-minute equivalent values changes over time with **Table 5-2** defining the average values for the time period. This sound descriptor is mainly used in South Africa to define sound and noise levels. The instrument is set to measure the impulse time-weighted sound levels.

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure 5-2** with **Table 5-2** defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound level. L_{A90} is a statistical indicator that describes the noise level that is exceeded 90% of the time and is frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 5-3**.

Measured maximum and minimum sound levels: These are statistical sound descriptors that can be used to characterise the sound levels in an area along with the other sound descriptors. These sound level descriptors are defined in **Figure 5-3** and **Table 5-2**.

Table 5-2: Sound levels considering various sound level descriptors at MPS-LT01

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic mean	-	42.8	37.5	27.2	-	-
Night arithmetic mean	-	38.9	32.2	25.8	-	-
Day minimum	-	30.8	26.4	-	20.4	-
Day maximum	83.0	59.9	55.2	-	-	-
Night minimum	-	29.1	26.2	-	17.4	-
Night maximum	68.2	53.5	44.3	-	-	-
Day 1 equivalent	-	44.2	37.1	-	-	Late afternoon and evening
Night 1 Equivalent	-	42.1	34.7	-	-	8 hour night equivalent average
Day 2 equivalent	-	46.2	40.8	-	-	16 hour daytime average
Night 2 Equivalent	-	40.9	32.8	-	-	8 hour night equivalent average
Day 3 equivalent	-	40.5	33.7	-	-	Morning only

The statistical data ($L_{A90,f}$) indicate a location with very low ambient sound levels both day and night. L_{Amin} data indicate a location with potential to become very quiet, confirming the rural development character of the area.

Figure 5-2 and **Figure 5-3** illustrate an area with a high potential to be quiet ($L_{Amin,f}$ values), and, based on the observations made onsite, natural sound are the reason for higher ambient sound level. As typical for most areas, dawn chorus (waking of birds) significantly raise the ambient sound levels from 5 am in the morning.

Considering the character of the area, sounds heard as well as the average $L_{Aeq,f}$ values, both day- and night-time ambient sound levels are typical of a **rural noise district** (SANS 10103:2008 – see **Table 6-1**) as illustrated in **Figure 5-4** and **Figure 5-5**.

Third octaves were measured and are displayed in **Figure 5-6** to **Figure 5-9**.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind and surf especially – indicated by a relative smooth curve) and sounds of anthropogenic origin and vehicles (engine sounds and electric motors – erratic bumps at certain frequencies). Lower frequencies tend to travel further through the atmosphere than higher frequencies. People generally do not hear these frequencies unless very quiet due to the low response of the ear to these low frequencies. Sounds from wind-induced noises generally have significant acoustic energy in this frequency range (normally identified by a smooth curve).

Third octave surrounding the 1,000 Hz (200 – 2,000 Hz) – This range contains energy mostly associated with human speech (350 Hz – 2,000 Hz) and dwelling noises (including sounds from larger animals such as chickens, dogs, goats, sheep and cattle). Road-tyre interaction (from vehicular traffic) normally peaking in 630 – 1,600 Hz range (depending on vehicular speed and road characteristics).

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc.

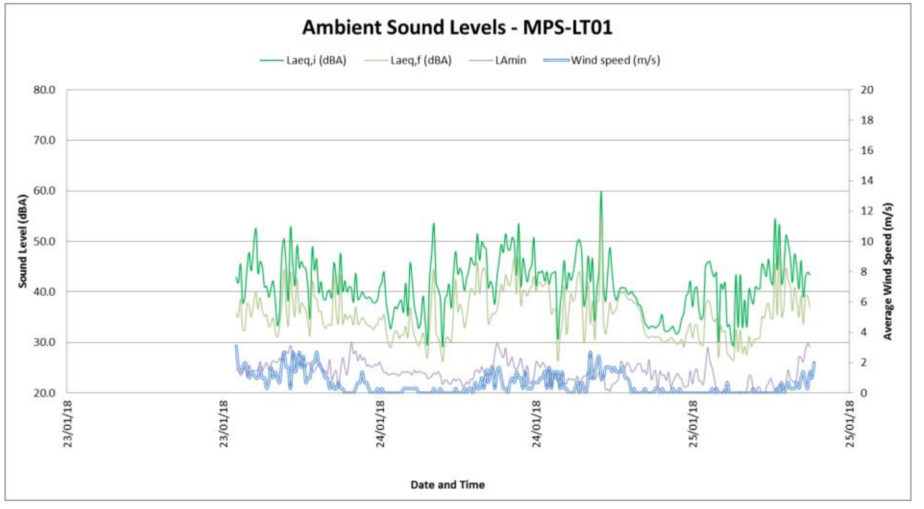

Figure 5-2: Ambient Sound Levels at MPS-LT01

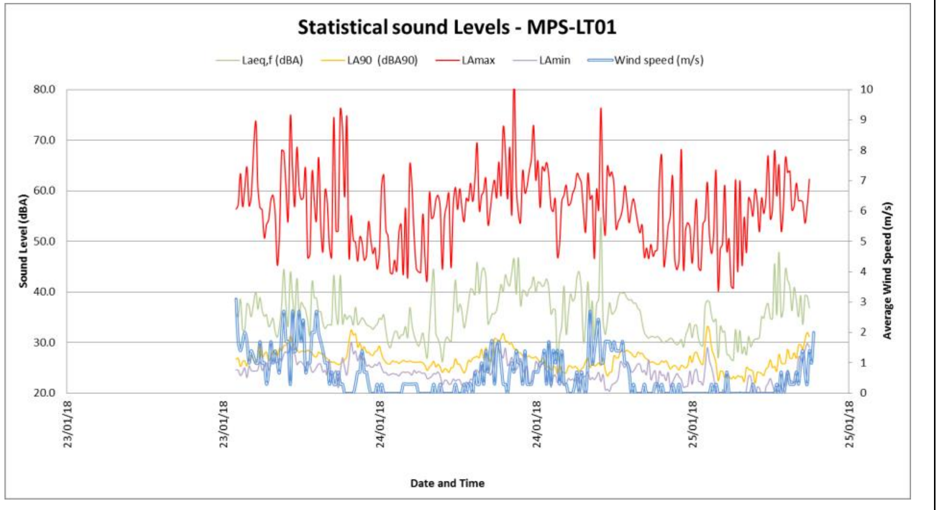

Figure 5-3: Maximum, minimum and statistical values (MPS-LT01)

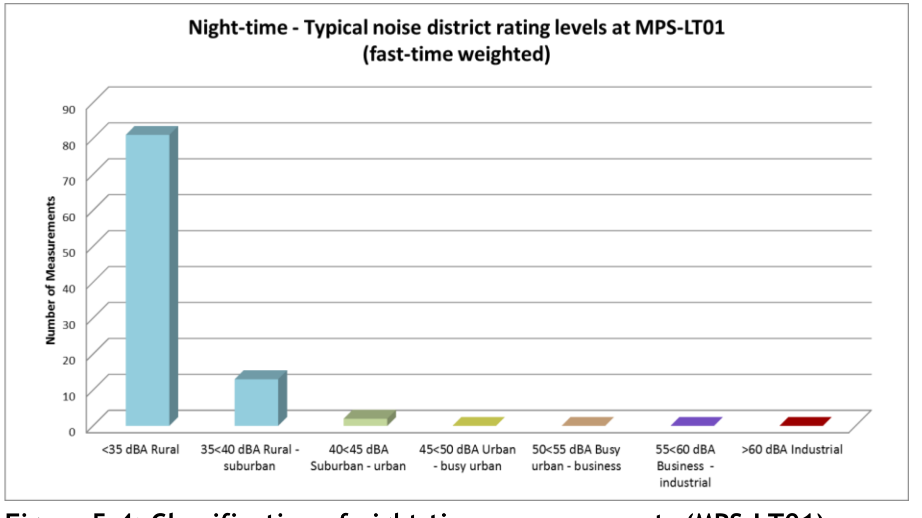

Figure 5-4: Classification of night-time measurements (MPS-LT01)

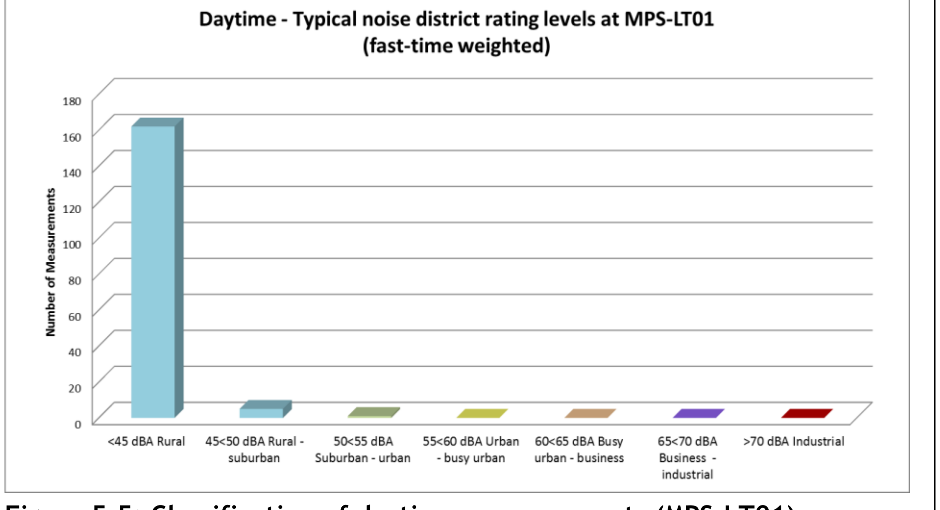

Figure 5-5: Classification of daytime measurements (MPS-LT01)

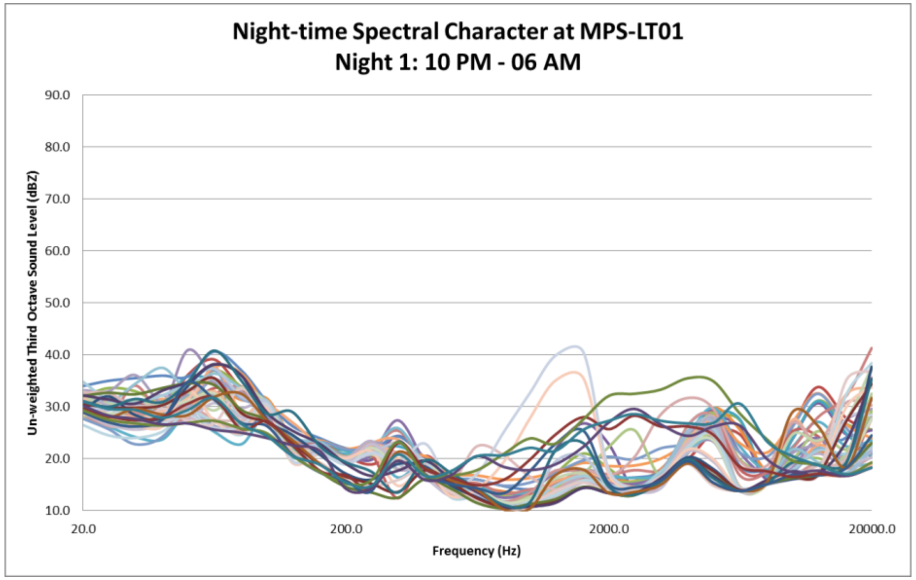

Figure 5-6: Spectral frequencies - MPS-LT01, Night 1

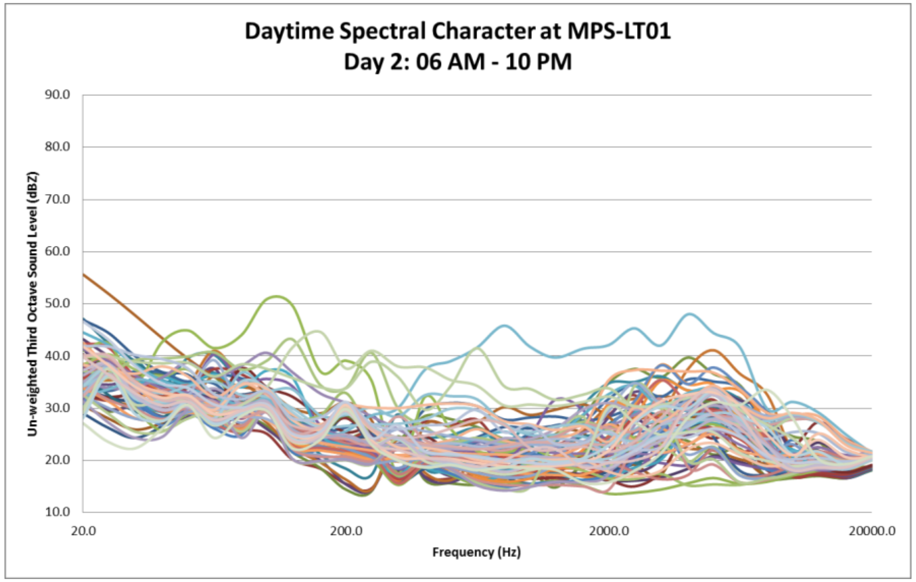

Figure 5-7: Spectral frequencies - MPS-LT01, Day 2

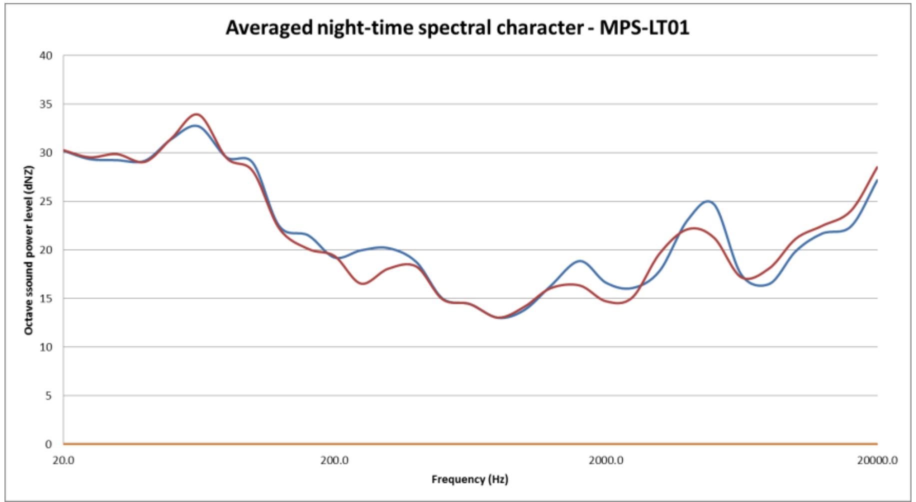

Figure 5-8: Average spectral frequencies - Night (MPS-LT01)

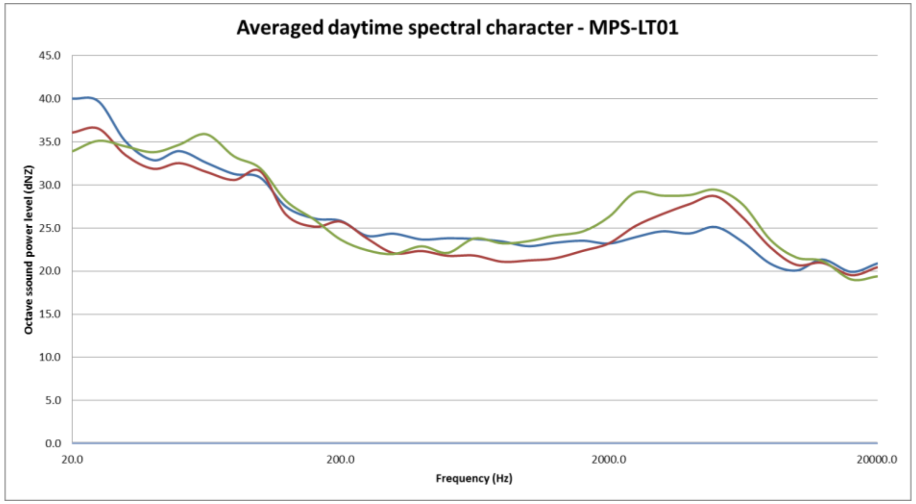

Figure 5-9: Average spectral frequencies - Day (MPS-LT01)

5.2.2 Ambient Sound Measurements at MPS-LT02

Measurements were collected from the afternoon of 23rd of January 2018 to the morning of 25th of January 2018 (late summer). The microphone was deployed at the house, away from any identifiable potential noise sources. There were a number of trees and palm trees close to the microphone and wind-induced noises would increase with increased wind speeds. There was a goat pen in the area and the goats were audible at times. The dominant sound was due to various birds in the area. A photo of the measurement location is presented in Appendix B. Sounds heard onsite are described in the following table. The equipment defined in **Table 5-3** was used to measure the noise levels.

Table 5-3: Equipment used to gather data at MPS-LT02

Equipment	Model	Serial no	Calibration
SLM	SVAN 955	27637	October 2018
Microphone	ACO Pacific 7052E	52437	October 2018
Calibrator	Quest CA-22	J 2080094	July 2018

- Microphone fitted with the appropriate windshield.

Impulse equivalent sound levels (South African legislation): Figure 5-10 illustrates how the impulse-weighted 10-minute equivalent values changes over time with **Table 5-4** defining the average values for the time period. This sound descriptor is mainly used in South Africa to define sound and noise levels. The instrument is set to measure the impulse time-weighted sound levels.

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure 5-10** with **Table 5-4** defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound level. **L_{A90}** is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 5-11**.

Measured maximum and minimum sound levels: These are statistical sound descriptors that can be used to characterise the sound levels in an area along with the other sound descriptors. These sound level descriptors are illustrated in **Figure 5-11** and defined in **Table 5-4**.

Table 5-4: Sound levels considering various sound level descriptors at MPS-LT02

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic mean	-	42.9	36.9	25.3	-	-
Night arithmetic mean	-	42.0	35.1	22.7	-	-
Day minimum	-	33.2	27.2	-	18.9	-
Day maximum	74.9	57.2	49.3	-	-	-
Night minimum	-	27.2	23.8	-	18.3	-
Night maximum	75.5	61.9	54.4	-	-	-
Day 1 equivalent	-	44.8	37.9	-	-	Late afternoon and evening
Night 1 Equivalent	-	50.6	42.9	-	-	8 hour night equivalent average
Day 2 equivalent	-	45.0	38.1	-	-	16 hour daytime average
Night 2 Equivalent	-	44.7	37.3	-	-	8 hour night equivalent average
Day 3 equivalent	-	41.6	34.4	-	-	Morning only

The $L_{Aeq,i}$, $L_{Aeq,f}$ and $L_{A90,f}$ sound level descriptors indicate a location that are generally quiet to very quiet. L_{Amax} levels exceeded 65 dBA more than 10 times at night with the source unknown, suspected to be due to the leaves rustling from the palm trees. When more than 10 sound events occur at night (where the noise level exceeds 65 dBA) it may disturb the sleep of people. Ambient sound levels are typical of a rural noise district (the existing rating level).

Figure 5-10 and **Figure 5-11** illustrate an area with a high potential to be quiet ($L_{Amin,f}$ values), and based on the observations made onsite, natural sound are the reason for higher ambient sound level. As typical for most areas, dawn chorus (waking of birds) significantly raise the ambient sound levels from 5 am in the morning.

Considering the character of the area, sounds heard as well as the average $L_{Aeq,f}$ values, both day- and night-time ambient sound levels are typical of a **rural noise district** (SANS 10103:2008 – see **Table 6-1**) as illustrated in **Figure 5-12** and **Figure 5-13**.

Third octaves were measured and are displayed in **Figure 5-14** to **Figure 5-17**.

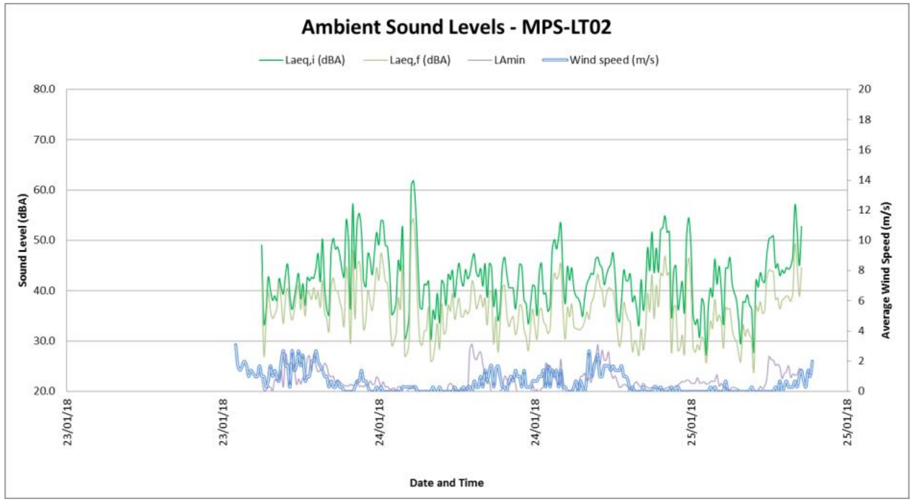

Figure 5-10: Ambient Sound Levels at MPS-LT02

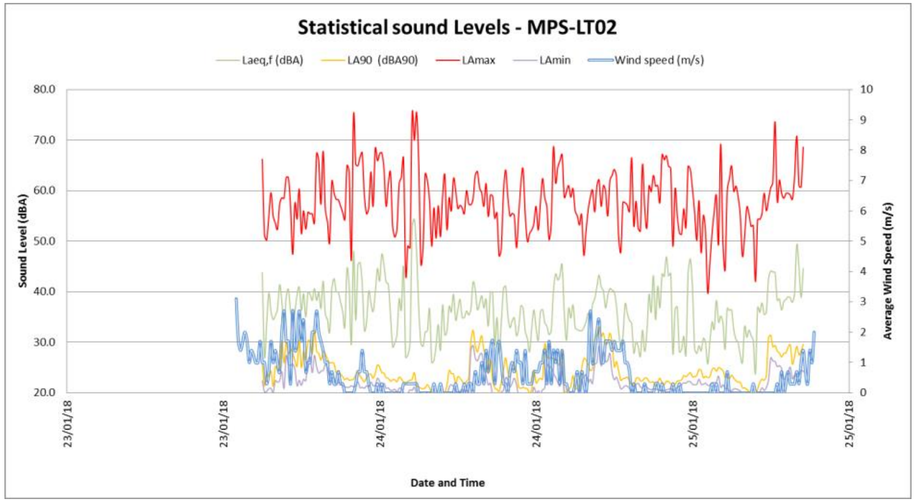

Figure 5-11: Maximum, minimum and statistical values (MPS-LT02)

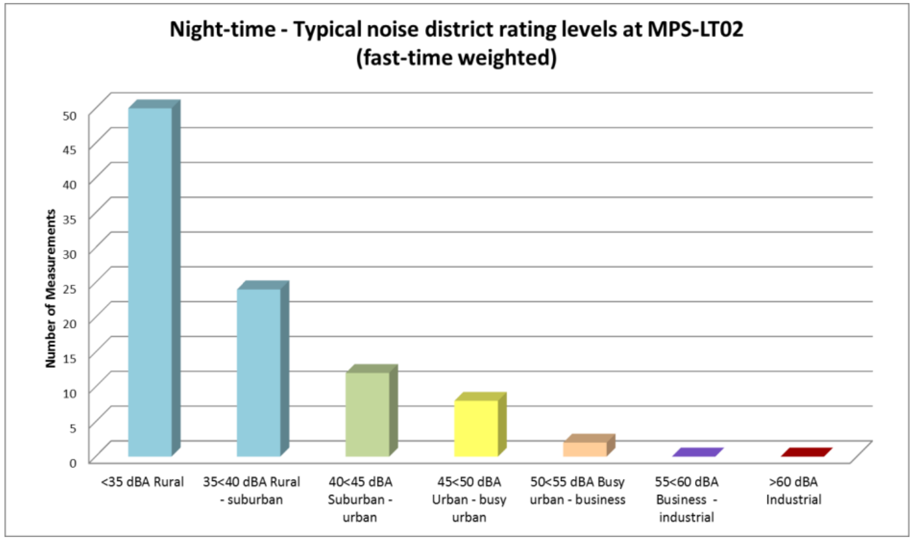

Figure 5-12: Classification of night-time measurements (MPS-LT02)

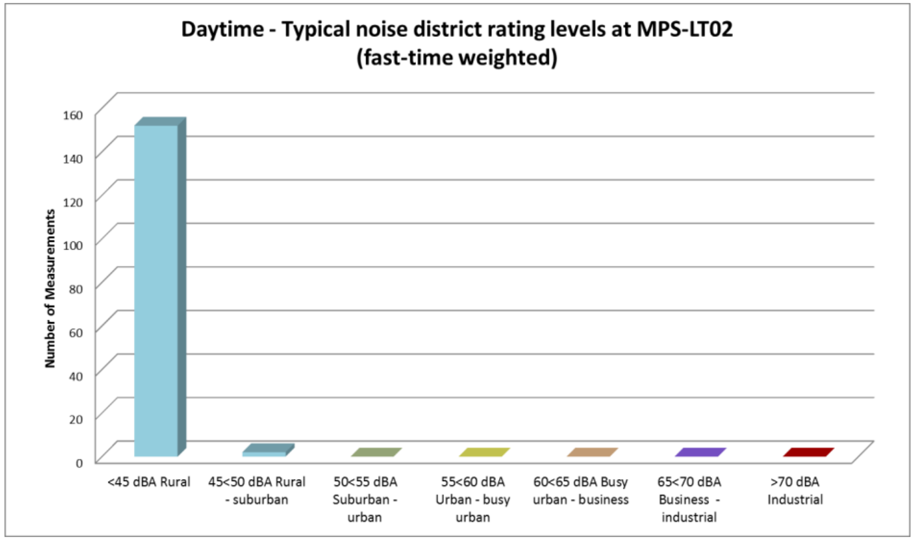

Figure 5-13: Classification of daytime measurements (MPS-LT02)

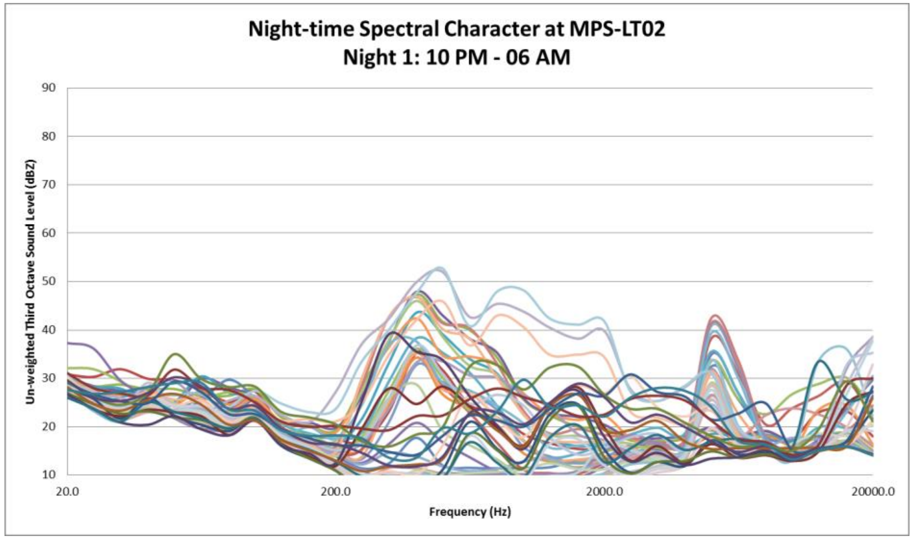

Figure 5-14: Spectral frequencies - MPS-LT02, Night 1

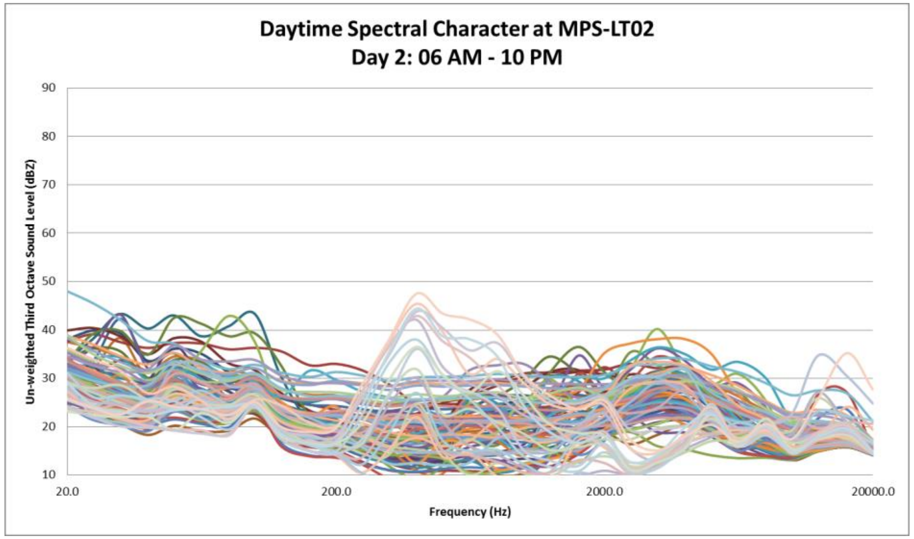

Figure 5-15: Spectral frequencies - MPS-LT02, Day 2

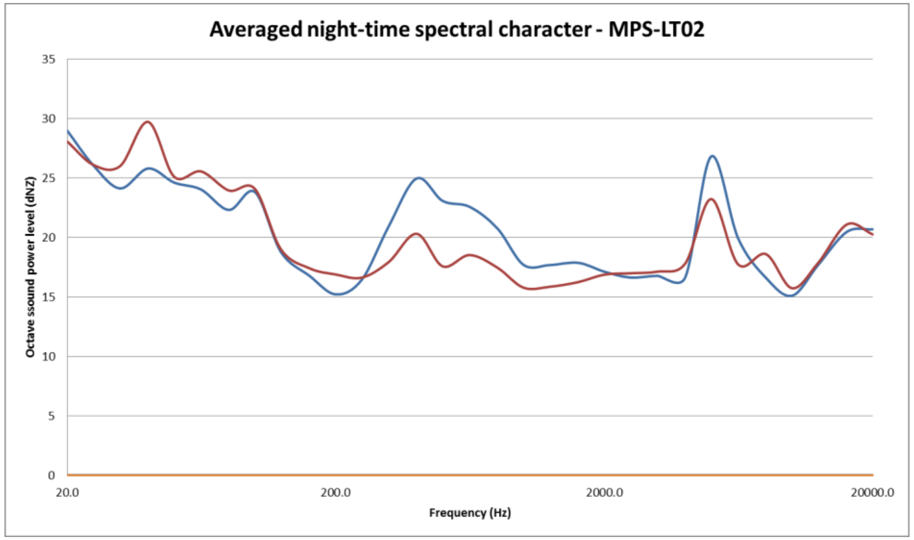

Figure 5-16: Average spectral frequencies – Night (MPS-LT02)

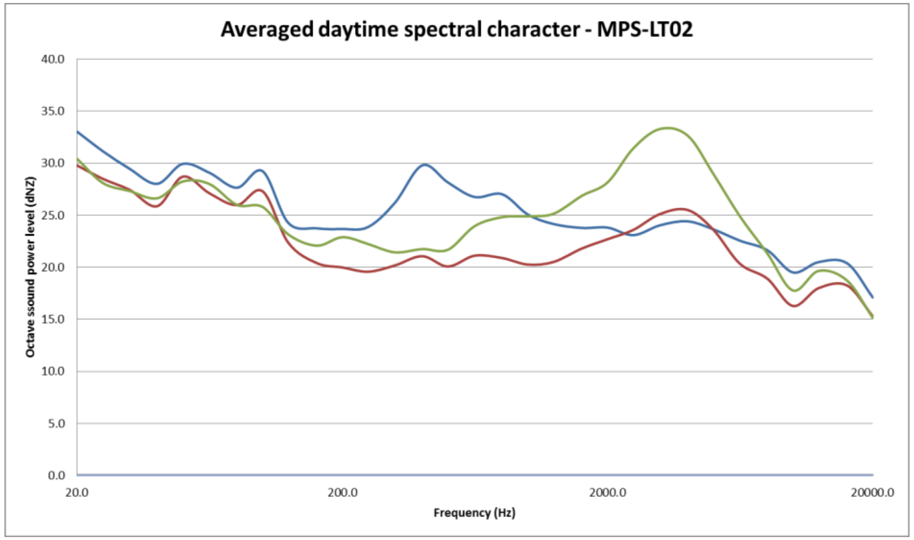

Figure 5-17: Average spectral frequencies – Day (MPS-LT02)

5.2.3 Ambient Sound Measurements at MAS06

The instrument was deployed 4 – 5 July 2013 (winter) with the measurement location inside a closed off area in a disused vegetable garden away from the receptors dwelling. Natural noises were the dominant noise source (wind-induced, birds and insects). Refer to Appendix B for a photo of this measurement point. The equipment defined in **Table 5-5** was used for gathering data.

Table 5-5: Equipment used to gather data at MAS06

Equipment	Model	Serial no	Calibration Date
SLM	Rion NL-32	01182945	03 April 2013
Microphone	Rion UC-53A	315479	03 April 2013
Calibrator	Rion NC-74	34494286	23 January 2013

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

Impulse equivalent sound levels (South African legislation): Figure 5-18 illustrates how the impulse-weighted 10-minute equivalent values changes over time with **Table 5-6** defining the average values for the time period. This sound descriptor is mainly used in South Africa to define sound and noise levels. The instrument is set to measure the impulse time-weighted sound levels.

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure 5-18** and **Figure 5-19** with **Table 5-6** defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound level. **L_{A90}** is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 5-19**.

Measured maximum and minimum sound levels: These are statistical sound descriptors that can be used to characterise the sound levels in an area along with the other sound descriptors. These sound level descriptors are illustrated in **Figure 5-19** and defined in **Table 5-6**.

Table 5-6: Sound levels considering various sound level descriptors at MAS06

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic mean	-	41.6	37.4	30.4	-	-
Night arithmetic mean	-	36.5	34.4	28.5	-	-
Day minimum	-	27.6	20.3	-	16.8	-
Day maximum	82.5	60.8	50.3	-	-	-
Night minimum	-	27.6	20.9	-	18.0	-
Night maximum	64.2	46.7	43.9	-	-	-
Day 1 equivalent	-	46.8	40.8	-	-	Late afternoon and evening
Night 1 Equivalent	-	38.8	36.8	-	-	8 hour night equivalent average
Day 2 equivalent	-	43.4	39.1	-	-	Morning only

The $L_{Aeq,i}$, $L_{Aeq,f}$ and $L_{A90,f}$ sound level descriptors indicate a location that are generally quiet to very quiet as illustrated in **Figure 5-20** and **Figure 5-21**.

Considering the character of the area, sounds heard as well as the average $L_{Aeq,f}$ values, both day- and night-time ambient sound levels are typical of a **rural noise district** (SANS 10103:2008 – see **Table 6-1**).

Third octave spectral analysis: The instrument is not fitted with a third-octave filter.

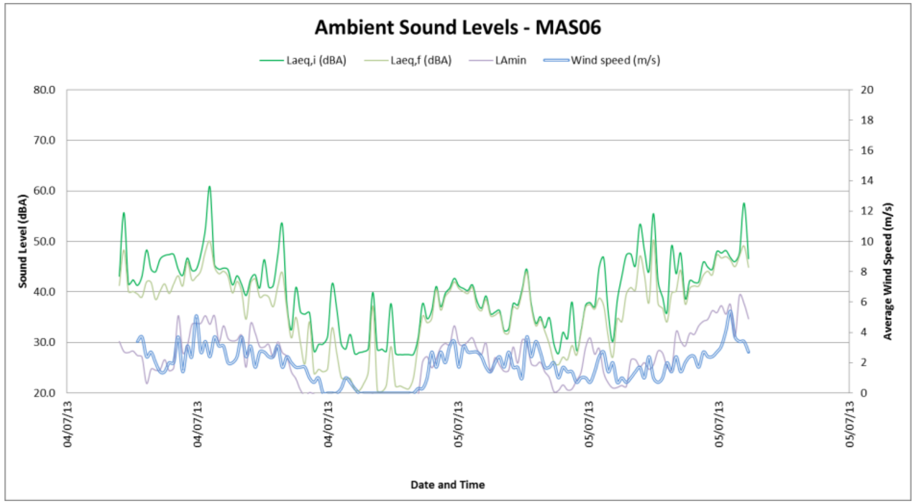

Figure 5-18: Ambient Sound Levels at MAS06

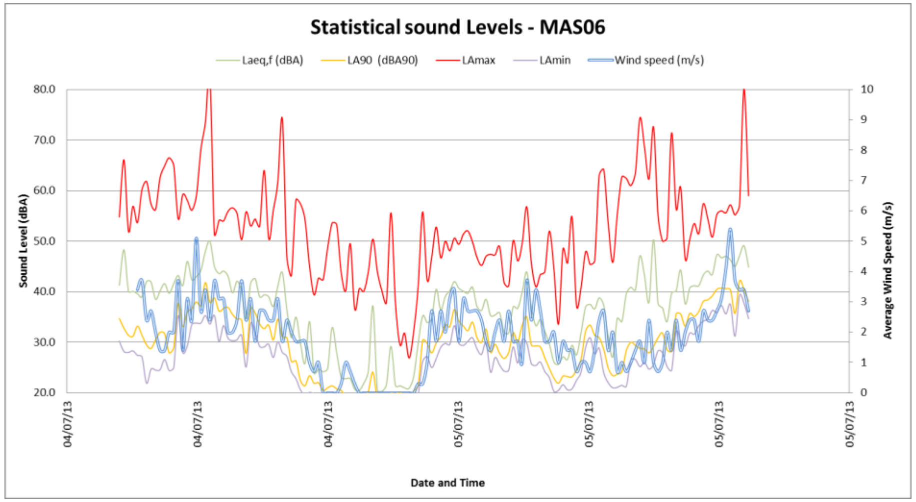

Figure 5-19: Maximum, minimum and statistical values (MAS06)

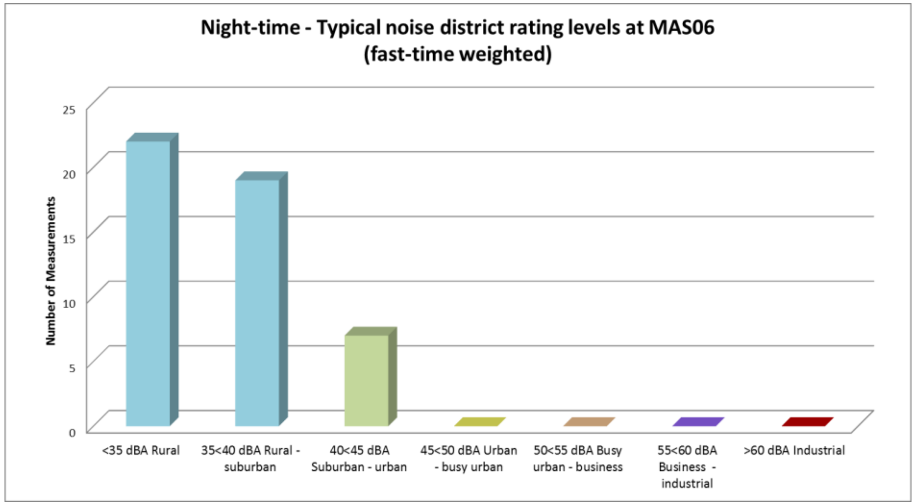

Figure 5-20: Classification of night-time measurements (MAS06)

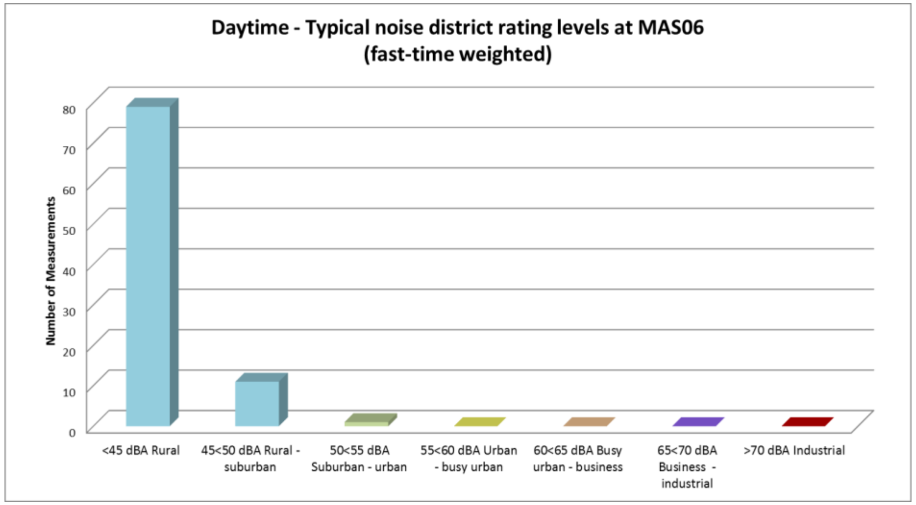

Figure 5-21: Classification of daytime measurements (MAS06)

5.2.4 Ambient Sound Measurements at GBN1

A number of 10 minute measurements were taken over a day/night period on 18th till 19th September 2013. The instrument was deployed in an area away from the residential dwelling close to the main entrance gate to the residential Erf. The area was clean with little vegetation covering the ground surrounding the microphone. There were no trees within 10 m that could potentially increase wind-induced noises during elevated wind speeds. The dominant sound was due to natural noises (wind, birds and insects) in the area. A photo of the measurement location is presented in Appendix B. Sounds heard onsite are described in the following table. The equipment defined in **Table 5-7** was used to measure the noise levels.

Table 5-7: Equipment used to gather data at GBN1

Equipment	Model	Serial no	Calibration
SLM	Svan 955	27637	15 May 2013
Microphone*	ACO 7052E	52437	15 May 2013
Calibrator	Rion NC-74	34494286	23 January 2013

- Microphone fitted with the appropriate windshield.

Impulse equivalent sound levels (South African legislation): Figure 5-22 illustrates how the impulse-weighted 10-minute equivalent values changes over time with **Table 5-8** defining the average values for the time period. This sound descriptor is mainly used in South Africa to define sound and noise levels. The instrument is set to measure the impulse time-weighted sound levels.

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure 5-22** and **Figure 5-23** with **Table 5-8** defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound level. **L_{A90}** is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 5-23**.

Measured maximum and minimum sound levels: These are statistical sound descriptors that can be used to characterise the sound levels in an area along with the other sound descriptors. These sound level descriptors are illustrated in **Figure 5-23** and defined in **Table 5-8**.

Table 5-8: Sound levels considering various sound level descriptors at GBN1

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic mean	-	48.0	42.1	28.8	-	-
Night arithmetic mean	-	46.1	41.3	33.4	-	-
Day minimum	-	33.8	31.1	-	> 16	-
Day maximum	79.0	64.9	58.8	-	-	-
Night minimum	-	39.8	34.1	-	> 16	-
Night maximum	72.4	52.9	47.5	-	-	-
Day 1 equivalent	-	49.7	43.5	-	-	Late afternoon and evening
Night 1 Equivalent	-	48.2	42.9	-	-	8 hour night equivalent average
Day 2 equivalent	-	49.7	42.7	-	-	Morning only

The $L_{Aeq,i}$, $L_{Aeq,f}$ and $L_{A90,f}$ sound level descriptors indicate a location that are generally quiet to very quiet. L_{Amax} levels exceeded 65 dBA more than 10 times at night, likely dogs barking for movement at night. When more than 10 sound events occur at night (where the noise level exceeds 65 dBA) it may disturb the sleep of people. Ambient sound levels are typical of a rural noise district (the existing rating level).

Ambient sound measurements illustrate an area with a high potential to be quiet ($L_{Amin,f}$ values), and based on the observations made onsite, natural sound are the reason for higher ambient sound level. As typical for most areas, dawn chorus (waking of birds) significantly raise the ambient sound levels from 5 am in the morning.

Considering the character of the area, sounds heard as well as the average $L_{Aeq,f}$ values, both day- and night-time ambient sound levels are typical of a **rural noise district** (SANS 10103:2008 – see **Table 6-1**) as illustrated in **Figure 5-24 a**nd **Figure 5-25**. While night-time sound levels are elevated, this is mainly due to natural noises as can be observed from the spectral data.

Third octaves were measured and are displayed in **Figure 5-26** to **Figure 5-29**.

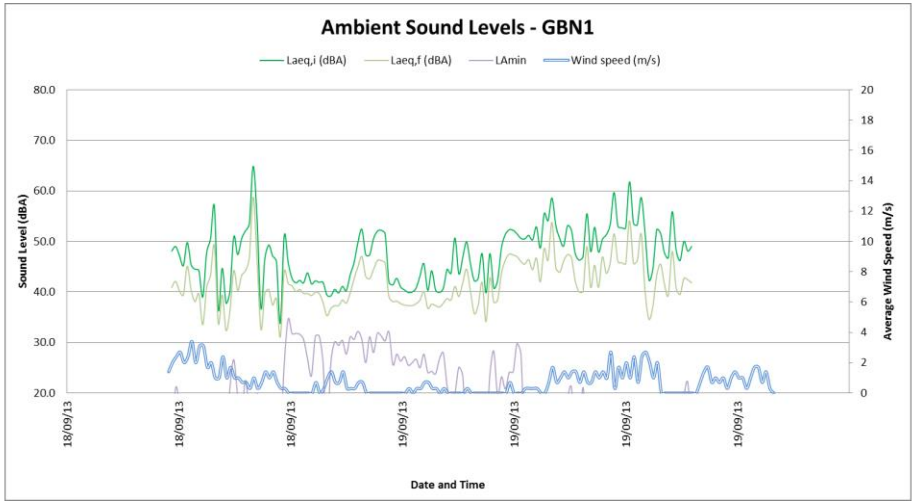

Figure 5-22: Ambient Sound Levels at GBN1

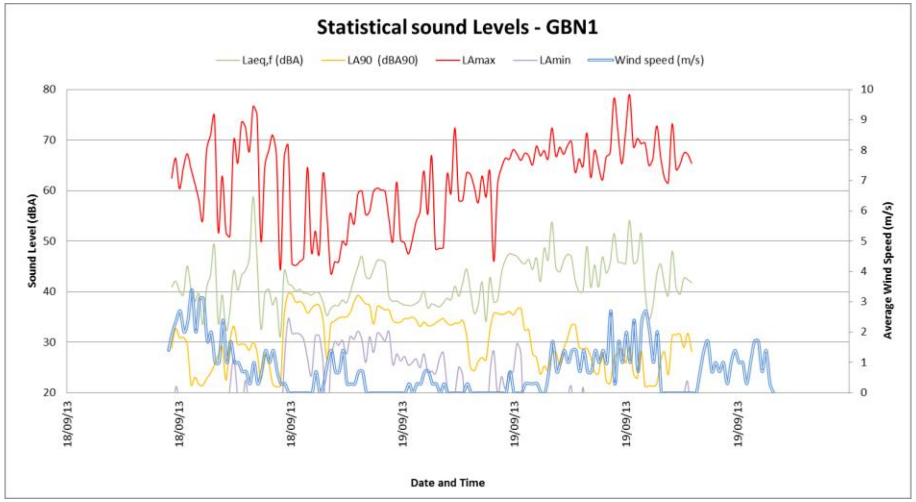

Figure 5-23: Maximum, minimum and statistical values

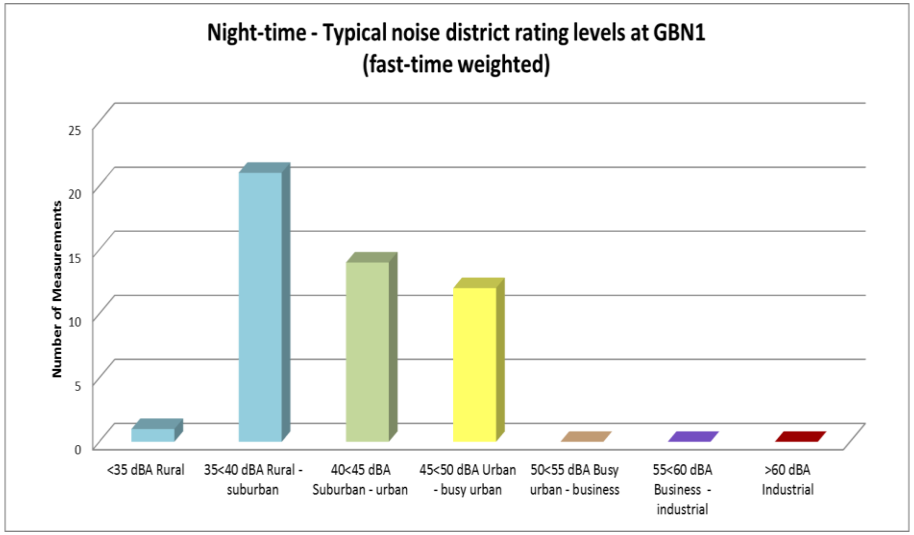

Figure 5-24: Classification of night-time measurements (GBN1)

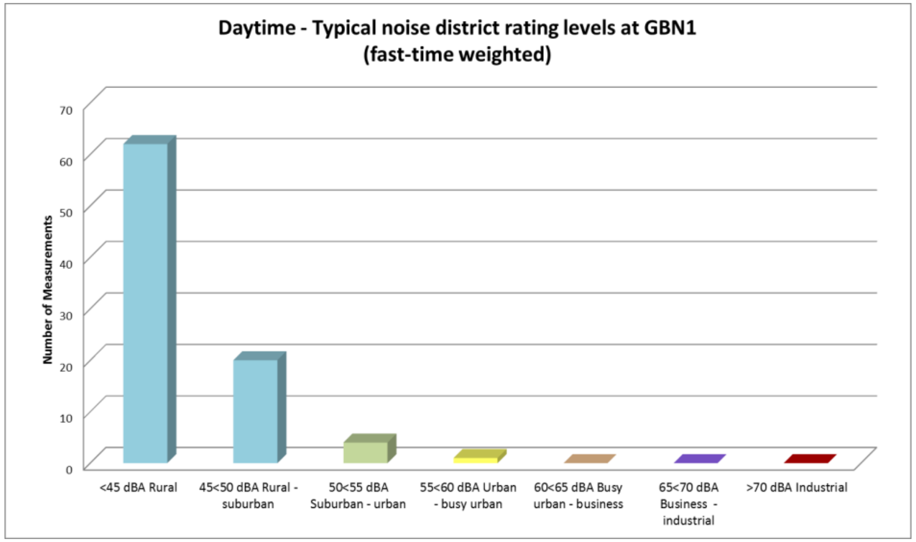

Figure 5-25: Classification of daytime measurements (GBN1)

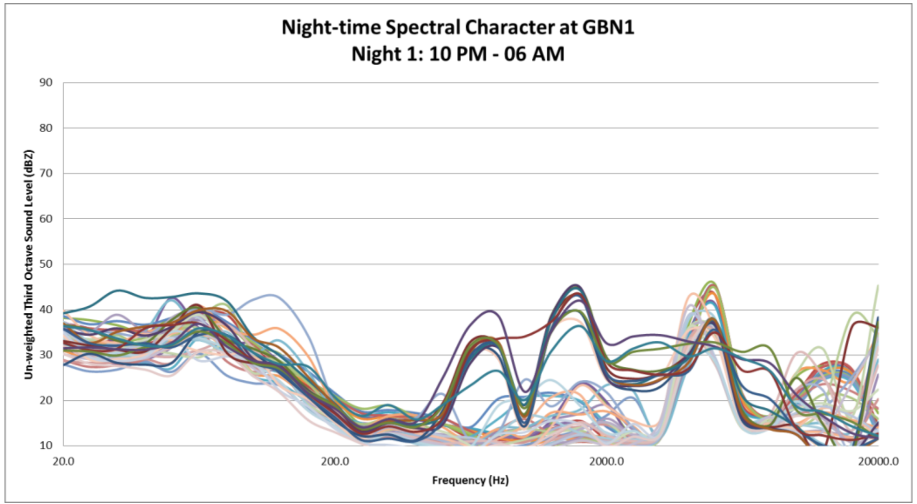

Figure 5-26: Spectral frequencies - GBN1, Night 1

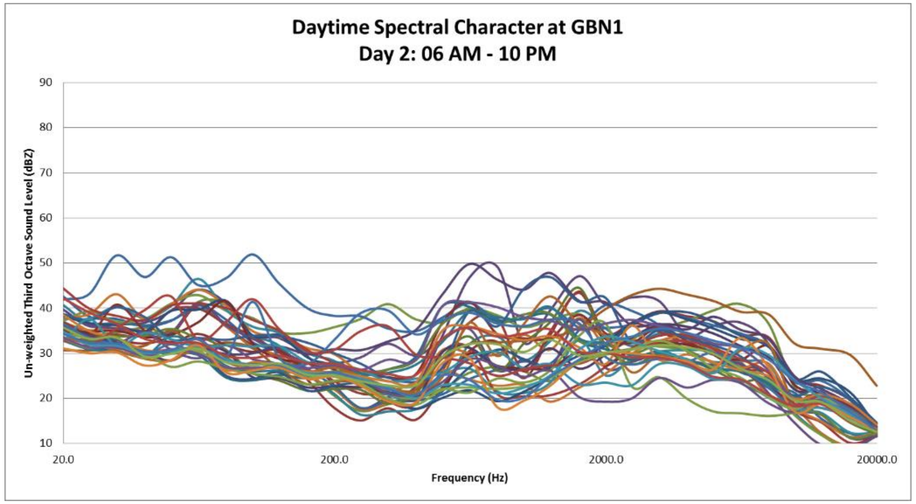

Figure 5-27: Spectral frequencies - GBN1, Day 2

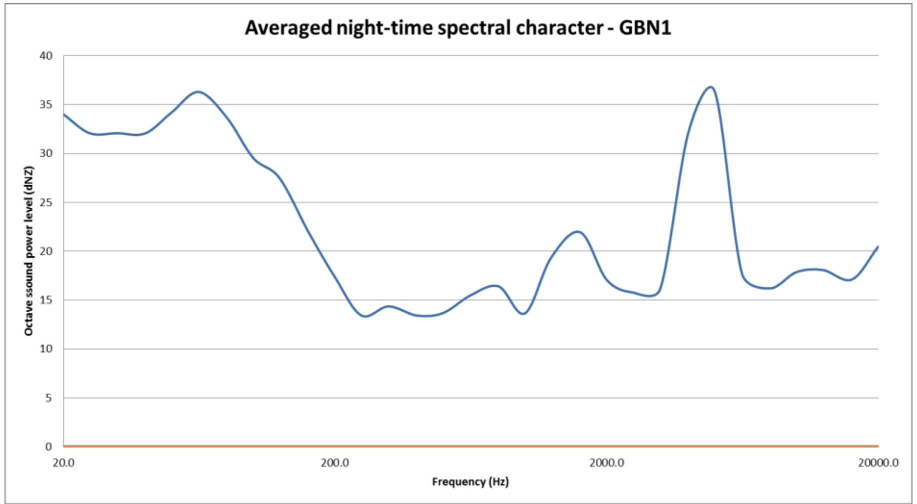

Figure 5-28: Average spectral frequencies - Night (GBN1)

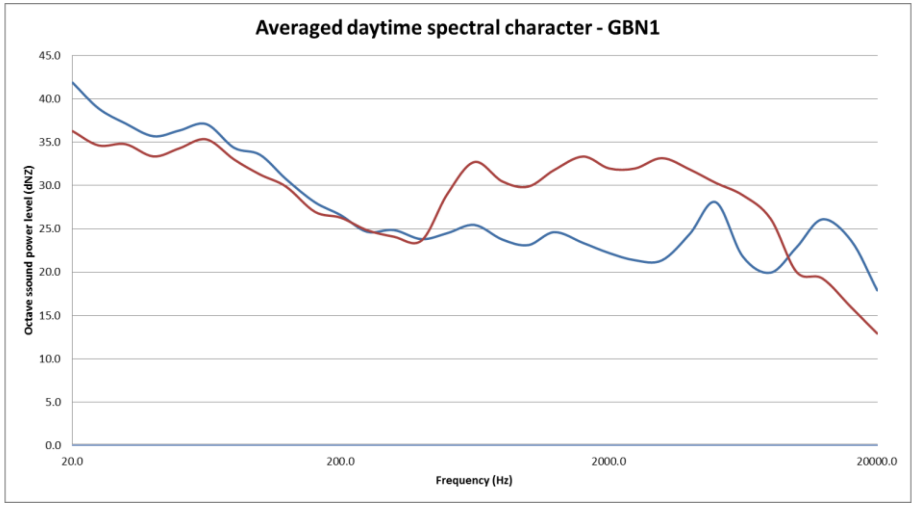

Figure 5-29: Average spectral frequencies - Day (GBN1)

5.2.5 Single Measurements – In vicinity of focus area

A number of single measurements were collected (7 March 2019) to augment the longer-term ambient sound levels measured in the area. The equipment used at these locations is defined in the following table. Refer to Appendix B for photos of typical measurements.

Table 5-9: Equipment used to do singular measurements around Hernic

Equipment	Model	Serial no	Calibration
SLM	Svan 955	27637	October 2018
Microphone	ACO SV 12l and 7052E	30336 and 52437	October 2018
Calibrator	Quest CA-22	J 2080094	July 2018

Note: SLM fitted at all times with appropriate windshield

Note:

$L_{Aeq,i}$ - Equivalent A-weighted noise level, similar to an average noise level – Impulse-detector

$L_{Aeq,f}$ - Equivalent A-weighted noise level, similar to an average noise level – Fast-detector

L_{A90} - Noise level that is exceeded 90% or more of the time – Fast-detector

The data collected and information about the measurement locations are presented in the following tables.

5.3 SUMMARY OF AMBIENT SOUND LEVEL MEASUREMENTS

Considering the ambient sound levels measured onsite, as well as the developmental character of the area, the acceptable zone rating level would be typical of a **rural area** (35 dBA at night and 45 dBA during the day) as defined in SANS 10103:2008 for most of the area.

Rating levels will be higher in an area up to 500m from the N1, mainly due to traffic noises from the national road. This will be relevant to NSDs 03 and 14, located very close to the N1 road. Night-time ambient sound levels may also be higher at NSD02.

The rating levels will also be higher in the town of Mopane, due to the activities of the existing Syferfontein Dolomite quarry.

Table 5-10: Summary of singular noise measurements

Measurement Location (d) - Day (n) - Night	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,f}$ level (dBA)	L_{A90} Level(dBA90)	Comments
MSEZSLST01 (d)	85.3	58.5	25.1	54.5	30.6	30 ºC, 28% humidity. Clear skies with wind gusts up to 5 m/s. Ave wind 2 m/s. 30 minute measurement. Birds clearly audible and likely dominant sound most of times. Passing traffic on N1 significant and possible dominant sound during event. Wind induced noises clearly audible at times with increased winds.
MSEZSLST02 (d)	74.3	50.6	25.0	48.4	27.8	Birds and wind induced noises dominating. One vehicle passing during measurement.
MSEZSLST03 (d)	62.3	50.0	23.2	41.8	29.0	Birds dominant with some wind induced noises.
MSEZSLST04 (d)	46.9	34.4	21.9	31.4	24.8	Birds and wind induced noises.
MSEZSLST05 (d)	64.0	38.5	21.9	32.0	24.7	Birds and wind induced noises
MSEZSLST06 (d)	48.4	36.1	22.1	32.4	24.9	Birds and wind induced noises.
MSEZSLST07 (d)	51.8	42.0	27.2	39.0	30.7	Birds and some wind induced noises.
MSEZSLST08 (d)	57.4	43.2	23.6	37.2	27.4	Birds and wind induced noises. Low hum barely audible in far distance. Rock breaker clearly audible for a few seconds. Truck airbrakes in far distance for a few seconds. Bird sounds dominate.
MSEZSLST09 (d)	83.2	59.2	26.1	54.8	29.6	Measurement location 10 m from centre of road. Bird sounds dominating. Some wind induced noises. Crusher or rock breaker audible at times. 3 vehicles passed during measurement.
MSEZSLST10 (d)	88.7	64.0	24.8	58.7	29.0	Birds and wind induced noises. Bells (cattle bells) just audible at times. Microphone close to vegetation a significant source of noise during wind gusts.

MSEZSLST11 (d)	76.0	57.9	32.2	55.4	35.4	Birds dominant. Traffic on N1 significant during passing and mostly audible, potentially dominant at times. 3 vehicles passed during measurement.
MSEZSLST12 (d)	94.5	74.9	27.8	71.5	33.9	Measurement location 10 m from centre of road. 182 cars and 69 heavy vehicles passing during the hour measurement. Birds clearly audible during quiet periods (no vehicles passing) with traffic noises dominant source of noise (14:40 – 15:40).
MSEZSLST01 (n)	60.3	51.7	35.5	50.5	38.5	24 ºC, 48% humidity. Crickets and other insects dominant. Traffic on N1 clearly audible and significant during passing.
MSEZSLST02 (n)	39.0	34.8	27.6	33.6	31.1	Insect sounds dominant. Night time birds audible. Trucks on N1 barely audible.
MSEZSLST04 (n)	38.8	35.7	26.4	35.0	31.1	Insect sounds dominant.
MSEZSLST06 (n)	45.5	39.8	25.8	34.6	31.3	Insect sounds dominant.
MSEZSLST08 (n)	44.5	41.5	36.4	41.0	38.8	Insects dominant. Sounds from Syferfontein Dolomite audible, possibly plant and trucks with impulsive noises at times.
MSEZSLST09 (n)	49.2	44.6	42.5	44.3	43.4	Insects. Singing or music from NSD (11 PM at night) in area. Dogs barking in Mopane. Activities on plant just audible. 1 vehicle slowly passing during measurement.
MSEZSLST10 (n)	52.2	43.7	36.9	42.6	40.1	Insect sounds dominant.
MSEZSLST11 (n)	76.0	57.9	32.2	55.4	35.4	Insect sounds dominant. Traffic on N1 clearly audible and significantly impact sound levels. Music from house in area.
MSEZSLST12 (n)	91.2	72.6	30.8	69.4	36.1	Insects significant with traffic likely dominant. 65 cars and 24 heavy vehicles during the half-hour measurement (23:38 – 00:08).

6 METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

6.1 NOISE IMPACT ON ANIMALS[1]

A significant amount of research was undertaken during the 1960's and 70's on the effects of aircraft noise on animals. While aircraft noise has a specific characteristic that might not be comparable with industrial noise, the findings should be relevant to most noise sources. A general animal behavioural reaction to aircraft noise is the startle response with the strength and length of the startle response to be dependent on the following:

- which species is exposed;
- whether there is one animal or a group of animals, &
- whether there have been some previous exposures.

Overall, the research suggests that species differ in their response to noise depending on the duration, magnitude, characteristic and source of the noise, as well as how accustomed the animals are to the noise (previous exposure).

Extraneous noises impact on animals as it can increase stress levels and even impact on their hearing. Masking sounds may affect their ability to react to threats, compete and seek mates and reproduce, hunt and forage, communicate and generally to survive.

Unfortunately, there are numerous other factors in the faunal environment 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.

The only animal species studied in detail are humans, and studies are still continuing in this regard. These studies also indicate that there is considerable variation between individuals, highlighting the loss of sensitivity to higher frequencies as human's age. Sensitivity also varies with frequency with humans. Considering the variation in the sensitivity to frequencies and between individuals, this is likely similar with all faunal species. Some of these studies are repeated on animals, with behavioural hearing tests being able to define the hearing threshold range for some animals as indicated on **Figure 6-1** below.

Only a few faunal (animal) species have been studied in a bit more detail so far, with the potential noise impact on marine animals most likely the most researched subject, with a few studies that discuss behavioural changes in other faunal species due to increased noises. Few studies indicate definitive levels where noises start to impact on animals, with most based on laboratory level research that subject animals to noise levels that are

[1] Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010; Manci, 1988

significantly higher than the noise levels these animals may experience in their environment (excluding the rare case where bats and avifauna fly extremely close to an anthropogenic noise, such as from a moving car or the blades of a wind turbine).

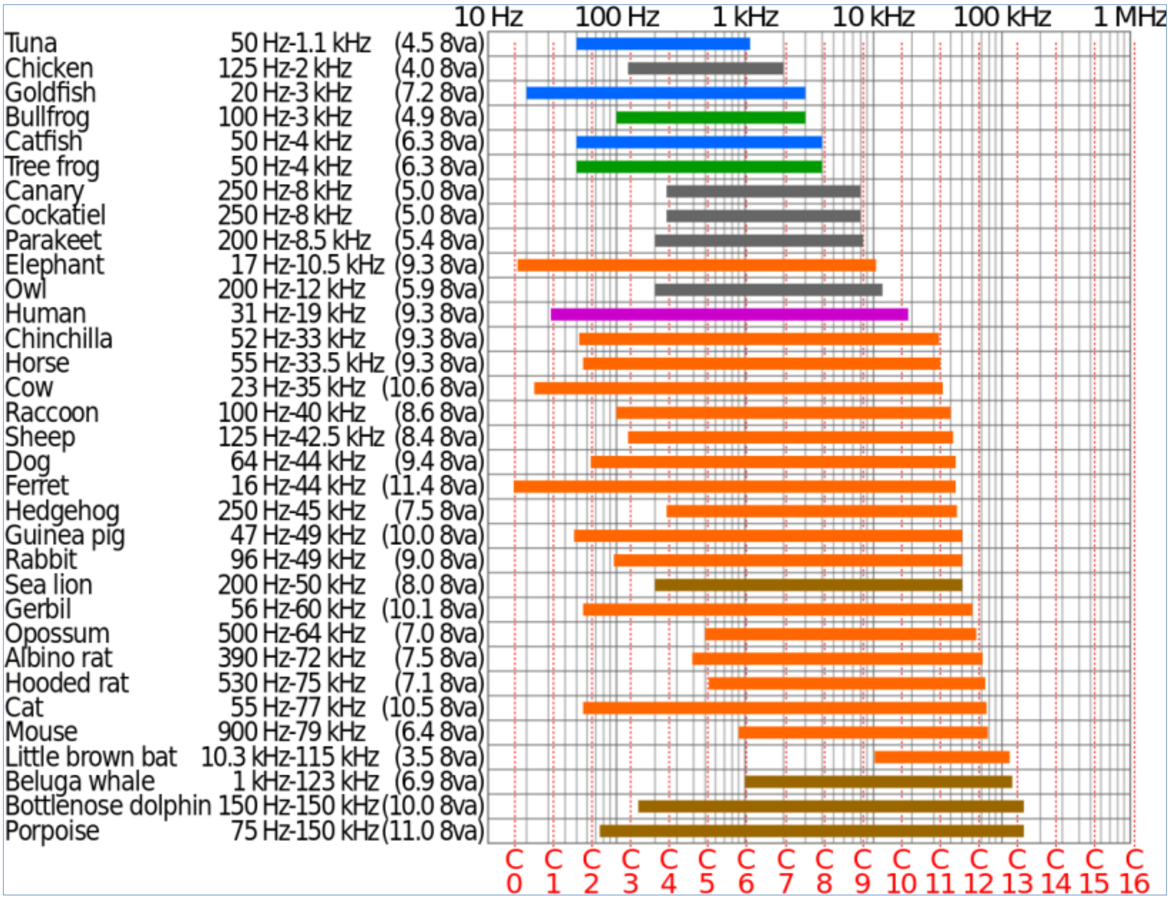

Figure 6-1: Logarithmic Chart of the Hearing Ranges of Some Animals[2]

6.1.1 Domestic 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)[3&4].The high noise levels may see negative influences on animals' cardiovascular systems and behaviour, and may be damaging to the hearing of dogs in the kennel facility[5].

[2] https://en.wikipedia.org/wiki/Hearing_range

[3] Crista L. Coppola. Noise in the Animal Shelter Environment: Building Design and the Effects of Daily Noise Exposure.

[4] David Key, Essential Kennel Designs.

[5] Wei, B. L. (1969). Physiological effects of audible sound. AAAS Symposium Science, 166(3904), 533-535.

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 due to any slight unfamiliar sounds or noises. 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. How small changes (in environmental noise levels) may impact on domesticated animals has not been studied.

According to Šottník, 2011, noise as high as 80 dB had no negative effect on dairy cows. As noise levels increased (up to 105 dB), feed consumption, milk yield and intensity of milk release decreased. Gygax and Nosal (2006) investigated the effect of vibration and noise on somatic cell counts (SCC) in milk, highlighting that SCC increased with an increasing intensity of vibration but not with acoustic noise. The study reported vibration as m/s^2, with SCC increasing as vibration increases above 0.1 m/s^2.

Unexpected high intensity noise (above 110 dB), such as low altitude jet aircraft over-flights at milking time could reduce effectiveness of the milk ejection reflex, decrease efficiency of milk removal, increase residual milk, and lead to overall reduction in milk yield. However, a majority of the studies reviewed suggests that there is little or no effect of aircraft noise on cattle. Adverse effects of low-altitude flights have been noted in some studies but have not been uniformly reproduced in other reports (Manci, 1988).

6.1.2 Wildlife

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, noise levels during early morning dawn chorus or loud cicada noises during late evening or early morning.

Potential noise impacts on wildlife are very highly species dependent. Studies showed that most animals adapt to noises and would even return to a site after an initial disturbance, even if the noise continues. The more sensitive animals that might be impacted by noise would most likely relocate to a quieter area. Stress levels can increase in animals restricted to areas where the sound levels are impacting on them (due to the level, character or both). Sound levels above about 90 dB are likely to be aversive to mammals and are associated with a number of behaviours such as retreat from the sound source, freezing, or a strong startle response. Manci (1988) highlighted that sound levels below about 90 dB usually causes much less aversive behaviour. Laboratory studies of domestic mammals have indicated that behavioural responses vary with noise types and levels as well as that domestic animals appear to acclimate to some sound disturbances (see also Annexure C).

6.1.3 Avifauna[6]

Noise impacts on birds include:

- It can cause hearing damage (very loud or loud impulsive sounds);
- It can increase stress levels (directly and indirectly);
- Masking (directly or indirectly) the sounds of their food, predators or mates;
- Their typical food sources may move;
- Relocation to less suitable habitats; &
- other behavioral reactions.

As with the impact on other wildlife, the impact of noise on avifauna depends on the character of the noise (including the impulsive character), the magnitude or intensity of the noise as well as the familiarity the birds have with the sound.

Similarly, different birds change their response to these sounds differently. Some may not be impacted while more sensitive species may relocate, some birds –

- may start to sing at different times;
- may change the frequency, pitch or character of their calls/singing/signals; or/and
- increase the volume of their calls/singing/signals.

As with other animals, there are no guidelines or even studies highlighting acceptable sound levels or other criteria before noise may start to impact on birds.

6.1.4 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.[7] 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[8].

6.1.5 Summary: Impact of noises on Animals

From these and other studies the following can be concluded that:

[6] Ortega, 2012; Halfwerk, 2011; Francis, 2012; Francis, 2011; Parris, 2009, Brumm, 2004.

[7]USEPA, 1971.

[8] Baldwin, 2007.

- Animals respond to impulsive (sudden) noises (higher than 90 dB) by running away. If the noises continue, animals would try to relocate (Brouček, 2014);
- Animals start to respond to increased noise levels with elevated stress hormone levels and hypertension. These responses begin to appear at exposure levels of 55 to 60 dBA (Barber, 2010);
- Animals of most species exhibit adaptation with noise (Brouček, 2014), including impulsive noises, by changing their behaviour;
- 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 (Dooling, 2007); &
- Noises associated with helicopters, motor- and quad bikes does significantly impact on animals. This is due to the sudden and significant increase in noise levels due to these activities.

To date there are, however, no guidelines or sound limits with regards to noise levels that can be used to estimate the potential significance of noises on animals.

6.2 WHY NOISE CONCERNS COMMUNITIES[9]

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); &
- Presents a health risk due to hearing damage.

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.

[9] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

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 like to sleep.

Severity of the annoyance depends on factors such as:

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

6.3 IMPACT ASSESSMENT CRITERIA

6.3.1 Noise Impacts and requirements for different land uses

The development of the proposed SEZ will result in a number of land use zones, including:

- Industrial areas (heavy and light), where a night-time boundary noise level of up to 70 dBA would be normal;
- Commercial, retail and business areas, where daytime boundary noise levels may be as high as 65 dBA, with night-time boundary noise levels dropping to less than 55 dBA (although it may be significantly less); &
- Residential areas, where ambient sound levels should be managed to be less than 45 dBA at night (55 dBA during the day).

Due to the different requirements, mix land use developments should consider and divide land uses into noise generators (industry and transport) and noise receptors (NSDs in this report). This is to ensure that the NSD are not unduly impacted by excessing noise levels as discussed in the following sections.

6.3.2 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; &
- 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.

6.3.3 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts considering the latest EIA Regulations, 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 (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 6-2**;
- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 6-1**; &
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 6-1**). 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.

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

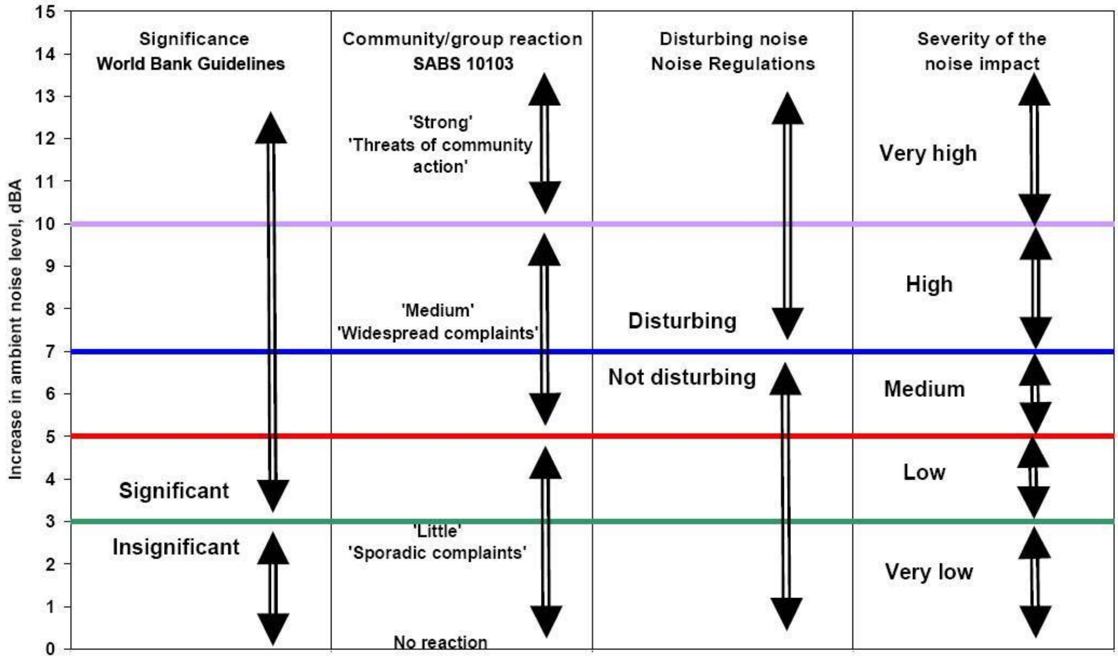

Figure 6-2: Criteria to assess the significance of impacts stemming from noise

Table 6-1: 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

6.3.4 Recommended Noise Limits

Acoustical measurements indicated an area where the ambient sound levels are typically of a rural noise district, and the potential conceptual noise impact (as should future ENIAs that should be completed for specific projects) was evaluated in terms of (i.t.o.) the following Zone Sound Levels (proposed rating levels):

- “Rural District” (45 and 35 dBA day/night-time Rating i.t.o. SANS 10103:2008) – Existing NSD staying further than 500m from the N1 highway or existing noise sources (such as Syferfontein Dolomite); &
- “Equator principles” (55 and 45 dBA day/night-time Rating i.t.o. IFC Noise Limits). These noise limits is the same as the “Urban District” rating, suitable for residential use.

In addition, considering the information contained in **section 6.1**, animals start to respond to increased noise levels of 55 to 60 dBA (Barber, 2010). However, this report will not consider the potential impact on animals, as the increased activities relating to the development of the SEZ will most likely result in animals relocating to a less stressful environment.

The development of appropriate noise limits (or acceptable rating levels) for a mixed land use development need to consider a number of requirements, including:

- ***Noise generator:*** Industrial areas (heavy and light), where a night-time boundary noise level of up to 70 dBA would be normal;
- ***Noise generator:*** Commercial and retail areas, where daytime boundary noise levels may be as high as 65 dBA, with night-time boundary noise levels dropping to less than 55 dBA (although it may be significantly less);
- ***Potential NSD and/or noise generator:*** Business areas (not significantly noise sensitive – administration and offices), where noises are generally generated by traffic and cooling systems with business activities not commonly generating significant noises. To ensure that ambient sound levels are not excessive (without the use of acoustic treatment to reduce intrusion noise levels), such activities should not be located in very noisy districts or land use zones. Frequently such land uses are allowed in the commercial / retail zones, although ideally it should be located on the edge of commercial / retail zones to assist in creating a buffer between a more noisy and quieter areas;
- ***Potential NSD:*** Business areas (noise sensitive), where noises are generally generated by traffic and cooling systems. Outdoor ambient sound levels should be managed while considering the land use, type of occupancy and / or indoor activity that may take place in the area. Table 1 of SANS 10103:2008 does provide guidelines for design and maximum equivalent continuous rating levels for ambient noise (noise limits) for certain uses (see also Appendix D). These land uses, occupancies and/or activities desire a quieter environment to ensure acceptable land use (such as a hotels, hospitals, schools, libraries, religious and community facilities as well as recreational activities). To ensure that ambient sound levels are not excessive (without the use of acoustic treatment to reduce intrusion noise levels), such zones should not be located in very noisy districts or land use zones and are normally located within, or on the edge of residential areas; &

- ***Definite NSD:*** Residential areas, where ambient sound levels should be managed to be less than 45 dBA at night (55 dBA during the day).

6.4 DETERMINING THE SIGNIFICANCE OF THE NOISE IMPACT

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Guidelines, published by the Department of Environmental Affairs and Tourism (DEAT, 2002). It requires an assessment of the nature (status), extent, duration, probability and significance of the identified potential environmental impacts of proposed projects.

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 summing the scores of Magnitude (**Table 6-2**), Duration (**Table 6-3**) and Spatial Extent (**Table 6-4**). The impact significance (see **Sections 6.4.1** and **Section 6.4.2**) is determined by multiplying the Consequence result with the Probability score (**Table 6-5**). An explanation of the impact assessment criteria is defined in the following tables.

Recommendation: To allow future ENIA to estimate the significance of proposed activities located within the SEZ, it is recommended that the acoustic specialist employ the same criteria and rating system.

Table 6-2: 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 $L_{Aleq,8hr}$ or $L_{Aleq,16hr}$ during measurement dates. Total projected noise level is less than the Zone Sound Level and/or IFC noise limits 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 IFC noise limits (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 IFC noise limits (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 IFC noise limits (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 IFC noise limits (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 where instantaneous noise levels exceed 65 dBA at any receptor.	10

Table 6-3: 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 6-4: 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 (further than 1,000 m from site).	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 6-5: 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,	1

	design or experience. The chance of this impact occurring is zero (0%).	
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% and 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 6-6** were used.

6.4.1 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).

6.4.2 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 was necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale:

Table 6-6: 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

Table 6-7: Significance without mitigation

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. An impact which could influence the decision about whether or not to proceed with the project.

Table 6-8: Significance with mitigation

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.

7 POTENTIAL NOISE SOURCES

7.1 NOISE FROM ACTIVITIES AND EQUIPMENT

Increased noise levels are directly linked with the various activities associated with the construction of the proposed SEZ and related infrastructure, as well as the operational phase of the activity. This section will only generically look at conceptual noise sources to assist in the identification of potential concerns. It will be required and recommended that future project specifically look at their potential noise impact on the identified NSDs as well as any new NSDs.

The development of the SEZ could result in a number of different noise generating activities, from various equipment during different operating periods. Increased traffic volumes will cumulatively add to existing and future noises.

Potential maximum noise levels generated by a few selected equipment and activities, as well as the potential extent, are presented in **Table 7-1**. 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 characteristics of the noise and the ambient soundscape in the surroundings.

Average or equivalent sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the NSD can experience. Typical sound power levels associated with a few selected activities and equipment that may be found within such a SEZ is presented in **Table 7-2**.

The level and character of the noise (during all phases of the SEZ) will be highly variable as different activities with different equipment take place at different times, for different periods of time (operating cycles), in different combinations/sequences and on different parts of the construction site.

Other factors, such as cumulative effects from simultaneous activities, projects and operations in the area, topography, layout of project (where buildings may shield some noises), the location of the project in relation with buildings that may act as a sound barrier and the distance to the closest potential noise-sensitive receptors / NSDs will determine the actual noise level in practice. This however can only be calculated once the specifics of each proposed project are known.

Recommendation: That an ENIA be completed for certain projects as information becomes available.

Table 7-1: Potential maximum noise levels generated by various activities and equipment

Equipment Description[10]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential maximum noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included - simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
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
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
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
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
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
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

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

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
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
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
Rivet 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
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
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
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 7-2: 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
Ball Mill (Chrome)	110.1	85.2	79.1	73.1	65.2	59.1	55.6	53.1	49.6	45.2	41.6	39.1	33.1
Breaking of cast ingots	125.5	100.5	94.5	88.5	80.5	74.5	71.0	68.5	64.9	60.5	57.0	54.5	48.5
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
Cement truck (with cement)	111.7	86.7	80.7	74.7	66.7	60.7	57.2	54.7	51.2	46.7	43.2	40.7	34.7
Coal crushing plant (50 k tons)	114.5	89.5	83.5	77.5	69.5	63.5	60.0	57.5	54.0	49.5	46.0	43.5	37.5
Coal Pulverisers	96.0	71.0	65.0	58.9	51.0	45.0	41.4	38.9	35.4	31.0	27.5	25.0	18.9
Cyclone (hard rock)	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
Compressor Doosan (Large)	116.3	91.3	85.3	79.3	71.3	65.3	61.8	59.3	55.8	51.3	47.8	45.3	39.3
Cooling fans	111.8	86.8	80.8	74.8	66.8	60.8	57.3	54.8	51.3	46.8	43.3	40.8	34.8
Crusher (Chrome)	121.7	96.7	90.7	84.7	76.7	70.7	67.2	64.7	61.2	56.7	53.2	50.7	44.7
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
Elevated Flare / (flue gas stack)	124.0	99.0	93.0	87.0	79.0	73.0	69.5	67.0	63.5	59.0	55.5	53.0	47.0
Excavator	112.0	87.0	81.0	75.0	67.0	61.0	57.5	55.0	51.4	47.0	43.5	41.0	35.0
Front End Loader (CAT 988)	115.6	90.7	84.6	78.6	70.7	64.6	61.1	58.6	55.1	50.7	47.1	44.6	38.6

Flotation	104.4	79.4	73.4	67.3	59.4	53.4	49.8	47.3	43.8	39.4	35.9	33.4	27.3
Furnace fans	115.2	90.2	84.2	78.2	70.2	64.2	60.7	58.2	54.7	50.2	46.7	44.2	38.2
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
General Noise - Construction (commercial)	96.5	71.6	65.6	59.5	51.6	45.6	42.0	39.5	36.0	31.6	28.1	25.6	19.5
Generator building	96.0	71.0	65.0	59.0	51.0	45.0	41.5	39.0	35.5	31.0	27.5	25.0	19.0
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
Intake Fans	97.7	72.8	66.8	60.7	52.8	46.8	43.2	40.7	37.2	32.8	29.3	26.8	20.7
Reactor building, Vanadium	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.4	46.9	43.4	40.9	34.9
Reclaiming plant	121.7	96.7	90.7	84.7	76.7	70.7	67.2	64.7	61.2	56.7	53.2	50.7	44.7
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
Screening plant (approx. 50k tons)	105.5	80.6	74.6	68.5	60.6	54.6	51.0	48.5	45.0	40.6	37.0	34.6	28.5
Silenced radiator	98.3	73.4	67.3	61.3	53.4	47.3	43.8	41.3	37.8	33.4	29.8	27.3	21.3
Smelter building	120.8	95.8	89.8	83.7	75.8	69.8	66.2	63.7	60.2	55.8	52.3	49.8	43.7
Steam Turbine Condenser	105.4	80.4	74.4	68.4	60.4	54.4	50.9	48.4	44.9	40.4	36.9	34.4	28.4
Steam venting	101.7	76.7	70.7	64.7	56.7	50.7	47.2	44.7	41.2	36.7	33.2	30.7	24.7
Spiral (Hard Rock)	109.2	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.0	44.6	41.1	38.6	32.6
Water Cooling Fans	113.0	88.0	82.0	76.0	68.0	62.0	58.5	56.0	52.4	48.0	44.5	42.0	36.0
Substation - one transformer	80.2	55.3	49.2	43.2	35.3	29.2	25.7	23.2	19.7	15.3	11.7	9.2	3.2

8 ASSUMPTIONS AND LIMITATIONS

8.1 MEASUREMENTS OF AMBIENT SOUND LEVELS

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. High measurements may not necessarily mean that noise levels in the area are high. 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 the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced a measurement using the reading result at the end of the measurement. Therefore trying to define ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above (one of the reasons why long-term measurements were collected). The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined. When short-term measurements was collected, one should be cautious and consider other sound descriptors (such as L_{A90} values), together with an opinion of the character of the area;
- It is assumed that the measurement locations represent residential dwellings in the area (similar environment), yet, in practice this can be highly erroneous as there are numerous factors that can impact on ambient sound levels, including:
  - the distance to closest trees, number and type of trees as well as the height of trees;
  - available habitat and food for birds and other animals;
  - distance to residential dwelling, type of equipment used at dwelling (compressors, air-cons);
  - general maintenance condition of house (especially during windy conditions); &
  - number and type of animals kept in the vicinity of the measurement locations (typical land use taking place around the dwelling).;
- Exact location of a sound level meter in an area in relation to structures, infrastructure, vegetation and external noise sources will influence measurements. It may determine whether one is measuring anthropogenic sounds from a receptors dwelling, or environmental ambient soundscape contributors of significance (faunal,

road traffic, railway line movement etc.). At times there are extraneous noises that cannot be heard during deployment, or not operational, that can significantly impact on readings (such as water pumps, transformers, faunal communication, etc.);

- Determination of existing road traffic and other noise sources of significance are important (traffic counts etc.). Traffic however is highly dependent on the time of day as well as general agricultural activities taking place during the site investigation. Traffic noise is one of the major components in urban areas and could be a significant source of noise during busy periods. Traffic may be audible at distances up to 3,000 m during quiet periods (little faunal and other noises), especially if the wind blows from the road to the receptors;
- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises. While the windshields used limits the effect of fluctuating pressure across the microphone diaphragm, the effect of wind-induced noises in the trees in the vicinity of the microphone did impact on the ambient sound levels. The site visit coincided with relatively low winds;
- Ambient sound levels are dependant not only on time of day and meteorological conditions, but also change due to seasonal differences. Ambient sound levels are generally higher in summer months when faunal activity is higher and lower during the winter due to reduced faunal activity. Many faunal species are more active during warmer periods than colder 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[11]. Winter months unfortunately also coincide with lower temperatures and very stable atmospheric conditions, ideal conditions for propagation of noise though faunal activity (and sounds) may be lower;
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high. This is due to faunal activity which can dominate the sound levels around the measurement location. This generally is still considered naturally quiet and understood 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_{AIeq}, L_{AFeq}, L_{Ceq}, L_{AMax}, L_{A10}, L_{A90} and spectral analysis forms part of the many variables that can be considered; &

[11]Clyne, D. *"Cicadas: Sound of the Australian Summer, Australian Geographic"* Oct/Dec Vol 56. 1999.

- As a residential area develops the presence of people will result in increased 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.

8.2 CALCULATING NOISE EMISSIONS – ADEQUACY OF PREDICTIVE METHODS

Project specifics are not yet know, and no noise model was developed. This assessment however looks at the worse-case scenario using the potential extent of noises from potential activities. It use simplified sound propagation model based on the ISO 9613-2 algorithm and considers the following.

- The sound power emission levels of processes and equipment; &
- The distance of the receiver from the noise sources.

This simplified model does not consider the following factors which must be evaluated on a project by project basis:

- The octave band sound pressure emission levels of processes and equipment, neither the height of potential noise sources;
- The operational details of the proposed project, such as projected areas where activities will be taking place;
- Potential cumulative effects;
- Potential shielding from proposed buildings;
- Meteorological effects;
- Ground surface effects;
- Topographical layout; &
- Acoustical characteristics of the ground. 50% soft ground conditions were modelled, as the area where the mining activity would be taking place is well vegetated and sufficiently uneven to allow the consideration of relatively soft ground conditions. This is because the use of hard ground conditions could represent a too precautionary situation.

The noise emission into the environment due to additional traffic was not calculated which should be calculated in a project basis once detailed information are available.

8.3 ADEQUACY OF UNDERLYING ASSUMPTIONS

Noise experienced at a certain location is the cumulative result of innumerable sounds emitted and generated both far and close, each in a different time domain, each having a different spectral character at a different sound level. Each of these sounds are also impacted differently by surrounding vegetation, structures and meteorological conditions that result in a total cumulative noise level represented by a few numbers on a sound level meter.

As previously mentioned, it is not the purpose of noise modelling to accurately determine a likely noise level at a certain receptor, but to calculate a noise rating level that is used to identify potential issues of concern.

8.4 UNCERTAINTIES ASSOCIATED WITH MITIGATION MEASURES

Any noise impact can be mitigated to have a low significance; however, the cost of mitigating this impact may be prohibitive, or the measure may not be socially acceptable (such as the relocation of a NSD). These mitigation measures may be engineered, technological or due to management commitment.

Intended for the purpose of the determination of the significance of the noise impact mitigation measures were selected that is feasible, mainly focussing on management of noise impacts using rules, policy and require a management commitment. This however does not mean that noise levels cannot be reduced further, only that to reduce the noise levels further may require significant additional costs (whether engineered, technological or management).

9 PROJECTED NOISE RATING LEVELS

This study assesses the potential worse-case scenario and mainly considers the night-time period. This is because people are more sensitive for intrusion noises at night, a period when a quieter environment is required. In addition, there are fewer acceptances of intrusion noises in a rural noise district, especially at night.

Considering the **Table 7-2**, there are a number of noisy activities or equipment (normally associated with heavy industry) that could change ambient sound levels as far as 2,000 m from these noisy activities or equipment. As it is unknown where the heavy industry may be located as this would effectively enclose the proposed SEZ site as depicted in **Figure 9-1** (e.g. worse-case with the larger area used for heavy industry).

Work done on industrial projects (including actual noise measurements and noise modelling) indicated that an industrial project in a rural noise district could change the noise levels higher than:

- 45 dBA at 2,000 m (green to yellow line in **Figure 9-2**). At this distance the activities or equipment will be audible during the quieter periods at night, and more noise-sensitive receptors may raise complaints about the noises;
- 50 dBA at 1,000 m (yellow to red line in **Figure 9-2**). At this distance the activities or equipment will be clearly audible at night and receptors may raise complaints about the noises; &
- 55 dBA at 500 m (area within red line in **Figure 9-2**). At this distance the activities or equipment will be clearly audible at night. It is highly likely that some receptors will complain about the intrusion noises.

It should be noted that this is a potential worse-case scenario, as buildings may shield some noises with ground conditions and atmospheric absorption may assist with the attenuation of noises over distance.

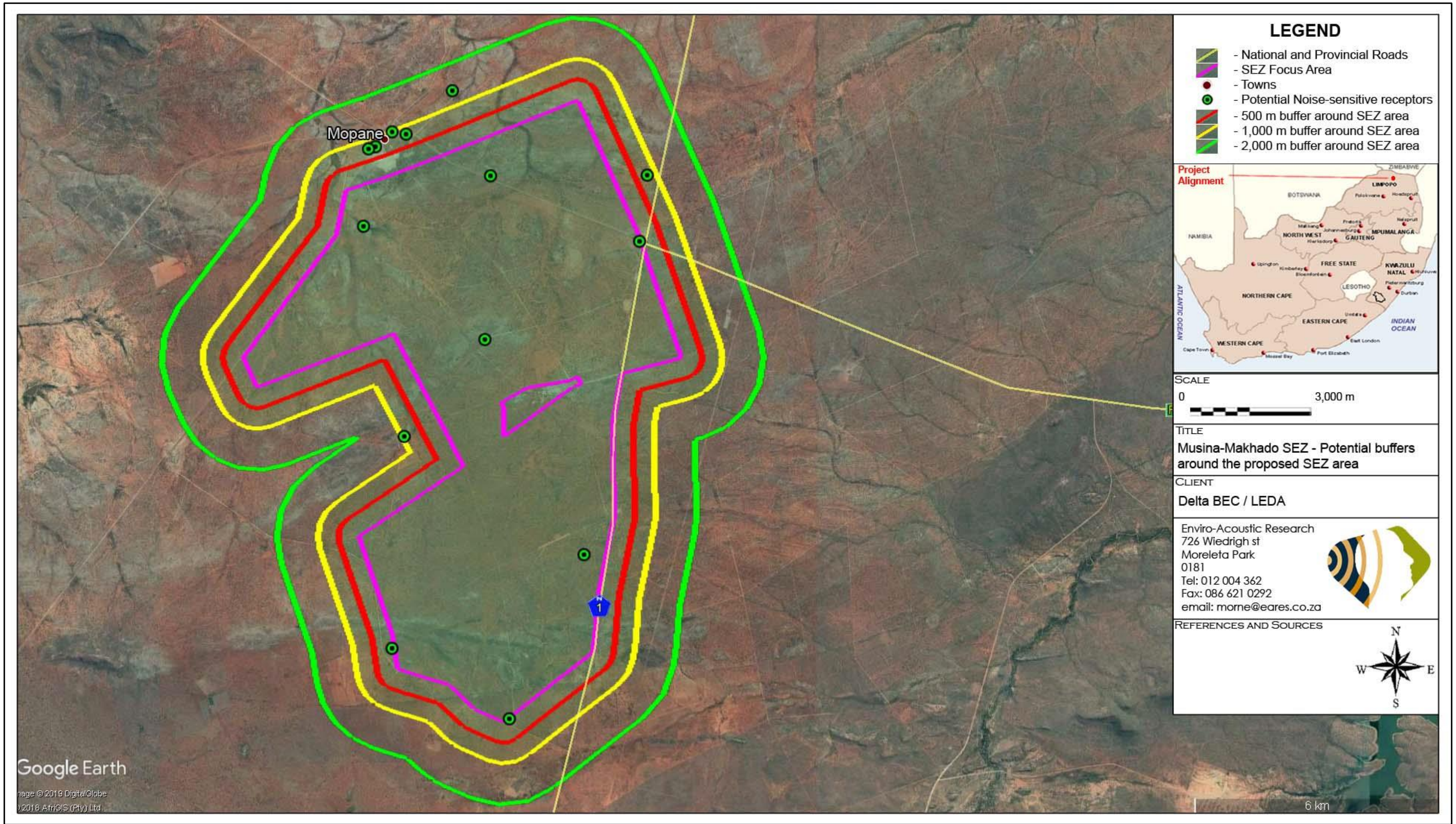

Figure 9-1: Worse-case scenario, buffers around the proposed project area

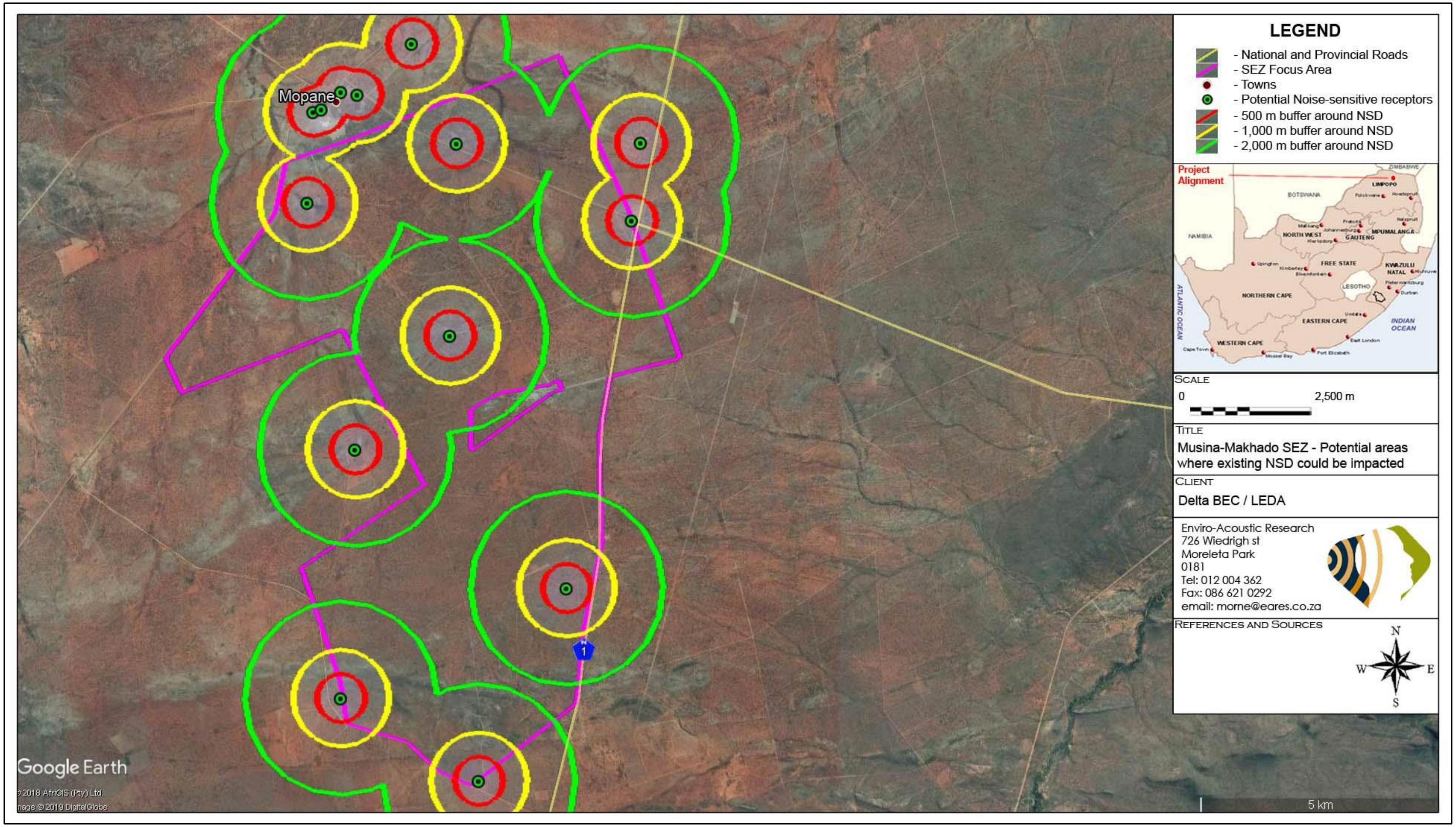

Figure 9-2: Worse-case scenario, buffers around the identified NSD in the focus area

10 SIGNIFICANCE OF THE POTENTIAL NOISE IMPACTS

10.1 POTENTIAL NOISE IMPACT – EXISTING NSD (USED TO QUIET ENVIRONMENT)

The potential noise impacts for the conceptual activities as conceptualised and estimated in **Section 9**. Three scenarios were considered, namely:

- Noise levels between 45 – 50 dBA at the houses of existing NSD, approximately 2,000 – 1,000m from the closest industrial noise sources;
- Noise levels between 50 - 55 dBA at the houses of existing NSD, approximately 1,000 – 500m from the closest industrial noise sources; &
- Noise levels exceeding 55 dBA at the houses of existing NSD, closer than 500m from industrial noise sources.

Excluding the area close to the N1 (approximately 500m) and a similar area around the Syferfontein Dolomite quarry, most of the focus area has an undeveloped and natural character, with the dominant sounds being mainly wind-induced and of faunal origin.

The potential significance of the noise impacts is summarized in **Table 10-1** (noise levels between 45 and 50 dBA at night), **Table 10-2** (noise levels between 50 and 55 dBA at night) and Table 10-3 (noise levels exceeding 55 dBA).

Table 10-1: Impact Assessment: Noise levels between 45 and 50 dBA

Nature:	***Numerous simultaneous industrial activities and equipment operating closer than 2,000m from NSD used to a quiet environment at night***	
Acceptable Rating Level	Area has a rural development character, confirmed by onsite ambient sound level measurements. Night-time ambient sound levels range between 33 and 45 dBA. Use $L_{Req,N}$ of 35 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude ***(Table 6-2)***	Noises will be just audible to clearly audible at closest NSD. Introduced noises may change ambient sound levels from 3 to more than 7 dBA. Low to high - 2 to 8	Noises will be just audible at closest NSD. Introduced noises may change ambient sound levels from 3 to more than 7 dBA. Low to high - 2 to 8
Duration ***(Table 6-3)***	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent – 5)	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent – 5)
Extent ***($\Delta L_{Aeq,D}$>7dBA)*** ***(Table 6-4)***	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional – 3)	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional – 3)

Probability ***(Table 6-5)***	Probable (2)	Improbable (1)
Significance of Impact	(8 + 5 + 3) x 2 = 32 Medium	(8 + 5 + 3) x 1 = 15 Low
Comments	Worst case scenario with numerous noisy heavy industry activities and equipment assumed.	
Degree of Confidence	High	
Mitigation:	- Do not allow the development of industrial zones closer than 2,000m from existing NSDs. If no alternative exist an ENIA must be completed to consider the noise impact on the NSD; & - Relocation of NSDs (purchase of the farms located within focus area).	
Cumulative impacts	Noises will cumulative add the noises from traffic on the N1 road.	
Residual Impacts:	The SEZ will permanently change the soundscape in the focus area.	

Table 10-2: Impact Assessment: Noise levels between 50 and 55 dBA

Nature:	***Numerous simultaneous industrial activities and equipment operating closer than 1,000m from NSD used to a quiet environment at night***	
Acceptable Rating Level	Area has a rural development character, confirmed by onsite ambient sound level measurements. Night-time ambient sound levels range between 33 and 45 dBA. Use $L_{Req,N}$ of 35 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude ***(Table 6-2)***	Noises will be clearly audible at closest NSD. Introduced noises may change ambient sound levels with more than 7 dBA. Medium to very high - 6 to 10	Noises will be just audible at closest NSD. Introduced noises may change ambient sound levels from 3 to more than 7 dBA. Low to high - 2 to 8
Duration ***(Table 6-3)***	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)
Extent ($\Delta L_{Aeq,D}$>7dBA) ***(Table 6-4)***	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)
Probability ***(Table 6-5)***	Likely to highly likely (4)	Improbable (1)
Significance of Impact	(10 + 5 + 3) x 4 = 72 High	(8 + 5 + 3) x 1 = 15 Low
Comments	Worst case scenario with numerous noisy heavy industry activities and equipment assumed.	

Degree of Confidence	High
Mitigation:	- Do not allow the development of industrial zones closer than 2,000m from existing NSDs. If no alternative exist an ENIA must be completed to consider the noise impact on the NSD; & - Relocation of NSDs (purchase of the farms located within focus area).
Cumulative impacts	Noises will cumulative add the noises from traffic on the N1 road
Residual Impacts:	The SEZ will permanently change the soundscape in the focus area.

Table 10-3: Impact Assessment: Noise levels higher than 55 dBA

Nature:	***Numerous simultaneous industrial activities and equipment operating closer than 500m from NSD used to a quiet environment at night***	
Acceptable Rating Level	Area has a rural development character, confirmed by onsite ambient sound level measurements. Night-time ambient sound levels range between 33 and 45 dBA. Use $L_{Req,N}$ of 35 dBA (rural)	
	Without Mitigation	***With Mitigation***
Magnitude (Table 6-2)	Noises will be clearly audible at closest NSD. Introduced noises may change ambient sound levels with more than 7 dBA. Very high - 10	Noises will be just audible at closest NSD. Introduced noises may change ambient sound levels from 3 to more than 7 dBA. Low to high - 2 to 8
Duration (Table 6-3)	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)
Extent ($\Delta L_{Aeq,D}$>7dBA) (Table 6-4)	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)
Probability (Table 6-5)	Definite (5)	Improbable (1)
Significance of Impact	(10 + 5 + 3) x 5 = 90 High	(8 + 5 + 3) x 1 = 15 Low
Comments	Worst case scenario with numerous noisy heavy industry activities and equipment assumed.	
Degree of Confidence	High	
Mitigation:	- Do not allow the development of industrial zones closer than 2,000m from existing NSDs. If no alternative exist an ENIA must be completed to consider the noise impact on the NSD; & - Relocation of NSDs (purchase of the farms located within focus area).	
Cumulative impacts	Noises will cumulative add the noises from traffic on the N1 road.	

Residual Impacts:	The SEZ will permanently change the soundscape in the focus area.

10.2 POTENTIAL NOISE IMPACT – NSD (USED TO INCREASED SOUND LEVELS)

As the SEZ are developed, the soundscape will change and the ambient sound levels will increase from a typical rural noise district to that of a sub-urban to commercial noise district. Potential NSD more used to higher ambient sound levels will include:

- NSDs staying close to the town of Mopane;
- NSDs staying close to the N1 national road; &
- NSDs working at, or visiting the SEZ development.

These NSDs will be more used to sound levels typical of an urban noise district and three scenarios can again be considered, namely:

- Noise levels between 45 – 50 dBA at the houses of existing NSD, approximately 2,000 – 1,000m from the closest heavy industrial noise sources;
- Noise levels between 50 - 55 dBA at the houses of existing NSD, approximately 1,000 – 500m from the closest heavy industrial noise sources; &
- Noise levels exceeding 55 dBA at the houses of existing NSD, closer than 500m from heavy industrial noise sources.

The potential significance of the noise impacts is summarized in **Table 10-4** (noise levels between 45 and 50 dBA at night), **Table 10-5** (noise levels between 50 and 55 dBA at night) and Table 10-5 (noise levels exceeding 55 dBA).

Table 10-4: Impact Assessment: Noise levels 45 – 50 dBA

Nature:	***Numerous simultaneous industrial activities and equipment operating closer than 2,000m from NSD used to ambient sound levels typically associated with an urban noise district at night***	
Acceptable Rating Level	Ambient sound levels should be suitable for residential use at the NSD. Use $L_{Req,N}$ of 45 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude ***(Table 6-2)***	Sound levels of 45 – 50 dBA are 0 – 5 dB higher than a typical urban noise district and a. Low to Low-medium – 2 to 4	Sound levels of 45 – 50 dBA are 0 – 5 dB higher than a typical urban noise district and a. Low to Low-medium – 2 to 4
Duration ***(Table 6-3)***	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent – 5)	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent – 5)
Extent ($\Delta L_{Aeq,D}$>7dBA)	Noises could change ambient sound levels further than 1,000m from the noise-	Noises could change ambient sound levels further than 1,000m from the noise-

(Table 6-4)	generating activities. (Regional - 3)	generating activities. (Regional - 3)
Probability ***(Table 6-5)***	Improbable (1)	Improbable (1)
Significance of Impact	(4 + 5 + 3) x 1 = 12 Low	(4 + 5 + 3) x 1 = 12 Low
Comments	Worst case scenario with numerous noisy heavy industry activities and equipment assumed.	
Degree of Confidence	**High**	
Mitigation:	- Should a heavy industry (with cooling/exhaust/intake/induced draft fans or exhaust stacks higher than 20m) be developed within 2,000m from a NSD, or an area that may in the future be used for residential purposes, an ENIA must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact. See clause 5.4 (i)]) and 5.4 (l) of SANS 10328:2008.	
Cumulative impacts	Noises will cumulative add the noises from traffic as well as other noise generating activities taking place within 2,000m.	
Residual Impacts:	The SEZ will permanently change the soundscape in the focus area.	

Table 10-5: Impact Assessment: Noise levels 50 – 55 dBA

Nature:	***Numerous simultaneous industrial activities and equipment operating closer than 1,000m from NSD used to ambient sound levels typically associated with an urban noise district at night***	
Acceptable Rating Level	Ambient sound levels should be suitable for residential use at the NSD. Use $L_{Req,N}$ of 45 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude ***(Table 6-2)***	Sound levels of 50 - 55 dBA are 5 - 10 dB higher than a typical urban noise district and a. Medium to Very High - 6 to 10	Sound levels of 45 - 50 dBA are 0 - 5 dB higher than a typical urban noise district and a. Low to Low-medium - 2 to 4
Duration ***(Table 6-3)***	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)
Extent ($\Delta L_{Aeq,D}$>7dBA) ***(Table 6-4)***	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)
Probability ***(Table 6-5)***	Probable (2) to Likely (3)	Improbable (1)
Significance of	(10 + 5 + 3) x 3 = 54	(4 + 5 + 3) x 1 = 12

Impact	Medium	Low
Comments	Worst case scenario with numerous noisy heavy industry activities and equipment assumed.	
Degree of Confidence	High	
Mitigation:	- Ideally no industrial areas should be planned closer than 1,000m from a NSD (residential areas and activities requiring a quieter soundscape). Similarly, no NSD should be allowed to develop within 1,000m from an area zoned for industrial use; & - Should an industry be planned or proposed within 1,000m from a NSD, or an area that may in the future be used for residential purposes, a ENIA must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact. See clause 5.4 (g)]) and 5.4 (h) of SANS 10328:2008. If the noise levels due to the proposed new industry may result in noise levels exceeding 50 dBA at NSD, management and mitigation measures must be implemented to ensure that the noise level at the NSD are less than 50 dBA.	
Cumulative impacts	Noises will cumulative add the noises from traffic as well as other noise generating activities taking place within 2,000m.	
Residual Impacts:	The SEZ will permanently change the soundscape in the focus area.	

Table 10-6: Impact Assessment: Noise levels exceeding 55 dBA

Nature:	***Numerous simultaneous industrial activities and equipment operating closer than 500m from NSD used to ambient sound levels typically associated with an urban noise district at night***	
Acceptable Rating Level	Ambient sound levels should be suitable for residential use at the NSD. Use $L_{Req,N}$ of 45 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude ***(Table 6-2)***	Sound levels of 55 dBA are 15 dB higher than a typical urban noise district and a. Very High - 10	Sound levels of 45 - 50 dBA are 0 - 5 dB higher than a typical urban noise district and a. Low to Low-medium - 2 to 4
Duration ***(Table 6-3)***	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)	Noise levels will remain elevated for duration of project (longer than 20 years). (Permanent - 5)
Extent ($\Delta L_{Aeq,D}$>7dBA) ***(Table 6-4)***	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)	Noises could change ambient sound levels further than 1,000m from the noise-generating activities. (Regional - 3)
Probability ***(Table 6-5)***	Highly Likely (4)	Improbable (1)
Significance of Impact	(10 + 5 + 3) x 4 = 72 Medium	(4 + 5 + 3) x 1 = 12 Low
Comments	Worst case scenario with numerous noisy heavy industry activities and equipment assumed.	

Degree of Confidence	**High**
Mitigation:	- No industrial areas must be developed or permitted within 500m from an NSD; - No NSD to be permitted to develop within 500m from an industrial area; - An ENIA to be compiled should a NSD be planned within 500m from the N1 highway or similar busy road; - Ideally no industrial areas should be planned closer than 1,000m from NSD (residential areas and activities requiring a quieter soundscape). Similarly, no NSD should be allowed to develop within 1,000m from an area zoned for industrial use; & - Should an industry be planned or proposed within 1,000m from and NSD, or an area that may in the future be used for residential purposes, a ENIA must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact. See clause 5.4 (g)]) and 5.4 (h) of SANS 10328:2008. If the noise levels due to the proposed new industry may result in noise levels exceeding 50 dBA at NSD, management and mitigation measures must be implemented to ensure that the noise level at the NSD are less than 50 dBA.
Cumulative impacts	Noises will cumulative add the noises from traffic as well as other noise generating activities taking place within 2,000m.
Residual Impacts:	The SEZ will permanently change the soundscape in the focus area.

11 MITIGATION OPTIONS

11.1 PLANNING PHASE OF THE SEZ

The proposed SEZ will introduce a number of activities and land used that will change the soundscape significantly. While this SEZ will develop over a number of years, the development will introduce noises into an area that is largely rural and undeveloped, with sound levels typical of a rural noise district.

NSDs (specifically people staying on farms within or close to the focus area) used to the rural environment will experience significant change and may complain about the increase in noise levels.

Mitigation required to ensure that the SEZ co-exist with the existing NSDs will require that, if an industry is planned within 2,000m from an existing NSD, a full ENIA must be completed. The NSD must be notified of the ENIA process and be allowed to comment on the projected noise levels as well as the potential noise impact. No industry should be permitted within 2,000m from an existing NSD if a full ENIA was not completed.

The developers of the SEZ should also consider purchasing the farms located within the focus area and relocate existing NSD on these farms.

Future land uses in the SEZ must be planned to ensure that the noise-generating activities does not impact on land uses with certain desired, design or maximum noise limits (see Appendix D: Design and maximum rating levels for ambient noise for different areas of occupancy or activity indoors). Planning should consider:

- Locating the industrial areas as far as possible from existing NSD (if not relocated) and areas that may be used in the future potential noise-sensitive activities;
- The placement of light industrial areas between commercial / retail areas and heavy industrial areas. The commercial / retail areas to be planned as buffer between industrial areas and potential noise-sensitive areas (NSD); &
- Using available space to ensure a buffer of at least 500m between industrial activities and potential NSDs, though a buffer of at least 1,000m is recommended.

11.2 DEVELOPMENTAL PHASE OF THE SEZ

As the SEZ develops ambient sound levels will increase. While correct planning will assist in minimising potential noise impacts, it will still be required to assess potential noise impacts for the following reasons:

- Should a heavy industry (with cooling/exhaust/intake/induced draft fans or exhaust stacks higher than 20m) be developed within 2,000m from an NSD, or an area that may in the future be used for residential purposes, an ENIA must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact;

- Should an industry be planned or proposed within 1,000m from a NSD, or an area that may in the future be used for residential purposes, an ENIA must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact; &
- Should a NSD be planned within 500m from the N1 or similar busy road, or a new road are proposed within 200m from an NSD, an ENIA must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact.

The development of an industrial area closer than 500m from an NSD should not be permitted, and, no NSD should be permitted closer than 500m from an industrial area.

11.3 OPERATION MITIGATION OPTIONS THAT SHOULD BE INCLUDED IN THE EMP

i. Future land uses in the SEZ must be planned to ensure that the noise-generating activities does not impact on potential noise-sensitive land uses with certain noise limits as defined in Table 1 of SANS 10103:2008;

ii. Should a heavy industry (with cooling/exhaust/intake/induced draft fans or exhaust stacks higher than 20m) be developed within 2,000m from an NSD, or an area that may in the future be used for residential purposes, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact;

iii. Should an industry be planned or proposed within 1,000m from a NSD, or an area that may in the future be used for residential purposes, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact; &

iv. Should a NSD be planned within 500m from the N1 or similar busy road, or a new road are proposed within 200m from an NSD, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact.

12 RECOMMENDATIONS AND CONCLUSION

This ENIA covers the proposed development of a SEZ between Musina and Makhado, Limpopo. The SEZ will comprise an offering of mixed land uses and infrastructure provision to ensure the optimal manufacturing operations in the energy and metallurgical complex. The proposed SEZ will introduce a number of activities and land used that will change the soundscape significantly that would impact on existing to future NSD. While this SEZ will develop over a number of years, the development will introduce noises into an area that is largely rural and undeveloped, with sound levels typical of a rural noise district.

No specific layout or activities were available at this planning phase of the project, and conceptual scenarios were developed to assist in the identification of potential noise impacts. These conceptual scenarios highlighted the potential of a noise impact of high significance for an unmitigated situation.

However, these potential noise impacts can be managed to reduce the potential impact to a low significance. The main mitigation recommended that:

v. Future land uses in the SEZ must be planned to ensure that the noise-generating activities does not impact on potential noise-sensitive land uses with certain noise limits as defined in Table 1 of SANS 10103:2008. This include:
   a. Locating the industrial areas as far as possible from existing NSD (if not relocated) and areas that may be used in the future for potential noise-sensitive activities;
   b. The placement of light industrial areas between commercial / retail areas and heavy industrial areas. The commercial / retail areas to be planned as buffer between industrial areas and potential noise-sensitive areas (NSD); &
   c. Using available space to ensure a buffer of at least 500m between industrial activities and potential NSDs, though a buffer of at least 1,000m is recommended.

vi. Should a heavy industry (with cooling/exhaust/intake/induced draft fans or exhaust stacks higher than 20m) be developed within 2,000m from an NSD, or an area that may in the future be used for residential purposes, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact.

vii. Should an industry be planned or proposed within 1,000m from a NSD, or an area that may in the future be used for residential purposes, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact.

viii. Should a NSD be planned within 500m from the N1 or similar busy road, or a new road are proposed within 200m from an NSD, an ENIA (as per the requirements of SANS 10328:2008) must be compiled to define the potential magnitude of the noise impact, the extent of the noise impact and the potential significance of the noise impact.

It is the opinion of the Author that the increase in noise levels does not constitute a fatal flaw, as the increases can be managed to a low significance. It is therefore the recommendation that the development of the SEZ be authorized (from a noise impact perspective).

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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 center 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.
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.
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.
Controlled area (as per National Noise Control Regulations)	a piece of land designated by a local authority where, in the case of- (a) road transport noise in the vicinity of a road- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65dBA; or (ii) the equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2metres, but not more than 1,4 metres, above the ground for a period extending from06:00 to 24:00 as calculated in accordance with SABS 0210-1986, titled: "Code of Practice for calculating and predicting road traffic noise", published under Government Notice No. 358 of 20 February 1987, and projected for a period of 15 years following the date on which the local

	authority has made such designation, exceeds 65 dBA; (b) aircraft noise in the vicinity of an airfield, the calculated noisiness index, projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; or (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 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 61 dBA;
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.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time	(1) Averaging detection time used in sound level meters.

weighting	(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 kilo Hertz (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 exists.
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.
Key issue	An issue rose during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
L_{A90}	the sound level exceeded for the 90% of the time under consideration
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.
L_{AMin} and L_{AMax}	Is the RMS (root mean squared) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of

	another sound.
Mitigation	To cause to become less harsh or hostile.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
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.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.

S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1]second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
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.
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 SANS10103:2008.

APPENDIX B

Site Investigation – Photos of monitoring locations

Photo B.1: Measurement location MPS-LT01

Photo B.2: Measurement location MPS-LT02

Photo B.3: Measurement location MAS06

Photo B.4: Measurement location GBN1

Photo B.5: Measurement location MSEZSLST01

Photo B.6: Measurement location MSEZSLST12

APPENDIX C

Some negative effects of noise and sonic booms on animals

Table C. 1: Some possitive negative effects of noise on faunal some species

SPECIES	TYPE OF NOISE	EFFECT
Domestic livestock:		
Various species	Sonic boom (80-370 mN/m2); low-level subsonic flights (50-200 m) (Nixon et al. 1968; Bond et al. 1974; Espmark et al. 1974).	Startle reaction
Dairy cow	Exploding paper bags (Ely and Petersen 1941)	Cessation of milk ejection
	General noise (105 dB) (Kovalcik and Sottnik 1971)	Reduces feed consumption, milk yield, and rate of milk release
	Tractor engine sound (97 dB) (Broucek et al. 1983)	Increased glucose concentration and leukocyte counts in the blood; reduced level of hemoglobin
	General noise (1 kHz, 110 dB) (Broucek et al. 1983)	Increase in glycemia, nonesterified fatty acids, creatin; decrease in hemoglobin and, thyroxin concentration
Goat	Jet noise (Sugawara et al, 1979)	Reduced milk yield
Swine	General noise (108-120 dB) (Borg 1981)	Influence on hormonal system: increase of plasma 11-OH-corticosterone and catecholamines; decreased corticosteroid level
	General noise (93 dB) (Dufour 1980)	Aldosteronism (excess secretion of aldosterone from the adrenals)
	Recorded aircraft noise (120-135 dB) (Bond et al. 1963)	Increased heart rate
Sheep	White noise (100 dB) (Ames and Arehart 1972)	Higher heart rate and respiration rate; lower feeding efficiency
	White noise (90 dB) (Ames 1978)	Decreased thyroid activity
	General noise (4 kHz, 100 dB) (Ames 1978)	Increased number of corpora lutea; more lambs/ewe
Wild ungulates:		
Reindeer	Sonic booms (35-702 Pa) (Espmark 1972)	Slight startle responses: raising of head, pricking the ears, scenting the air
Caribou	Low-altitude aircraft (<200 ft): fixed-wing, helicopter (Klein 1973)	Running and panic behavior
	Low-altitude aircraft (<500 ft): fixed-wing, helicopter (Calef et al. 1976)	Escape or strong panic reactions
	General noise (Calef 1974)	Increased incidence of miscarriages; lower birth rates
Pronghorn	Low-altitude helicopters (150 ft, slant range of 500 ft; 77 dBA) (Luz and Smith 1976)	Running

Laboratory rodents and rabbits:		
Various species	General noise (150 Hz-40 kHz, 132-140 dB) (Anthony and Ackerman 1957)	"Anxiety-like" behavior
Guinea pig	General noise (128 dB SPL) (Beagley 1965); simulated sonic booms (130 dB) (Hajeau-Chargois et al. 1970)	Anatomical hearing damage; hearing loss
Mouse	Simulated sonic booms (Reinis 1976)	Auditory damage; inner ear bleeding
	Intermittent noise (l10 dB) (Anthony and Ackerman 1955)	Decrease in circulating eosinophils; adrenal activation
	Recorded subway noise (105 dB SPL) (Busnel and Holin 1978)	Longer time interval between litters; lower weight gain of young; increased incidence of miscarriage, resorption and malformations
	Continuous, high-intensity jet engine noise (127 dB); random onset noise (103-ll0 dB); high-frequency noise (l13 dB) (Nawrot et al. 1980)	Decreased pregnancy rate (all groups); decrease in number of implantation sites per litter and fetolethal effects (high-intensity jet noise)
	General noise (106 dB) (Ishii and Yokobori 1960)	Teratogenic effects
Rat	General noise (105 dB SPL) (Moller 1978; Borg 1979, 1981)	Hearing loss; damage to inner ear structure
	General noise (80 dB SPL) (Borg 1978a,b,c)	Vasoconstriction
	General intermittent sound (Buckley and Smookler 1970)	Rise in blood pressure; hypertension
	Recorded thunderclaps (98-100 dB SPL, 50-200 Hz) (Ogle and Lockett 1966)	Increased urinary excretion of sodium and potassium; excretion of oxytocin and vasopressin
	Electric buzzer (110 dB) (Sackler et al. 1959)	Decreased adrenal , body, thymus, spleen, liver, pituitary, ovary, and uterine weights; slight gain in thyroid weight; increased production of ACTH; inhibition of gonadotrphin, ovarian hormones, and possible inhibition of the thyrotrophic and thyroid hormones
	General noise (1 kHz, 95 dB) (Fell et al. 1976)	Suppressed thyroid activity
	General noise (120 Hz, 95-105 dB) (Jurtshuk et al. 1959)	Reduced glutathione levels in blood, increased adrenal weights and ascorbic acid; decrease in total adrenal cholesterol
	Intermittent noise(95 dB)(Hrubes and Benes 1965)	Increased secretion of catecholamines in the urine; increased free fatty acids in the blood plasma; increased weight of the adrenals; inhibition of growth
	General noise (92 dB) (Gamble 1982)	Persistent vaginal estrus prolonged vaginal cornification; higher preweaning mortality of young
	White noise (102-l14 dB) (Friedman et al. 1967)	Change in the hypothalymus

	Electric bell (95-100 dB) (Zondek and Isacher 1964)	Enlarged ovaries; persistent estrus; follicular hematomas
	General noise (Zondek 1964)	Decreased fertility
Domestic rabbit	White noise (107-112 dB) (Nayfield and Besch 1981)	Increased adrenal weights; decreased spleen and thymus weights
	White noise (102-114 dB) (Friedman et al. 1967)	Change in the hypothalymus; higher plasma cholesterol and plasma triglycerides; fat deposits in the irises of the eyes; more aortic atherosclerosis and higher cholesterol content in the aortas
	Electric bell (95-100 dB) (Zondek and Isacher 1964)	Enlarged ovaries; persistent estrus; follicular hematomas
Chinchilla	Simulated sonic booms; general noise (65-105 dB) (Carder and Miller 1971, 1972; Reinis 1976)	Hearing loss; outer cell damage of the cochlea
Wild rodents:		
Desert kangaroo rat	ORV noise (78-110 dB SPL) (Brattstrom and Bondello 1983)	Temporary threshold shift in hearing
House mouse (feral)	Aircraft (110-120 dB) (Chesser et al. 1975)	Increased adrenal weights
Cotton rat	Recorded aircraft noise (110 dB SPL) (Pritchett et al. 1978)	Increased body weights; increased secretion of ACTH
	High-pitched whistles (Hepworth 1966)	Enlarged ovaries; persistent estrus; follicular hematomas
Carnivores:		
Domestic cat	Noisy laboratory (Liberman and Beil 1979)	Hearing threshold shifts; loss or damage to hair cells of inner ear
	General noise (100-1,000 Hz) (Miller et al. 1963)	Hearing threshold shifts
Domestic dog	Sudden loud noises (Stephens 1980)	Increase in plasma corticosteroid concentrations
Farm-raised mink	Simulated sonic booms (167-294 mN/m2) (Travis et al. 1974)	Brief startle reaction
Wolf/grizzly bear	Low-altitude fixed-wing aircraft and helicopters (Klein 1973)	Startle reaction; running
Aquatic mammals:		
Beluga whale	Boat traffic (Acoustical Society of America 1980)	Easily displaced
Pinnepeds	Sonic booms (80-89 dBA SPL) (Jehl and Cooper 1980)	Startle reactions
Elephant seal	Impulse noise created by a carbide pest control cannon (115.6-145.5 dBA) (Stewart 1982)	Alert behavior

Sea lion	Simulated boom (Stewart 1982)	Left beach during non-breeding season and went into surf
Other mammal groups:		
Rhesus monkey	General noise (Leq (24): 85 dB) (Peterson et al. 1981)	Increased blood pressure

Reference list available at:

http://www.nonoise.org/library/animals/litsyn.htm#REFERENCES

APPENDIX D

Design and maximum rating levels for ambient noise for different areas of occupancy or activity indoors

Table D.1: Design and maximum rating levels for ambient noise for different areas of occupancy or activity indoors (Table 1 from SANS 10103:2008)

1	2	3
Types of occupancy or activity	**Design equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA	**Maximum equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA
1. **Educational buildings**		
Classrooms	35	40
Secondary "open space" teaching areas	40	45
Primary and pre school "open space" teaching areas	45	50
Conference rooms		
Up to 250 seats	30	35[b]
More than 250 seats	25	30[b]
Corridors and lobbies	45	50
Engineering workshops	45	55
Gymnasiums	45	55
Laboratories		
Teaching	35	40
Working	40	50
Lecture, teaching, and research staff offices	35	40
Lecture theatres or assembly halls		
Up to 250 seats	30	35[b]
More than 250 seats	25	30[b]
Manual arts workshops	40	45
Music practice rooms	35	45
Music studios	30	35
Office areas	40	45
Professional and administrative offices	35	40
Seminar rooms	30	35
Tutorial rooms	30	35
2. **Health buildings**		
Audiological test rooms	See SANS 10182	
Casualty areas	40	45
Corridors and lobby spaces	40	50
Dental clinics and consulting rooms	40	45
Kitchens, sterilizing and service areas	45	50
Office areas	40	45
Operating theatres (see note 1)	30	35
Staff residential areas	30	35
Surgery and consulting rooms	40	45
Ward spaces		
Single bed	30	35
Two or more beds	35	40
Waiting rooms and reception areas	40	50

1	2	3
Types of occupancy or activity	**Design equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA	**Maximum equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA
3. **Industrial buildings**		
Assembly lines		
Light machinery	50	70
Packaging and delivery	50	60
Foremen's offices and general control rooms	45	50
Industrial processing or manufacturing	See SANS 10083	
Laboratories or test areas	40	50
Lunch and rest rooms	40	55
Precision assembly	40	50
4. **Indoor sports buildings**		
Billiard and snooker rooms	40	50
Bowling alleys and gymnasiums	50	55
Squash courts	50	55
Swimming pools	50	60
5. **Office buildings** (see note 2)		
Boardrooms and conference rooms	30	35
Cafeterias	45	50
Calculation and tabulation areas	45	55
Computer rooms	45	55
Corridors and lobbies	45	50
Design and draughting offices	40	50
General office areas	40	45
Private offices	35	40
Public spaces	40	50
Reception areas	40	45
Rest rooms	40	45
Typing pool areas	45	55
6. **Public buildings**		
Airport terminals		
Departure lounges	45	55
Luggage despatch and collection areas	45	60
Passenger check-in areas	45	50
Art galleries	40	50
Auditoriums		
Cabarets and theatre restaurants	30	35
Concert and recital halls	25	30

1	2	3
Types of occupancy or activity	**Design equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA	**Maximum equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA
6. **Public buildings** (*continued*)		
Conference and convention centres		
Up to 250 seats	30	35[b]
More than 250 seats	25	30[b]
Drama theatres	25	30
Motion picture theatres	30	35
Opera halls	25	30
Theatres for operettas and musical plays	30	35
Places of worship		
Up to 250 seats	30	35[b]
More than 250 seats	25	30[b]
Municipal buildings		
Administrative offices	35	40
General offices	40	45
Public spaces	40	50
Council chambers	25	30
Courts		
Court rooms	25	30
Court reporting and transcript areas	35	40
Judges' chambers	30	35
Legal and interview rooms	40	45
Waiting areas	40	50
Libraries		
Administrative office spaces	35	40
Reading areas	40	45
Stack areas	45	50
Workshop areas	45	55
Museums (exhibition spaces)	40	45
Parking stations (car-park areas)	55	65
Post offices and general banking areas	45	50
Corridors and lobbies	45	50
Railway and bus terminals		
Ticket sales areas	45	55
Waiting areas	45	55
Restaurants and cafeterias		
Cafeterias	45	55
Coffee bars	40	50
Restaurants	40	45

1	2	3
Types of occupancy or activity	**Design equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA	**Maximum equivalent continuous rating level ($L_{Req,T}$)[a] for ambient noise** dBA
6. **Public buildings** (*continued*)		
Hotels and motels		
Bars and lounges	45	55
Conference areas		
Up to 250 seats	30	35[b]
More than 250 seats	25	30[b]
Dining-rooms	40	45
Enclosed car parks	55	65
Foyers and recreation areas	45	50
Kitchens, laundries and maintenance areas	45	55
Sleeping areas	30	40
Washrooms and toilets	40	55
Hostels and barracks		
Cafeterias	40	50
Common rooms	35	40
Games rooms	40	50
Kitchens and service areas	45	55
Sleeping areas	30	40
7. **Shop buildings**		
Department stores and supermarkets		
General shopping areas	50	55
Speciality areas or show areas	45	50
Enclosed car parks	55	65
Show rooms, small retail stores and speciality shops	45	50
8. **Studio buildings**		
Drama studios	20	25
Music recording studios	20	25
Sound stages	20	25
Talk-show studios	25	30
Television studios	25	30
9. **Residential buildings**		
Living rooms	35	45
Kitchens and service areas	45	55
Bathrooms and toilets	40	55
Bedrooms	30	40

NOTE 1 If acoustical listening devices are used in operating theatres, the recommended levels given in table 1 could be inappropriate. Expert advice should be sought in such cases.

NOTE 2 In open-plan offices, acoustic masking may be specifically introduced to assist in providing speech privacy between adjacent areas. The acoustic masking can take the form of electronically generated noise, appropriately distributed, or of sound generated by other noise sources, such as air-conditioning systems. Where acoustic masking is employed, a rating level in excess of 45 dBA and a sound spectrum containing predominantly low frequencies could give rise to other problems, i.e. fatigue or lack of concentration.

NOTE 3 There is seldom any benefit in achieving ambient noise levels that are substantially lower than those recommended in column 2 of table 1, and in certain cases levels that are too low could degrade acoustical privacy.

NOTE 4 Noise rating numbers (NR and NC) are frequently used for design purposes although there is no direct correlation between corresponding NR, NC and L_{pA} levels. However, for most sound spectra encountered in buildings, the NR or NC value will typically be 5 dBA lower than the L_{pA} value. Designs based on this assumption should allow adequate safety factors.

NOTE 5 For "open-plan" living areas, the most stringent of the rating levels given for the applicable areas apply, e.g. the rating level given for a bedroom will apply in cases where the same area is used as a living room and also as a bedroom.

NOTE 6 When the noise has a prominent maximum and is of a recurrent nature, the average maximum sound level measured using F-time weighting should not exceed the appropriate norms given in column 3 of table 1 for cases where speech communication or disturbance of sleep are considerations.

NOTE 7 Where the spectrum of the sound contains prominent low frequency sound characteristics, i.e. an unbalanced spectrum, special precautions should be taken to prevent psycho acoustic problems. In these cases advice by a specialist should be obtained. See annex B.

a The values given in columns 2 and 3 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise.

b In cases where a speech amplification system is available to the speaker(s), the maximum rating level for ambient noise ($L_{Req,T}$) can be increased to 40 dBA.

End of Report