APPENDIX L: NOISE IMPACT ASSESSMENT

Updated Noise Impact Assessment for the Mokala Manganese Mine near Hotazel in the Northern Cape Province

Project done for **SLR Consulting (South Africa) (Pty) Ltd**

Report Compiled By:
Nick Grobler

Original Report Compiled By:
Nicolette von Reiche
Oladapo Akinshipe

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Address: 480 Smuts Drive, Halfway Gardens | Postal: P O Box 5260, Halfway House, 1685
Tel: +27 (0)11 805 1940 | Fax: +27 (0)11 805 7010
www.airshed.co.za

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Prepared by	Nick Grobler, BEng (Chem), BEng (Hons) (Env) (University of Pretoria)
Original Report Prepared by	Nicolette von Reiche, BEng Hons (Mech.) (University of Pretoria) Oladapo Akinshipe, MSc. (Env. Tech) (University of Pretoria)
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Rev1	August 2021	All	Addressed SLR comments
Rev2	September 2021	All	Addressed client comments
Final	January 2022		Issued as final

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
ASG	Atmospheric Studies Group
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
EC	European Commission
EHS	Environmental, Health, and Safety (IFC)
Hz	Frequency in Hertz
IEC	International Electro technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
kW	Power in kilo Watt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{Aleq} (T)	The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period
L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)
L_{PZ}	Un-weighted sound pressure level (in dB)
L_W	Sound Power Level (in dB)
Mtpa	Million tonnes per annum
MW	Power in mega Watt
NEMAQA	National Environment Management Air Quality Act
NSR	Noise sensitive receptor
p	Pressure in Pa
p_{ref}	Reference pressure, 20 µPa
rpm	Rotational speed in revolutions per minute
SABS	South African Bureau of Standards
SANS	South African National Standards
SLM	Sound Level Meter
SLR	SLR Consulting (Africa) (Pty) Ltd
SoW	Scope of Work
USGS	United States Geological Survey
WG-AEN	Working Group – Assessment of Environmental Noise (EC)
WHO	World Health Organisation

Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by SLR Consulting (South Africa) (Pty) Ltd to update the Noise Impact Assessment for the Mokala Manganese Mine near Hotazel in the Northern Cape Province. Airshed conducted a noise impact assessment, including a baseline noise survey, for the Mokala Manganese Mine in 2015, prior to commencement of activities at the Mokala Manganese Mine. This assessment however only assessed the impact of the originally planned mining activities (now termed Phase 1) and infrastructure layout for the project. It is now proposed that the extent of the open cast pit be expanded to increase the life mine. This will be achieved in an additional five phases, termed Phase 2 to 6. In support of the above, additional infrastructure is proposed, including expansion of the current waste rock dump, establishment of a new waste rock dump, establishment of a low-grade ore stockpile and establishment of additional topsoil stockpiles. Mining rates are expected to be ~1.56 mtpa ROM (and product) and 16 to 17 mtpa waste rock per year. The same mining and hauling methods currently employed for Phase 1 will continue for the subsequent phases.

The following tasks were included as part of the scope of work:

1. A review of updated technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of noise sensitive receptors (NSRs) from available maps;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from the survey conducted as part of the 2015 Noise Impact Assessment.
4. An impact assessment, including:
    a. The update of the source inventory for the additional Phases of the Project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. An updated specialist noise impact assessment report.

In the assessment of sampled and simulated noise levels reference was made to the International Finance Corporation (IFC) guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these (a) are applicable to nearby NSRs which include towns and a mine village and (b) in-line with South African National Standards (SANS) 10103 guidelines for urban districts. The IFC's 3 dBA increase criterion is used to determine the potential for noise impact.

The baseline acoustic environment was described in terms of the location of NSRs in relation to approved and proposed activities, the ability of the environment to attenuate noise over long distances and existing or pre-mining noise levels. The following was found:

- NSR's include single homesteads/farmsteads, towns and a mine village. The closest NSRs include residences of the Gloria Mine village situated approximately 1.3 km north of the northern mine boundary and residences of the town of Hotazel which lies approximately 3.9 km east of the eastern mine boundary. All other residences, farmsteads and towns lie further than 4 km from the mine boundary. The impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source and it is therefore unlikely that these will be affected by the Project.
- Atmospheric conditions are more conducive to noise attenuation during the day.

- Based on the average wind field, noise impacts are expected to be most notable to the south-west during the day and north-west during the night.
- Baseline noise levels are affected by traffic along the R380, existing mining/industrial activities, birds and insects. Representative day- and night-time noise levels of 48.8 dBA and 44.4 dBA respectively were calculated from survey results.

The following scenarios were considered:

- **Operational** phase – representative of mining and associated processing, handling and transport activities during Phase 2 of the expanded operations.

Sound power levels for main equipment were determined from equipment specifications and calculations. The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA). Noise levels were calculated over an area of 10 km east-west by 10 km north-south at intervals of 25 m and at nearby NSRs. The following was found:

During the day, Phase 2 operations are expected to result in an increase of 3 dBA from baseline levels up to 600m to the east of the mine boundary, 200m to the north of the mine boundary and up to 300m to the south of the mine boundary (impacts to the south and east will of course be dependent on the location of the box cut being worked at any given time). The simulated increase in noise levels are well below 3 dBA at all sensitive receptor locations, meaning that the mining, processing and hauling operations are unlikely to be a nuisance at any of these locations.

Because of the lower night-time baseline noise levels and atmospheric conditions less conductive to noise attenuation, the increase from baseline levels due to the Mokala Manganese Mine operations are expected to be more significant during the night, with an increase of 3 dBA simulated up to 800m to the north, south and east of the mine boundary. The increase from baseline could reach 10 dBA up to 100m to the north, south and east of the mine boundary as well.

Due to the distance between the operations and any nearby sensitive receptor locations, the impact of the mining operations on noise levels at sensitive receptor locations, both during the day and during the night, are expected to be insignificant and well below the IFC guidelines.

It is important to note the following conservative assumptions when interpreting results summarised above:

- Baseline noise levels on the lower side of what was measured were applied in calculations. The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in the project area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels.
- All mining activities were assumed to be at the surface of pit areas. The mitigating effect of pit walls and waste rock dumps were therefore not accounted for.
- The section of the open pit mining area that is situated closest to the NSRs was selected for inclusion in the assessment

It is concluded that, given the conservative nature of the assessment, the implementation of the basic good practice management measures recommended in this report will ensure low significance noise impact levels.

NEMA Regulation (2014), Appendix 6

NEMA Regulations (2014) (as amended) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report	Report Details
The expertise of that person to compile a specialist report including a curriculum vitae	Report Details and Annex B
A declaration that the person is independent in a form as may be specified by the competent authority	Report details
An indication of the scope of, and the purpose for which, the report was prepared	Section 1.1 and 1.2
An indication of the quality and age of base data used for the specialist report	Section 3.3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 2, Section 3.3 and Section 4.2
The duration date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.3
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 1.5
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 alternative	Section 4
An identification of any areas to be avoided, including buffers	Section 4
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 3.1 and Section 4.2
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.6
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 4.2
Any mitigation measures for inclusion in the EMPr	Section 5
Any conditions for inclusion in the environmental authorisation	Section 5
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 5.5
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and regarding the acceptability of the proposed activity or activities	Section 5
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 5
A description of any consultation process that was undertaken during the course of preparing the specialist report	Provided in the EIA
A summary and copies of any comments received during any consultation process and where applicable all responses thereto	Provided in the EIA
Any other information requested by the competent authority.	Not applicable.

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1 INTRODUCTION

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by SLR Consulting (South Africa) (Pty) Ltd to update the Noise Impact Assessment for the Mokala Manganese Mine near Hotazel in the Northern Cape Province. Airshed conducted a noise impact assessment, including a baseline noise survey, for the Mokala Manganese Mine in 2015, prior to commencement of activities at the Mokala Manganese Mine. This assessment however only assessed the impact of the originally planned mining activities (now termed Phase 1) and infrastructure layout for the project. It is now proposed that the extent of the open cast pit be expanded to increase the life mine. This will be achieved in an additional five phases, termed Phase 2 to 6 as well as mining of the Kgalagadi barrier pillar to the south of the operations. In support of the above, additional infrastructure is proposed, including expansion of the current waste rock dump, establishment of a new waste rock dump and establishment of a low grade ore stockpile. Mining rates are expected to be ~1.56 mtpa ROM (and product) and 16 to 17 mtpa waste rock per year. The same mining and hauling methods currently employed for Phase 1 will continue for the subsequent phases.

The study purpose, description of activities from an environmental noise perspective and tasks included in the Scope of Work (SoW) are given below.

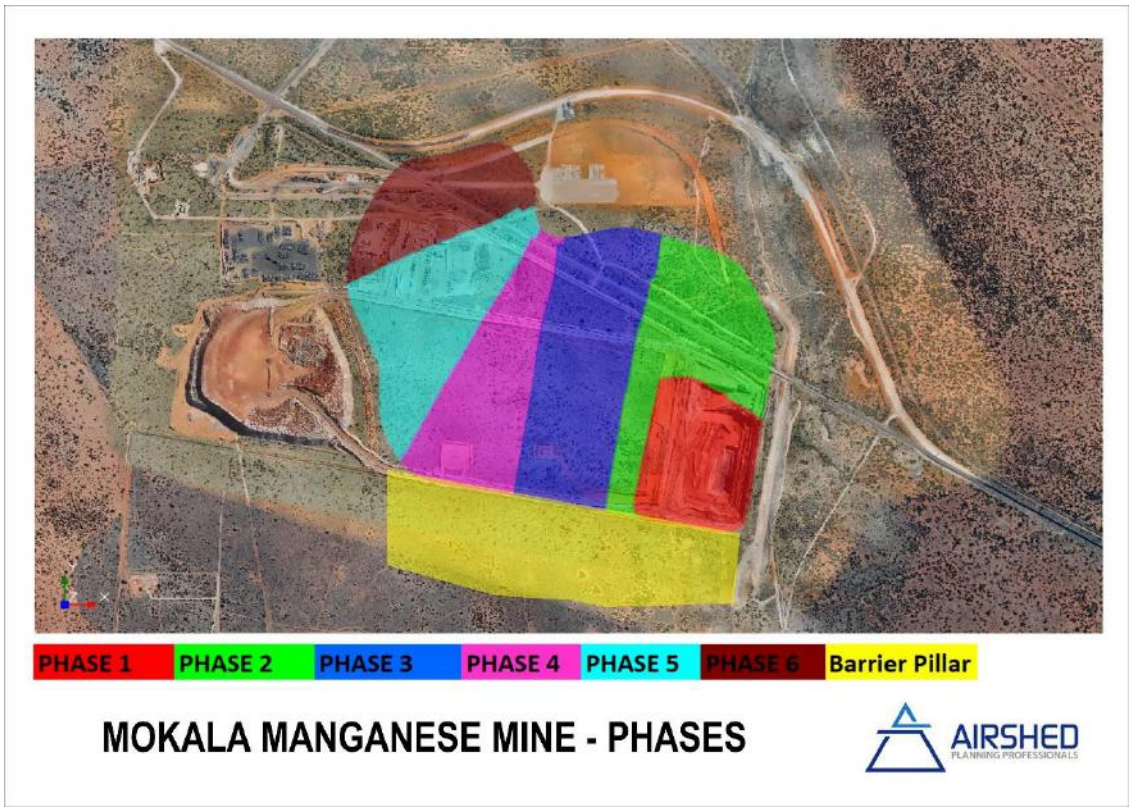


Figure 1: Phases of the Mokala Manganese Mine Expansion

1.1 Purpose

The main purpose of the noise study was to determine the potential impact on the acoustic climate and noise sensitive receptors (NSRs) given mining activities proposed as part of the proposed additional Phases. The approved layout plan as well as the proposed changes is included in Figure 2 (approved layout is shown in blue and proposed changes in pink).

1.2 Scope of Work

The following tasks were included in the SoW:

1. A review of updated technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of noise sensitive receptors (NSRs) from available maps;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from the survey conducted as part of the 2015 Noise Impact Assessment.
4. An impact assessment, including:
    a. The update of the source inventory for the additional Phases of the Project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
    d. Rating of the significance of simulated impacts using SLR's impact rating methodology.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. An updated specialist noise impact assessment report.

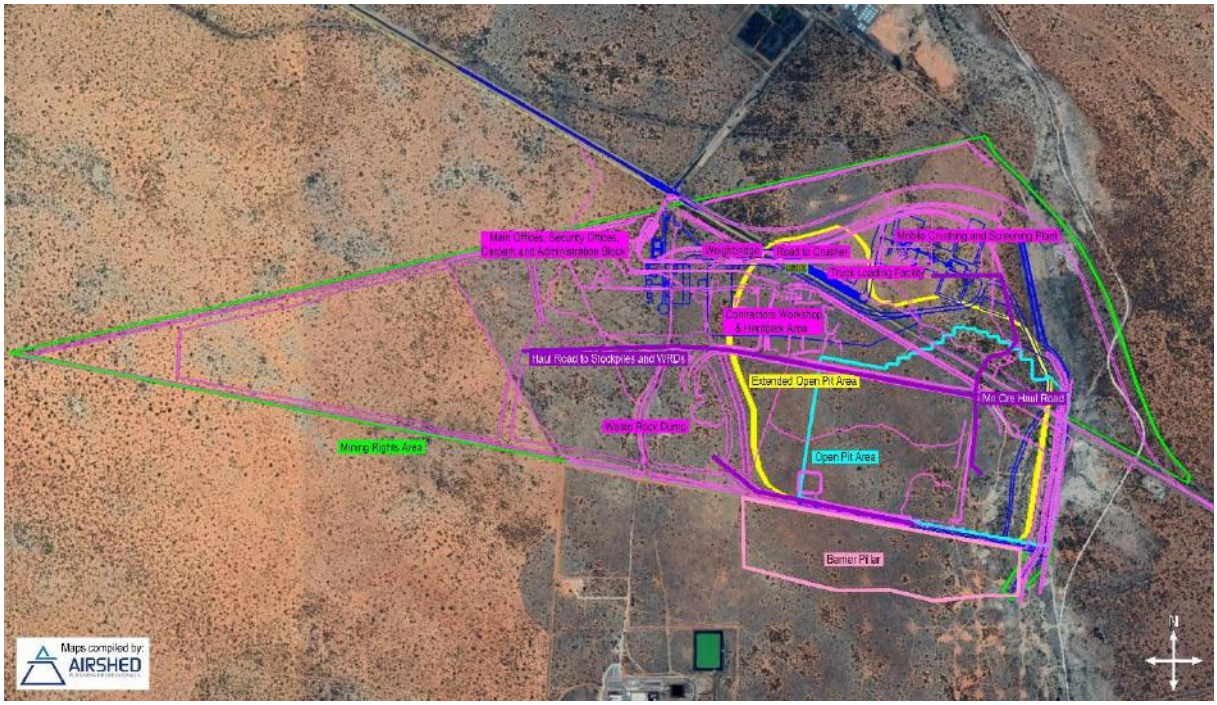


Figure 2: Mine Layout with approved layout in blue and proposed changes in pink

1.3 Description of Activities from a Noise Perspective and Selection of Assessment Scenarios

As is typical of opencast mining and ore processing facilities, sources of noise at the Mokala Manganese Mine include the following:

- Drilling;
- Blasting;
- Ore and waste rock handling (loading, unloading, pushing, dozing) in open pits, on waste rock dumps, on the low grade stockpile or backfill areas and crusher/plant area;
- Crushing and screening of ore;
- Haul truck traffic;
- Diesel mobile equipment use (including reverse warnings);
- Diesel generators;
- Access road traffic; and
- Ore processing activities such as crushing and screening.

Whereas ore processing activities generate noise fairly constantly; drilling, blasting, ore and waste handling, transport activities and operating diesel mobile equipment generate noise that is intermittent and highly variable spatially even over 24 hours. Intuitively, the extent of noise impacts from a source point of view is a function of:

- Mining rates (activity levels);
- Fleet size;
- Spatial distribution of activities; and
- Source type.

Taking into consideration the above in addition to the location of potential NSRs in relation to operational areas the Noise Impact Assessment for the expansion will focus on Phase 2 operations, since during this phase the haul distance for waste rock will be the longest and the mining activities will be closest to sensitive receptor locations.

1.4 Background to Environmental Noise and the Assessment Thereof

Before more details regarding the approach and methodology adopted in the assessment is given, the reader is provided with some background, definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

Noise is reported in decibels (dB). "dB" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in this equation.

$$L_p = 20 \cdot \log_{10}\left(\frac{p}{p_{ref}}\right)$$

Where:

L_p *is the sound pressure level in dB;*
p *is the actual sound pressure in Pa; and*
p_{ref} *is the reference sound pressure (p_{ref} in air is 20 μPa)*

1.4.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing of a young, healthy person ranges between 20 Hz and 20 000 Hz.

In terms of L_P, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. Even though an increase in sound pressure level of 6 dB represents a doubling in sound pressure, an increase of 8 to 10 dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.4.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 3). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

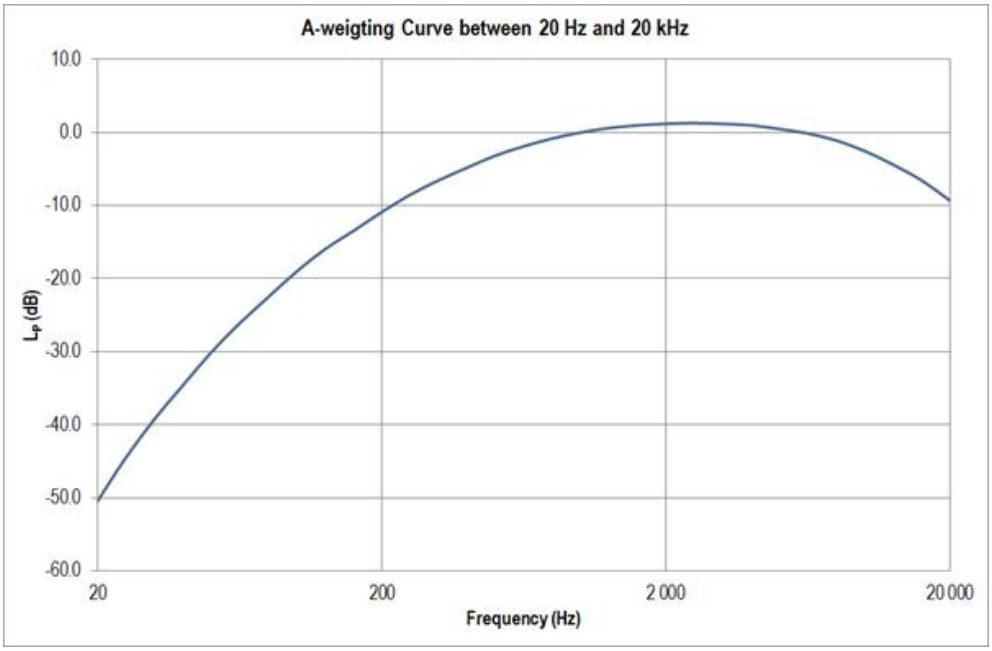


Figure 3: A-weighting curve

1.4.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot just simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

$$L_{p_combined} = 10 \cdot \log\left(10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + 10^{\frac{L_{p3}}{10}} + \cdots 10^{\frac{L_{pi}}{10}}\right)$$

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.4.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power (L_W);
- The distance between the source and the receiver;
- Atmospheric conditions (wind speed and direction, temperature and temperature gradient, humidity etc.);
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption; and
- Reflections

To arrive at a representative result from either measurement or calculation, all these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.4.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is generally made to the following indices:

- **L_{Aeq} (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). The International Finance Corporation (IFC) provides guidance with respect to L_{Aeq} (1 hour), the A-weighted equivalent sound pressure level, averaged over 1 hour.
- **L_{Aleq} (T)** – The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). In the South African Bureau of Standards' (SABS) South African National Standard (SANS) 10103 of 2008 for 'The measurement and rating of environmental noise with respect to annoyance and to speech communication' prescribes the sampling of L_{Aleq} (T).
- **$L_{Req,d}$** – The L_{Aeq} rated for impulsive sound (L_{Aleq}) and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
- **$L_{Req,n}$** – The L_{Aeq} rated for impulsive sound (L_{Aleq}) and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
- **$L_{R,dn}$** – The L_{Aeq} rated for impulsive sound (L_{Aleq}) and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10 dB in order to account for the additional disturbance caused by noise during the night
- **L_{A90}** – The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.
- **L_{AFmax}** – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.
- **L_{AFmin}** – The minimum A-weighted noise level measured with the fast time weighting. It's the lowest level of noise that occurred during a sampling period.

1.5 Approach and Methodology

The assessment included a study of the legal requirements pertaining to noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels (L_W's) (noise 'emissions') and sound pressure levels (L_P's) (noise impacts) associated with the construction and operational phases of the Project. The findings of the assessment components informed recommendations of management measures, including mitigation and monitoring. Individual aspects of the noise impact assessment methodology are discussed in more detail below.

1.5.1 Information Review

An information requirements list was submitted to SLR at the onset of the study. SLR supplied, for inclusion in the assessment, the following information:

- Georeferenced maps and site layouts;
- A detailed process description;
- Mining rates; and
- A list of mining equipment (fleet information).

1.5.2 Baseline Noise Survey

A baseline noise survey was conducted as part of the 2015 noise impact assessment. Because mining activities are currently conducted at Mokala Manganese Mine, the baseline noise survey was not updated, as the baseline survey from 2015 still remains representative of baseline (pre-mining) conditions.

The survey methodology, which closely follows guidance provided by the IFC General Environmental Health and Safety (EHS) Guidelines (IFC, 2007) and SANS 10103 (SANS 10103, 2008), is summarised below:

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using Type 1 sound level meters (SLM's) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of SLM's was tested with a portable acoustic calibrator before and after each sampling session.
- Samples of between 20 and 30 minutes, representative and sufficient for statistical analysis were taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time[1] acoustic climate were taken.
- As recommended, the following acoustic indices were recoded:
    - SANS 10103 - The impulse corrected equivalent A-weighted sound pressure level (L_{Aleq} (T)). In the absence of impulsive sounds which is often the case with measurements in rural areas, L_{Aeq} (T) = L_{Aleq} (T). L_{Aleq} (T) is used to determine day and night-time rating levels as prescribed in SANS 10103 (2008).
    - IFC General EHS Guidelines - The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (L_{Aeq} (T))
    - Other:
        - The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}).
        - The maximum A-weighted noise level measured with the fast time weighting (L_{AFmax}). It is the highest level of noise that occurred during a sampling period.
        - The minimum A-weighted noise level measured with the fast time weighting (L_{AFmin}). It is the lowest level of noise that occurred during a sampling period.
        - Although not required by the IFC or SANS 10103, octave band frequency spectra were also recorded to assist with characterising the acoustic climate. A frequency analysis was conducted as part of the desktop baseline study.
    - The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
    - SANS 10103 states that one must ensure (as far as possible) that the measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It does not specify a wind speed limit or weather condition limitations. The following good practice was applied during sampling; avoid measurements when wind speeds of more than 5 m/s occur and while raining or the ground is wet.

[1] The IFC defines day-time as between 07:00 and 22:00 and night-time between 22:00 and 07:00 (IFC, 2007). SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008). The overlap hour between 06:00 and 07:00 was avoided during attended day- and night-time sampling.

- A detailed electronic log and record was kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic climate of each site.

1.5.3 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEM:AQA) (Act. 39 of 2004) but environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to SANS 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication'*. These guidelines, which are in line with those published by the IFC and World Health Organisation (WHO), were considered in the assessment.

1.5.4 Study of the Receiving Environment

NSRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside the industrial facility's property. Homesteads and residential areas which were included in the assessment as NSRs were identified from available maps and satellite imagery.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain. Atmospheric attenuation potential was described based on site specific simulated Weather Research and Forecasting Model (WRF) weather data obtained for 2017 to 2019. Readily available terrain and land cover data was obtained from the Atmospheric Studies Group (ASG) via the United States Geological Survey (USGS) web site. A study was made of Shuttle Radar Topography Mission (STRM) (30 m, arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa.

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in the study area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from baseline noise survey was studied to determine representative baseline noise levels for use in the assessment of cumulative impacts.

1.5.5 Source Inventory

The source noise inventory was informed by:

- Equipment specific L_W predictive equations for the mine fleet and power generation as published by Crocker (1998);
- Generic area wide L_W's for industrial areas as published by the European Commission (EC WG-AEN, 2003); and
- Traffic noise determined in accordance with SANS 10210 (2008), *'Calculating and Predicting Road Traffic Noise'*.

1.5.6 Noise Propagation Modelling

The propagation of noise from proposed activities will be simulated with the DataKustic CadnaA software. Use was made of the International Organisation for Standardization's (ISO) 9613 module for outdoor noise propagation from industrial noise sources.

1.5.6.1 ISO 9613

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects; geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

$$L_P = L_W - \sum [K_1, K_2, K_3, K_4, K_5, K_6]$$

Where;

L_P *is the sound pressure level at the receiver;*
L_W *is the sound power level of the source;*
K_1 *is the correction for geometrical divergence;*
K_2 *is the correction for atmospheric absorption;*
K_3 *is the correction for the effect of ground surface;*
K_4 *is the correction for reflection from surfaces; and*
K_5 *is the correction for screening by obstacles.*

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources.

To apply the method of ISO 9613, several parameters need to be known with respect to the geometry of the source and of the environment, the ground surface characteristics, and the source strength in terms of octave-band sound power levels for directions relevant to the propagation.

1.5.7 Simulation Domain

If the dimensions of a noise source are small compared with the distance to the listener, it is called a point source. All sources will be quantified as point sources or areas/lines represented by point sources. The sound energy from a point source spreads out spherically, so that the sound pressure level is the same for all points at the same distance from the source and decreases by 6 dB per doubling of distance. This holds true until ground and air attenuation noticeably affect the level. The impact of an intruding industrial noise on the environment will therefore rarely extend over more than 5 km from the source and is therefore always considered “local” in extent. A study domain of 10 km x 10 km was included in the simulations, with the project located centrally.

1.5.8 Presentation of Results

Noise impacts were calculated in terms of:

- Day- and night-time noise levels as a result of the Mokala Manganese Mine in comparison with guidelines; and
- The effective increase ambient day and night-time noise levels over the baseline as a result of the project.

Results are presented in isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case L_P) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.
Simulated noise levels were assessed according to guidelines published in SANS 10103 and by the IFC. To assess annoyance at nearby places of residence, reference was made to guidelines published in SANS 10103.

1.5.9 Recommendations of Management and Mitigation

The findings of the noise specialist study informed the recommendation of suitable noise management and mitigation measures.

1.6 Limitations and Assumptions

- All mining activities were assumed to be at the surface of pit areas. The mitigating effect of pit walls and waste rock dumps were therefore not accounted for.
- Although not assessed as part of this study, the character of noise generated by blasting is mentioned. Blasting can cause noise and vibration, which can have an impact upon neighbouring noise receptors. Blasting usually results in both ground and airborne vibration. The latter includes both audible noise and vibration known as airblast, which can cause objects to rattle and make noise. Annoyance and discomfort from blasting can occur when noise startles individuals or when airblast or ground vibration causes vibration of building elements such as windows. The degree of annoyance is influenced by the level of airblast and vibration as well as factors such as the time of day, the frequency of occurrence and the sensitivity of individuals. The generation and transmission of airblast and ground vibration is affected by a number of factors including blast design, meteorology (particularly wind speed and direction and temperature inversions), topography, geology and soil water content (Earth Resources | Victoria State Government, 2015). Whereas the audible part of the airblast (acoustic) is characterized by frequencies ranging from 20 to 20 000 Hz, the non-audible part, consist of sound energy below 20 Hz and is referred to as an ‘over pressure’ when the air blast pressure exceeds atmospheric pressure. Airblast over pressure exerts a force on structures and may in turn cause secondary and audible rattles within structures such as windows (Aloui, Bleuzen, Essefi, & Abbes, 2016).
- Predicting the noise caused by blasting events is a highly complex and unreliable process. For this reason, it was not included in the impact assessment. Although not causing significant noise impacts, blasting at the surface will be audible over long distances and may cause a startling reaction at receptors in close proximity. This can be mitigated by adhering to blast schedules that have been communicated to affected parties. While high sound pressure levels are usually experienced during the blasting event, due to the short term nature of blasting, blasting events usually have an insignificant impact on average daytime L_{Aeq} levels.

2 LEGAL REQUIREMENTS AND NOISE LEVEL GUIDELINES

2.1 SANS 10103 (2008)

SANS 10103 (2008) successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa, and is fully aligned with the WHO guidelines for Community Noise (WHO, 1999). The values given in Table 1 are typical rating levels that should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be considered to be annoying to the community.

Table 1: Typical rating levels for outdoor noise, SANS 10103 (2008)

Type of district	Equivalent Continuous Rating Level ($L_{Req,T}$) for Outdoor Noise		
	Day/night $L_{R,dn}$[(c)] (dBA)	Day-time $L_{Req,d}$[(a)] (dBA)	Night-time $L_{Req,n}$[(b)] (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40
Urban districts	55	55	45
Urban districts with one or more of the following; business premises; and main roads	60	60	50
Central business districts	65	65	55
Industrial districts	70	70	60

Notes

(a) $L_{Req,d}$ =The L_{Aeq}[2] rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.

(b) $L_{Req,n}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.

(c) $L_{R,dn}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.

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

- $\Delta \leq 0$ dB: There will be no community reaction;
- 0 dB < $\Delta \leq 10$ dB: There will be 'little' reaction with 'sporadic complaints';
- 5 dB < $\Delta \leq 15$ dB: There will be a 'medium' reaction with 'widespread complaints'. $\Delta = 10$ dB is subjectively perceived as a doubling in the loudness of the noise;
- 10 dB < $\Delta \leq 20$ dB: There will be a 'strong' reaction with 'threats of community action'; and
- 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'.

The categories of community response overlap because the response of a community does not occur as a stepwise function, but rather as a gradual change.

[2] $L_{Aeq,T}$ is the A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).

2.2 IFC Guidelines on Environmental Noise

The IFC General Environmental Health and Safety Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines.

The IFC states that noise impacts **should not exceed the levels presented in Table 2**, or result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

It is further important to note that the IFC noise level guidelines for residential, institutional and educational receptors correspond with the SANS 10103 guidelines for urban districts.

Table 2: IFC noise level guidelines

Noise Level Guidelines (IFC, 2007)		
Area	**One Hour L_{Aeq} (dBA) 07:00 to 22:00**	**One Hour L_{Aeq} (dBA) 22:00 to 07:00**
Industrial receptors	70	70
Residential, institutional and educational receptors	55	45

2.3 Criteria Applied in this Assessment

Reference is made to the IFC guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these (a) are applicable to nearby NSRs which include towns and a mine village and (b) in-line with SANS 10103 guidelines for urban districts. The IFC's 3 dBA increase criterion is used to determine the potential for noise impact.

3 DESCRIPTION OF THE RECEIVING ENVIRONMENT

This chapter provides details of the receiving acoustic environment which is described in terms of:

- Local NSRs;
- The local environmental noise propagation and attenuation potential; and
- Sampled baseline or pre-development noise levels.

3.1 Noise Sensitive Receptors

A map of potential NSRs is included in Figure 4. These include single homesteads/farmsteads, towns and a mine village. The closest NSRs include residences of the Gloria Mine village situated approximately 1.3 km north of the northern mine boundary and residences of the town of Hotazel which lies approximately 3.9 km east of the eastern mine boundary.

All other residences, farmsteads and towns lie further than 4 km from the mine boundary. As indicated earlier, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source and it is therefore unlikely that these will be affected by the Project.

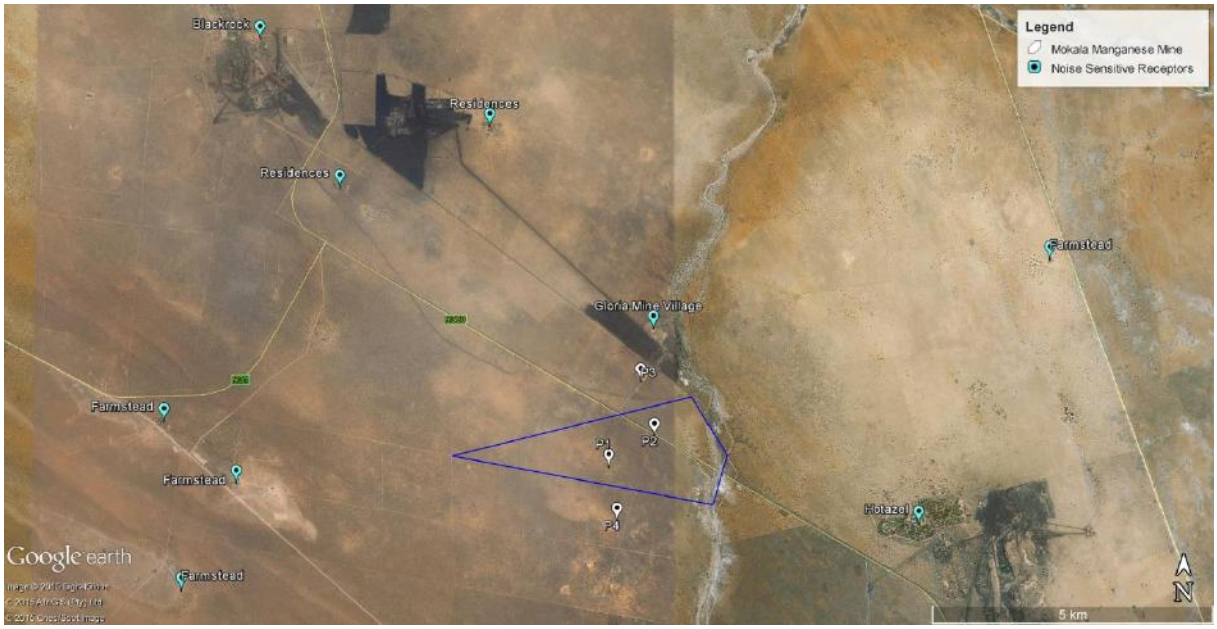


Figure 4: Location of NSRs

3.2 Environmental Noise Propagation and Attenuation Potential

Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation on noise from a source to receiver.

The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These along with other parameters such as relative humidity affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy. Use is made of the WRF modelled meteorological data for a point on-site for the period January 2017 to December 2019.

Wind speed increases with altitude. This results in the 'bending' of the path of sound to 'focus' it on the downwind side and creating a 'shadow' on the upwind side of the source. Depending on the wind speed, the downwind level may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). It should be noted that at wind speeds of more than 5 m/s, ambient noise levels are mostly dominated by wind generated noise.

The diurnal wind field for the area is presented in Figure 5. Wind roses represent wind frequencies for 16 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated.

The WRF data indicates a wind field dominated by winds from the northern sectors during the day. During the night, the wind field is mostly from the northeast, east-northeast and south-southeast (Figure 5). Day- and night-time average wind speeds are 4.55 m/s and 3.93 m/s, respectively. Calm conditions (wind speeds of less than 1 m/s) occur 3.46% of time during the day and 4.42% during the night.

The average temperature in the study area over the three-year period was 21°C and the average humidity 31%. Noise impacts are expected to be slightly more notable to the south of the operations during the day and to the southwest and north-northwest of the operations during the night.

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night. The diurnal temperature profile for the WRF data is shown in Figure 6. During the day, temperatures increase to reach maximum at around 14:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 06:00 i.e. just before sunrise.

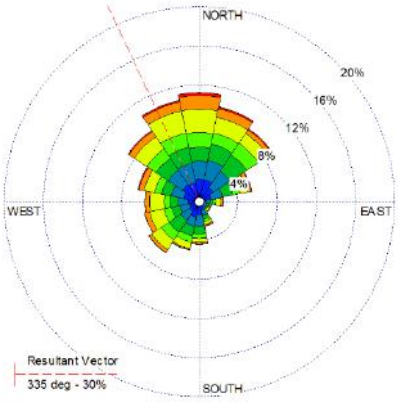
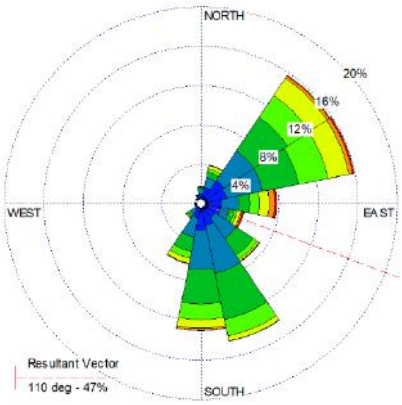
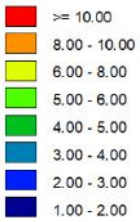
(a) Day-time wind field (06:00 to 22:00)	(b) Night-time wind field (22:00 to 06:00)	Wind speed (m/s)
		
Calms = 3.46%	Calms = 4.42%	

Figure 5: Day- and night-time wind field for AERMET processed WRF data (January 2017 to December 2019)

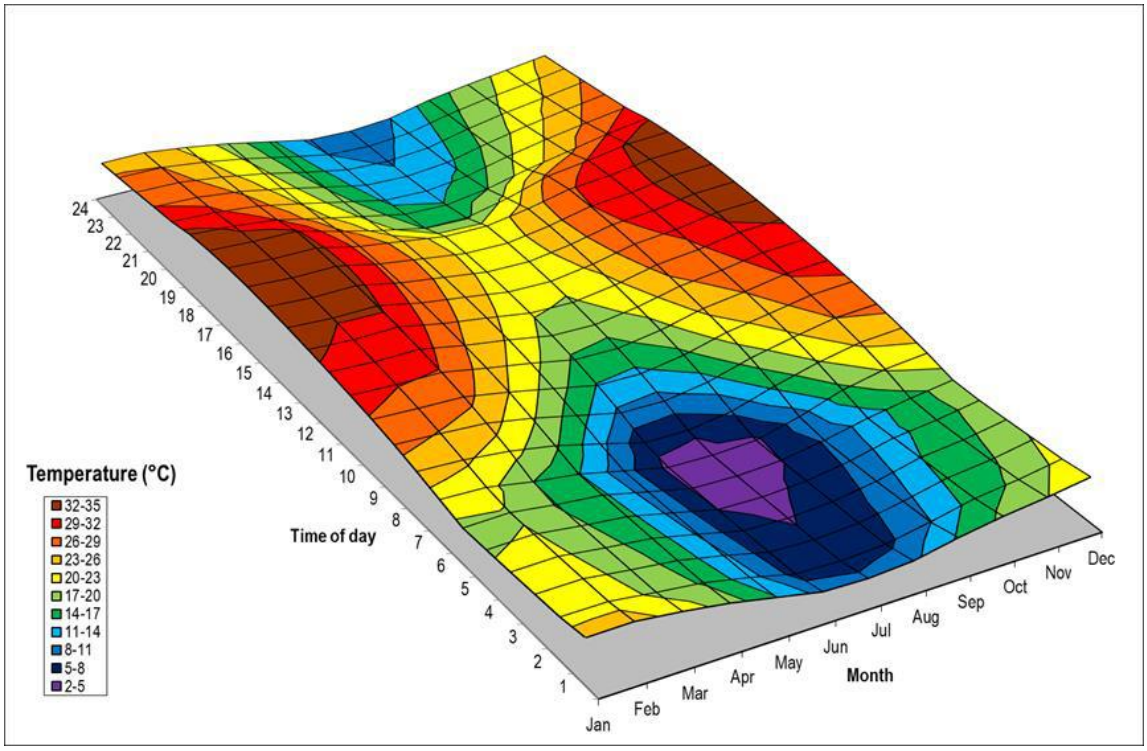


Figure 6: Monthly average temperature profile for AERMET processed WRF data (January 2017 to December 2019)

3.2.1 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) depends on two factors namely the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

The terrain of the study area is shown in Figure 7. The topography of the surrounding area is mostly flat with the main terrain features in the study area being lower lying riverbeds (as low as 1010 metres above sea level [masl]) to the north and east of the mine and hills to the east beyond 10 km from the proposed Project. The topography of the study area ranges in height from 1010 masl to the east and up to 1060 masl to the west of the operations. The land use in the vicinity of the operations is comprises primarily mining, residential and farming. The vegetation is classified as part of the Savanna Biome and is mostly used for grazing.

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g., concrete or water), soft (e.g., grass, trees or vegetation) and mixed surfaces. Ground attenuation is often calculated in frequency bands to take into account the frequency content of the noise source and the type of ground between the source and the receiver (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). The attenuation potential of the study area is acoustically mixed.

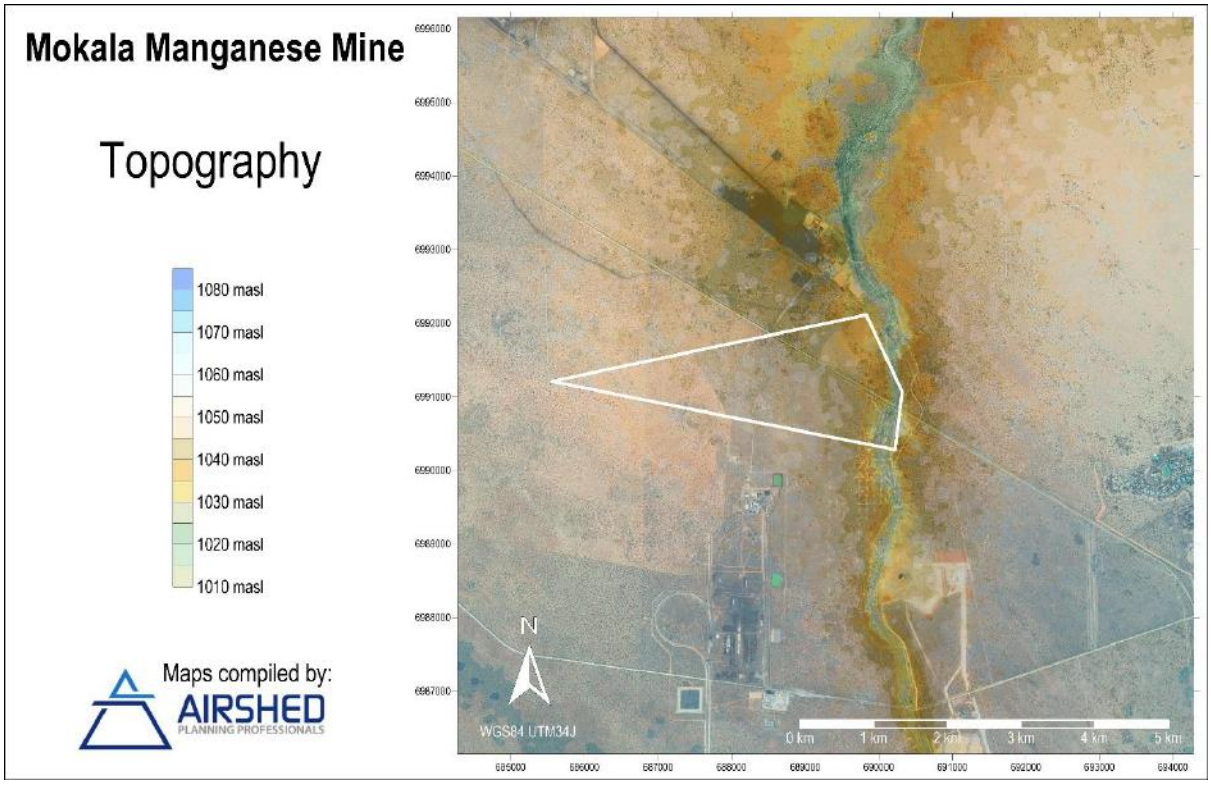


Figure 7: Study Area Topography

3.3 Sampled Baseline and Representative Pre-development Noise Levels

A baseline noise survey was conducted as part of the original noise impact assessment in January 2015. The survey was conducted in accordance with the guidelines as set out in SANS 10103 (2008) at sites indicated in Figure 8. The survey consisted of attended 20 to 30 minute samples during the day and night (results summarised in Table 3). The main findings of the survey is summarised below.

- Ambient noise levels are affected by traffic on the R380, mining and ore storage/handling activities directly north of the R380 and Mokala Manganese Mine, birds and insects.
- At P1 and P4 sampled noise levels correspond to what SANS 10103 states is typically found in rural areas. The small difference between day- and night-time noise levels at these locations correspond with what is found in areas with limited human activity. Insect noise at night often results in night-time noise levels that are slightly higher than during the day.
- Noise levels at P2 and P3 correspond to what SANS 10103 states is typically found in suburban areas i.e. areas with some human activity. The 5 to 10 dBA difference between day- and night-time noise levels at these locations are as a result of changes in traffic volumes along the R380.
- Baseline noise levels in the Project area do not currently exceed IFC guidelines.

For estimating the increase in ambient noise levels as a result of the Mokala Manganese Mine, the following representative background noise levels were calculated from survey results.

- 48.8 dBA for the day; and
- 44.4 dBA for the night.

Detailed results are included in Annex A respectively.

Table 3: Summary of attended 20 minute survey conducted on 6 and 7 January 2015

Sampling Point	P1		P2		P3		P4	
Description	In an open area where the current waste rock dump is located		On the current R380 near the proposed truck staging area.		Close to the northern fence, surrounded by trees.		In an open area near the south fence security gate.	
Latitude	S 27.19141		S 27.18652		S 27.17777		S 27.19993	
Longitude	E 22.90116		E 22.90936		E 22.90690		E 22.90263	
Time of Day	Day	Night	Day	Night	Day	Night	Day	Night
Start Time	12:02:43	23:45:26	10:59:40	23:14:48	14:27:42	22:44:39	12:49:46	00:16:35
Duration	00:30.00	00:22:07	00:30.00	00:20:18	00:30.00	00:21:01	00:30.00	00:19:40
Acoustic Observations	Short trees, medium height grass with sandy patches. R380 traffic (900 m away). Birds	Short trees, medium height grass with sandy patches R380 traffic (900 m away) Bird and insects	Short trees, medium height grass with sandy patches R380 traffic (nearby) Birds	Short trees, medium height grass with sandy patches R380 traffic (nearby) Bird and insects	Short trees and medium height. Close to wired fence & northern access road from R380. People nearby in conversation Birds	Short trees and medium height Close to wired fence & northern access road from R380. Birds and insects	Short trees and medium height grass Close to southern service road Noise from distant mine activity (about 300 metres east) Birds	Short trees and medium height grass Close to southern service road Noise from distant mine activity (about 300 metres east) Birds and insects
L_{Amax} (dBA)	51.0	51.5	73.2	65.5	68.7	62.6	62.8	56.1
L_{Amin} (dBA)	26.8	30.9	56.0	27.4	42.6	34.9	30.6	41.6
L_{Aeq} (dBA)	37.4	36.1	51.5	44.5	51.7	42.6	42.5	47.7
L_{A90} (dBA)	33.1	34.3	42.2	30.3	49.1	37.7	37.2	44.0

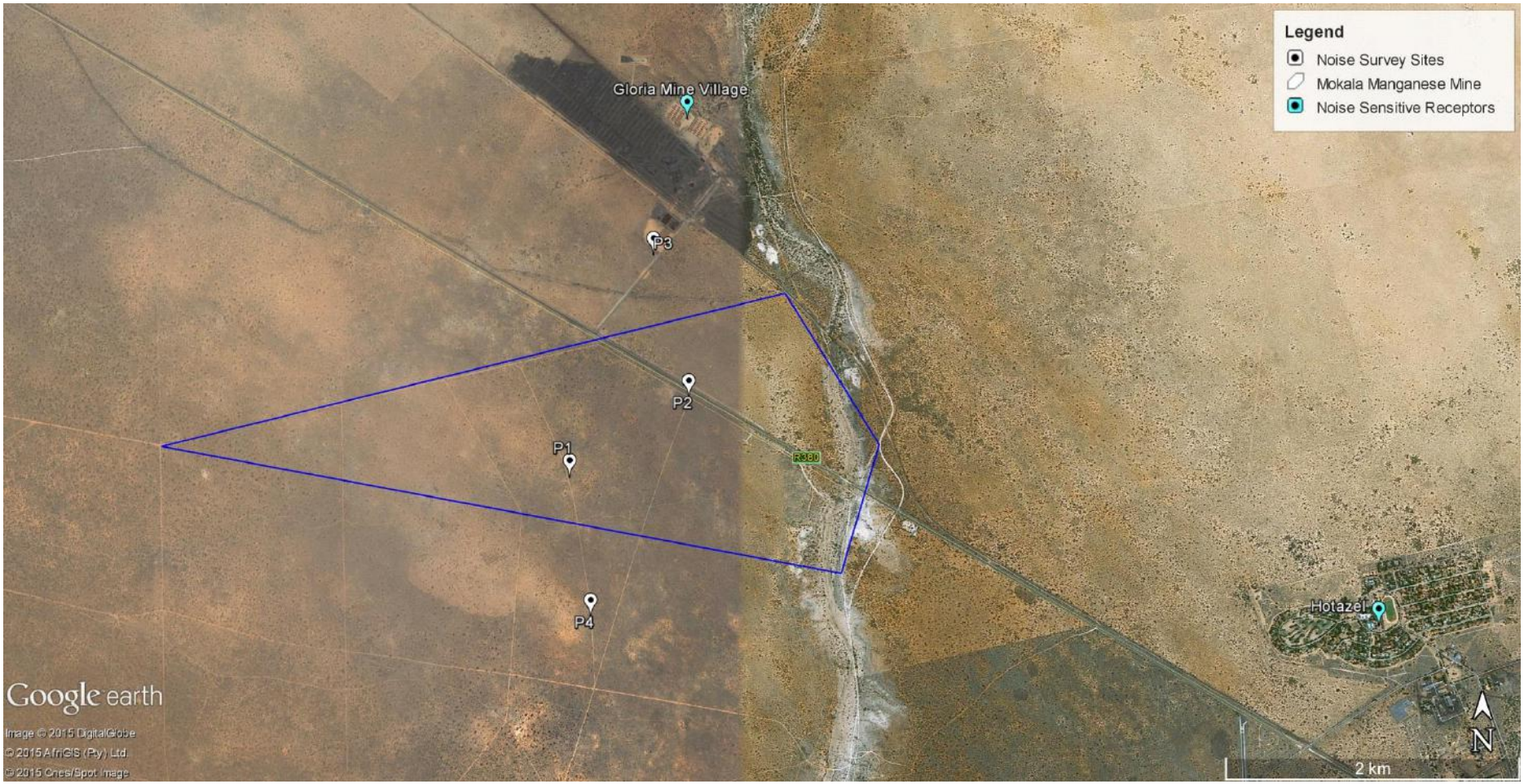


Figure 8: Baseline noise survey sites

4 IMPACT ASSESSMENT

The noise source inventory, noise propagation modelling and results for the additional operational phases at the Mokala Manganese Mine are discussed below. The focus is on Phase 2, as due to the haul distance and proximity to receptors, noise impacts are expected to be most significant during this Phase 2. The results provided below are for the unmitigated scenario.

4.1 Noise Sources and Sound Power Levels

The extent and character of operational phase noise, especially mining, will be variable as the mine progresses. The following operational phase sources of noise were included in the study:

- Diesel mobile equipment, operational within the pit, along haul routes, on the stockpiles and within the plant;
- Loading and unloading of ROM and waste rock;
- Ore processing through crushing and screening;
- Diesel power generation; and
- Transport of ore and waste materials.

4.1.1 Diesel Mobile Equipment

The fleet size, provided by SLR, and calculated L_W's are given in Table 4, the summary of the operational phase source inventory. L_W's were estimated using the method described in Section 1.5.5.

4.1.2 Ore Processing

L_W's of crushing, screening and material handling operations are given in Table 4. These L_W's were obtained from a reference database for such operations (Francois Malherbe Acoustic Consulting).

4.1.3 Diesel Power Generation

Noise as a result of power generation with one Caterpillar 3516, 1 600 KVA diesel generator was included in the source inventory. The overall L_W's of the generator was estimated with the following equation recommended by Crocker (1998) for V-type diesel fuelled engines operation at speeds of 1 500 rpm and higher, with or without turbocharging:

$$L_W = 93 + 10 \cdot \log kW$$

In the equation, L_W is the overall sound power level in dB and kW is the power rating of the engine. Octave band sound power levels were obtained by applying adjustments recommended by Crocker (1998). Calculated L_W's are included in Table 4, the summary of the operational phase source inventory.

4.1.4 Traffic Noise

On-site traffic noise accounted for in the assessment of operational phase noise include the transport of mine materials inside active box-cuts, ore transport to and within the plant area, the transport of product to the R380 road, and the transport of waste and low grade ore to stockpile areas. Traffic volumes included return trips required for trucks to transport ore, waste or product to its destinations and accounted for two LDV trips per hour on all roads. Traffic information as included in the source inventory included in Table 4.

Table 4: Operational phase source noise inventory

Diesel Mobile Equipment and Power Generation										
Equipment Type	**Qty.**	**Power Rating (kW)**	**Octave Band Sound Power Levels, L_{Wi} (dB)**							**L_{WA} (dBA)**
			63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	
CAT 5316 1600 kVA diesel generator	1	1640	123.1	124.1	124.1	124.1	122.1	120.1	117.1	131.1	131.9
CAT 777E	12	758	116.8	121.8	124.8	119.8	117.8	114.8	108.8	102.8	123.1
Volvo A60H	12	495	114.9	119.9	122.9	117.9	115.9	112.9	106.9	100.9	121.2
Volvo A40F Water truck	1	355	113.5	118.5	121.5	116.5	114.5	111.5	105.5	99.5	119.8
Bell B20D Water truck	1	153	109.8	114.8	117.8	112.8	110.8	107.8	101.8	95.8	116.1
CAT 140K	2	112	108.5	113.5	116.5	111.5	109.5	106.5	100.5	94.5	114.8
Bell 315S	1	72	106.6	111.6	114.6	109.6	107.6	104.6	98.6	92.6	112.8
CAT 966H	2	209	111.2	116.2	119.2	114.2	112.2	109.2	103.2	97.2	117.5
Volvo L220H	4	273	112.4	117.4	120.4	115.4	113.4	110.4	104.4	98.4	118.6
CAT D8T	3	259	112.1	117.1	120.1	115.1	113.1	110.1	104.1	98.1	118.4
CAT D9	1	256	112.1	117.1	120.1	115.1	113.1	110.1	104.1	98.1	118.3
Hitachi EX1200	5	566	115.5	120.5	123.5	118.5	116.5	113.5	107.5	101.5	121.8
Hitachi 670	2	345	113.4	118.4	121.4	116.4	114.4	111.4	105.4	99.4	119.6
ZX330	1	184	110.6	115.6	118.6	113.6	111.6	108.6	102.6	96.6	116.9
D65 Atlas Copco	3	403	114.1	119.1	122.1	117.1	115.1	112.1	106.1	100.1	120.3
DP1500i Pantera Sandvik	1	261	112.2	117.2	120.2	115.2	113.2	110.2	104.2	98.2	118.4
Ore Processing											
Activity			**Octave Band Sound Power Levels, L_{Wi} (dB)**								**L_{WA} (dBA)**
			63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	
Primary crushing, secondary crushing and screening			100.6	105.6	108.6	103.6	101.6	98.6	92.6	-	106.8
Rockfall			80.0	90.0	100.4	102.6	100.2	99.1	91.0	-	105.2
Traffic											
Activity			**Trips per hour**			**Average Vehicle Speed (km/h)**			**% Heavy Vehicles**		
Product from plant to access gate			11			40			82%		
Waste and low grade ore to stockpiles			26			40			92%		
RoM to Plant			7			40			71%		

4.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the operational phase was calculated with CadnaA in accordance with ISO 9613. Meteorological and site-specific acoustic parameters as discussed in Section 3.2 and along with source data discussed in 4.1, were applied in the model. Results are presented as isopleths in Figure 9 to Figure 12.

Isopleth plots are shown for Phase 2 of the extended operations, as due to the haul distance and proximity to receptors, noise impacts are expected to be most significant during Phase 2. The results provided below are for the unmitigated scenario.

During the day, Phase 2 operations (Figure 10) are expected to result in an increase of 3 dBA from baseline levels up to 600m to the east of the mine boundary, 200m to the north of the mine boundary and up to 300m to the south of the mine boundary (impacts to the south and east will of course be dependent on the location of the box cut being worked at any given time). The simulated increase in noise levels are well below 3 dBA at all sensitive receptor locations, meaning that the mining, processing and hauling operations are unlikely to cause a disturbance at any of these locations.

Because of the lower night-time baseline noise levels and atmospheric conditions less conductive to noise attenuation, the increase from baseline levels due to the Mokala Manganese Mine operations (Figure 12) are expected to be more significant during the night, with an increase of 3 dBA simulated up to 800m to the north, south and east of the mine boundary. The increase from baseline could reach 10 dBA up to 100m to the north, south and east of the mine boundary as well.

Due to the distance between the operations and any nearby sensitive receptor locations, the impact of the mining operations on noise levels at sensitive receptor locations, both during the day (Figure 9) and during the night (Figure 11), are expected to be insignificant and well below the IFC guidelines.

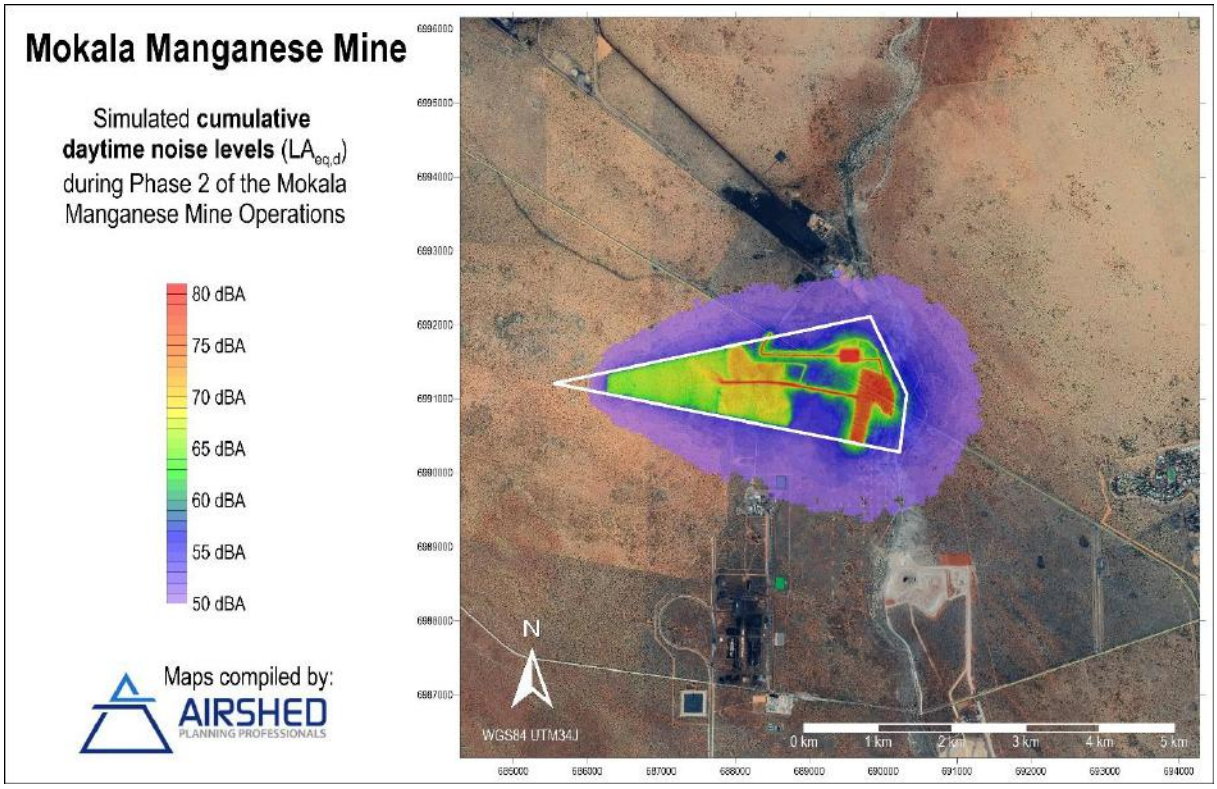


Figure 9: Simulated cumulative day-time noise levels as a result of Phase 2 of operations at the Mokala Manganese Mine

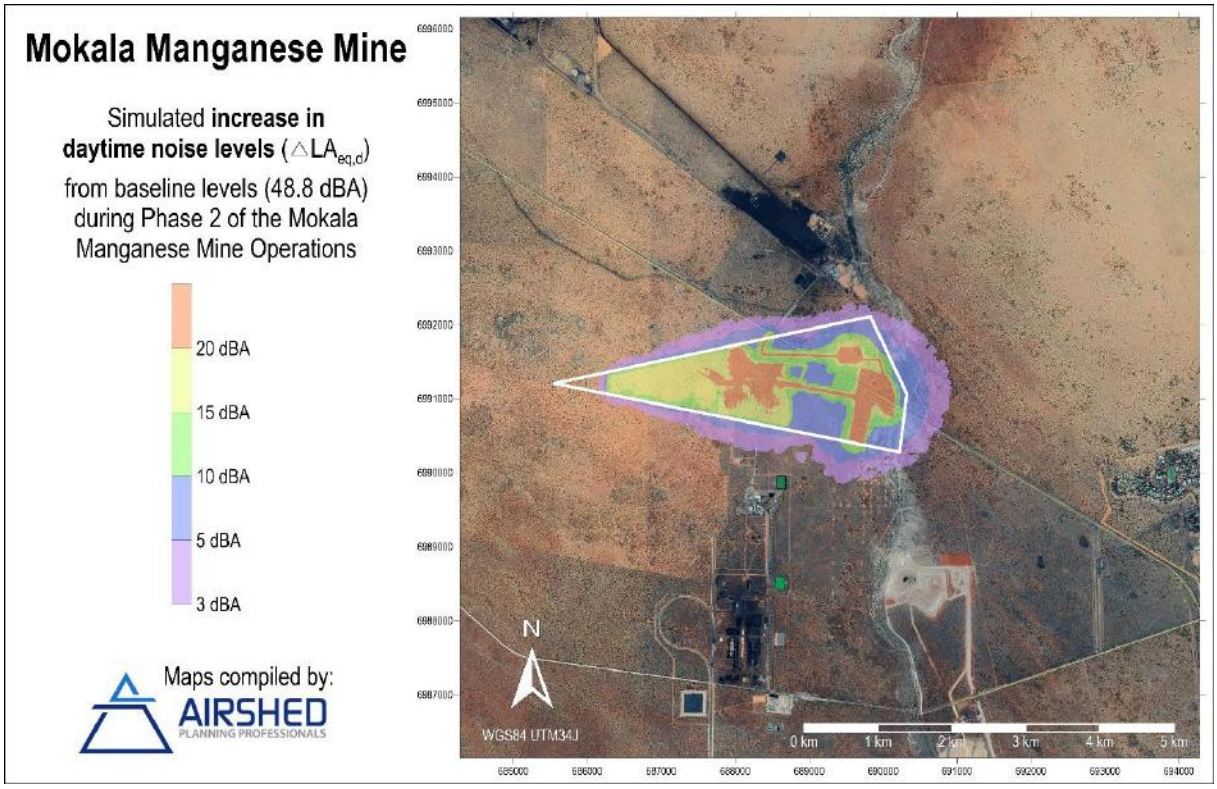


Figure 10: Increase in day-time noise levels over the baseline as a result of Phase 2 of operations at the Mokala Manganese Mine

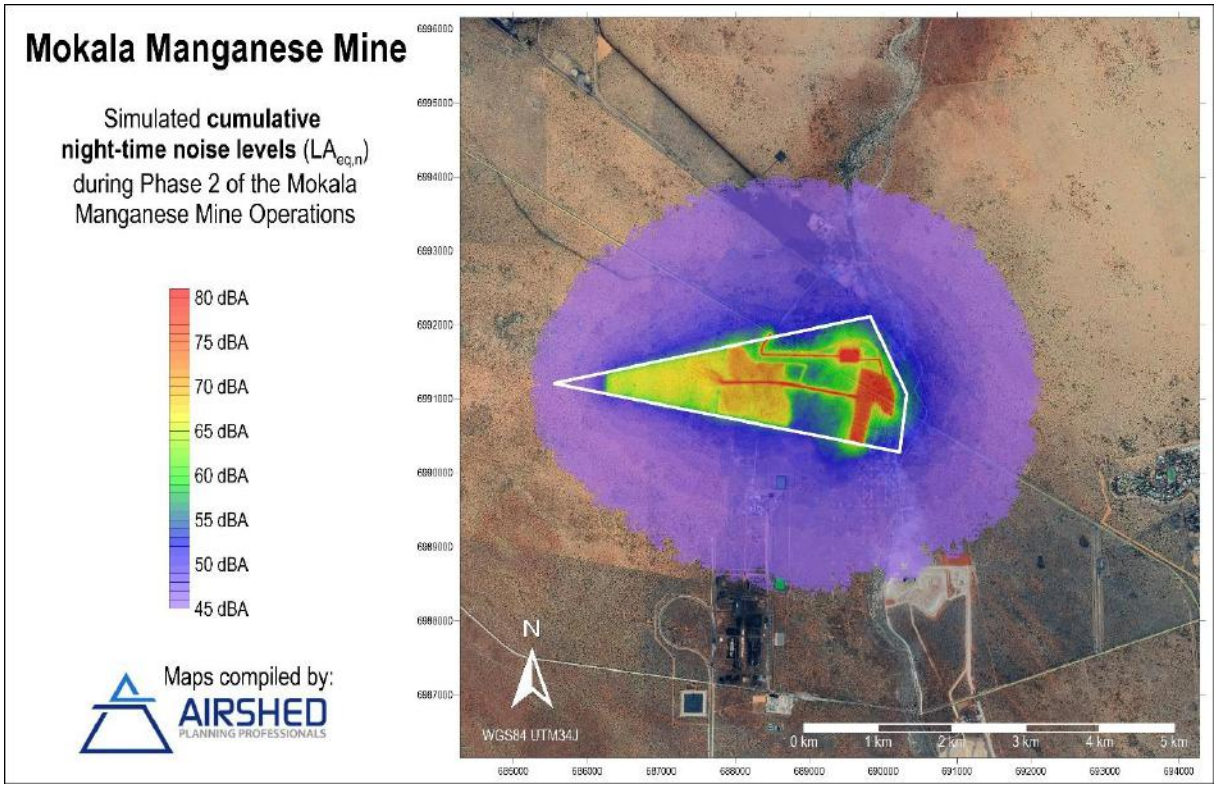


Figure 11: Simulated night-time noise levels as a result of Phase 2 of operations at the Mokala Manganese Mine

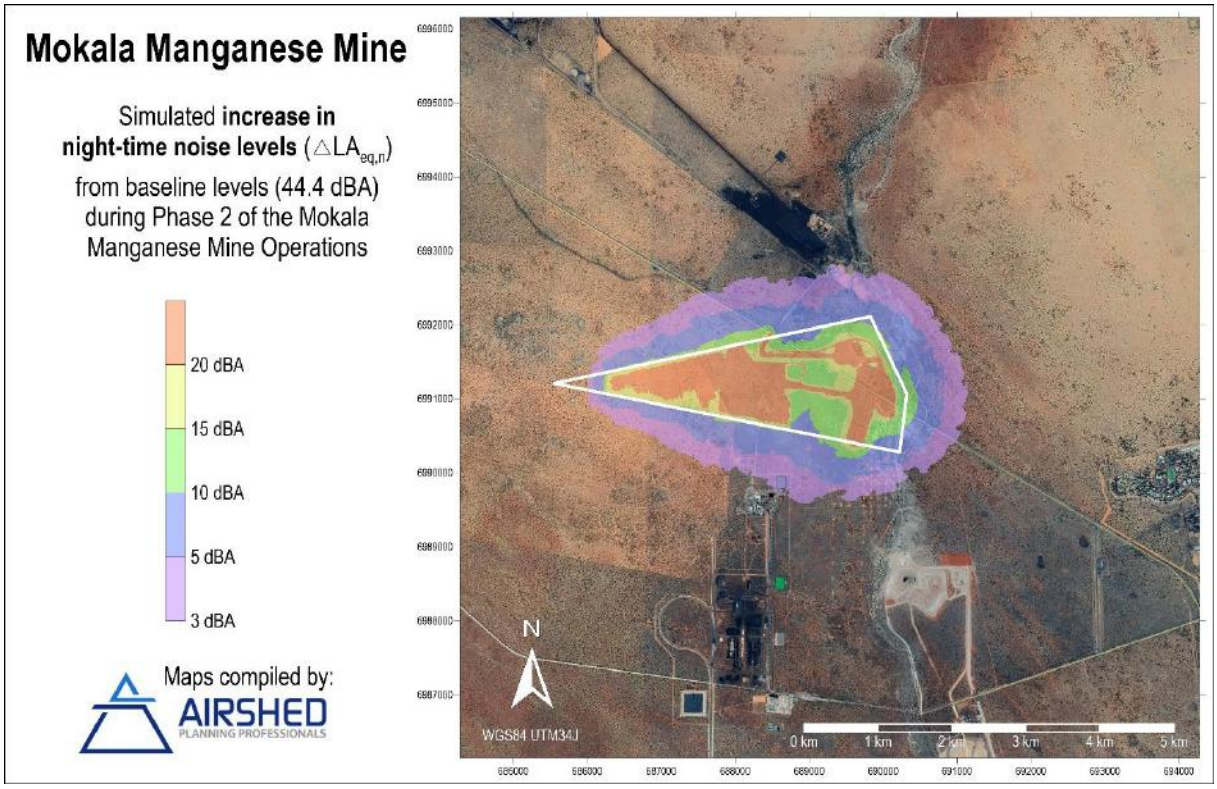


Figure 12: Increase in night-time noise levels over the baseline as a result of Phase 2 of operations at the Mokala Manganese Mine

5 MANAGEMENT, MITIGATION AND RECOMMENDATIONS

In the quantification of noise emissions and simulation of noise levels as a result of the Mokala Manganese Mine it was predicted that IFC and SANS evaluation criteria for human receptors will not be exceeded at the nearest NSR to site during Phase 2 of the expanded operations. Given that the haul distance is greatest during Phase 2 of the operations, and that the distance between the operations and NSRs is the shortest, noise impacts of the operations on the receiving environment during Phase 3 to 6 are expected to be lower compared to during Phase 2. It is the specialist's opinion that the proposed operations will not result in a significant negative impact on the receiving environment. It is however recommended that the following **basic good practice measures** be considered.

5.1 Good Engineering and Operational Practices

For general activities during Phase 2 to 6 of the operations, the following good engineering practice should be applied:

- All diesel-powered equipment and plant vehicles should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as a trigger for withdrawing it for maintenance.
- To minimise noise generation, vendors should be required to guarantee optimised equipment design noise levels.
- Vibrating equipment such as crushers and screens should be mounted on vibration isolation mountings.
- A mechanism to monitor noise levels, record and respond to complaints and mitigate impacts should be developed.
- Blasting at the surface will be audible over long distances and may cause a startling reaction at receptors in close proximity. This can be mitigated by adhering to blast schedules that have been communicated to the affected parties.

5.2 Traffic

The measures described below are considered good practice in reducing traffic related noise.

In general, road traffic noise is the combination of noise from individual vehicles in a traffic stream and is considered as a line source if the density of the traffic is high enough to distinguish it from a point source. The following general factors are considered the most significant with respect to road traffic noise generation:

- Traffic volumes i.e. average daily traffic.
- Average speed of traffic.
- Traffic composition i.e. percentage heavy vehicles.
- Road gradient.
- Road surface type and condition.
- Individual vehicle noise including engine noise, transmission noise, contact noise (the interaction of tyres and the road surface, body, tray and load vibration and aerodynamic noise

In managing transport noise specifically related to trucks, efforts should be directed at:

- Minimizing individual vehicle engine, transmission and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
- Minimize slopes by managing and planning road gradients to avoid the need for excessive acceleration/deceleration.
- Maintain road surface regularly to avoid corrugations, potholes etc.
- Avoid unnecessary idling times.
- Minimising the need for trucks/equipment to reverse through optimised route layout and traffic management on site. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the

traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level in the vicinity of the moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009).

5.3 Monitoring

In the event that Mokala receives noise related complaints, then Mokala should consider conducting short term (24-hour) ambient noise measurements as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The following procedure should be adopted for all noise surveys:

- Any surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 sound level meter (SLM) that meets all appropriate International Electrotechnical Commission (IEC) standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of at least 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic climate should be taken.
- The following acoustic indices should be recoded and reported:
    - L_{Aeq} (T)
    - Statistical noise level L_{A90},
    - L_{Amin} and L_{Amax}
    - Octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic climate of each site.

6 IMPACT SIGNIFICANCE

The significance of environmental noise impacts due to the extended Mokala Manganese operations were assessed in accordance with the procedure set out by SLR. The proposed method for the assessment of environmental issues is presented in Table 6.

This assessment methodology enables the assessment of environmental issues including: cumulative impacts, the severity of impacts (including the nature of impacts and the degree to which impacts may cause irreplaceable loss of resources), the extent of the impacts, the duration and reversibility of impacts, the probability of the impact occurring, and the degree to which the impacts can be mitigated.

The significance rankings of the noise impacts from the Mokala Manganese Mine during Phases 2 to 6 of the operations is given in Table 5. The impact significance, mainly due to the large spatial separation between the operations and nearby NSRs is ***'low'***. Impacts during construction and decommissioning are expected to be similar to or less significant than during the operational phases, and noise impacts are expected to seize post-closure.

Table 5: Assessment of the significance of environmental noise impacts from the Mokala Manganese Mine during operational Phases 2 to 6 (with or without additional mitigation and good practice measures).

Activity	Impact	Severity of Impact	Spatial Scale of Impacts	Duration of Impact	Consequence of Impact	Probability of Impact	Significance
Operational phases 2 - 6	Cumulative noise levels	Low	Medium	Medium	Low	Low	**Low**
	Increase from baseline noise levels	Low	Medium	Medium	Low	Low	**Low**

Table 6: Criteria for assessing impacts as provided by SLR

PART A: DEFINITION AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
SEVERITY = M					
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
SEVERITY = H					
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

7 REFERENCES

Aloui, M., Bleuzen, Y., Essefi, E. & Abbes, C., 2016. Ground Vibrations and Air Blast Effects Induced by Blasting in Open Pit Mines: Case of Metlaoui Mining Basin, Southwestern Tunisia. Journal of Geology and Geophysics, 5(3).

Brüel & Kjær Sound & Vibration Measurement A/S, 2000. *www.bksv.com.* [Online] Available at: http://www.bksv.com [Accessed 14 October 2011].

Burgess, M. & McCarty, M., 2009. *Review of Alternatives to 'Beeper' Alarms for Construction Equipment,* Canberra: University of New South Wales.

Crocker, M. J., 1998. *Handbook of Acoustics.* s.l.:John Wiley & Sons, Inc.

Earth Resources | Victoria State Government, 2015. Ground Vibration and Airblast Limits for Blasting in Mines and Quarries. [Online]

Available at: http://earthresources.vic.gov.au/earth-resources-regulation/licensing-and-approvals/minerals/guidelines-and-codes-of-practice/ground-vibration-and-airblast-limits-for-blasting-in-mines-

EC WG-AEN, 2003. *Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure,* s.l.: s.n.

IFC, 2007. *General Environmental, Health and Safety Guidelines,* s.l.: s.n.

Republic of South Africa, 2014. *Environmental Impact Assessment Regulation, 2014.* Pretoria(Gauteng): Government Printing Works.

SANS 10103, 2008. *The measurement and rating of environmental noise with respect to annoyance and to speech communication,* Pretoria: Standards South Africa.

SANS 10210, 2008. *Calculating and Predicting Road Traffic Noise,* Pretoria: Standards South Africa.

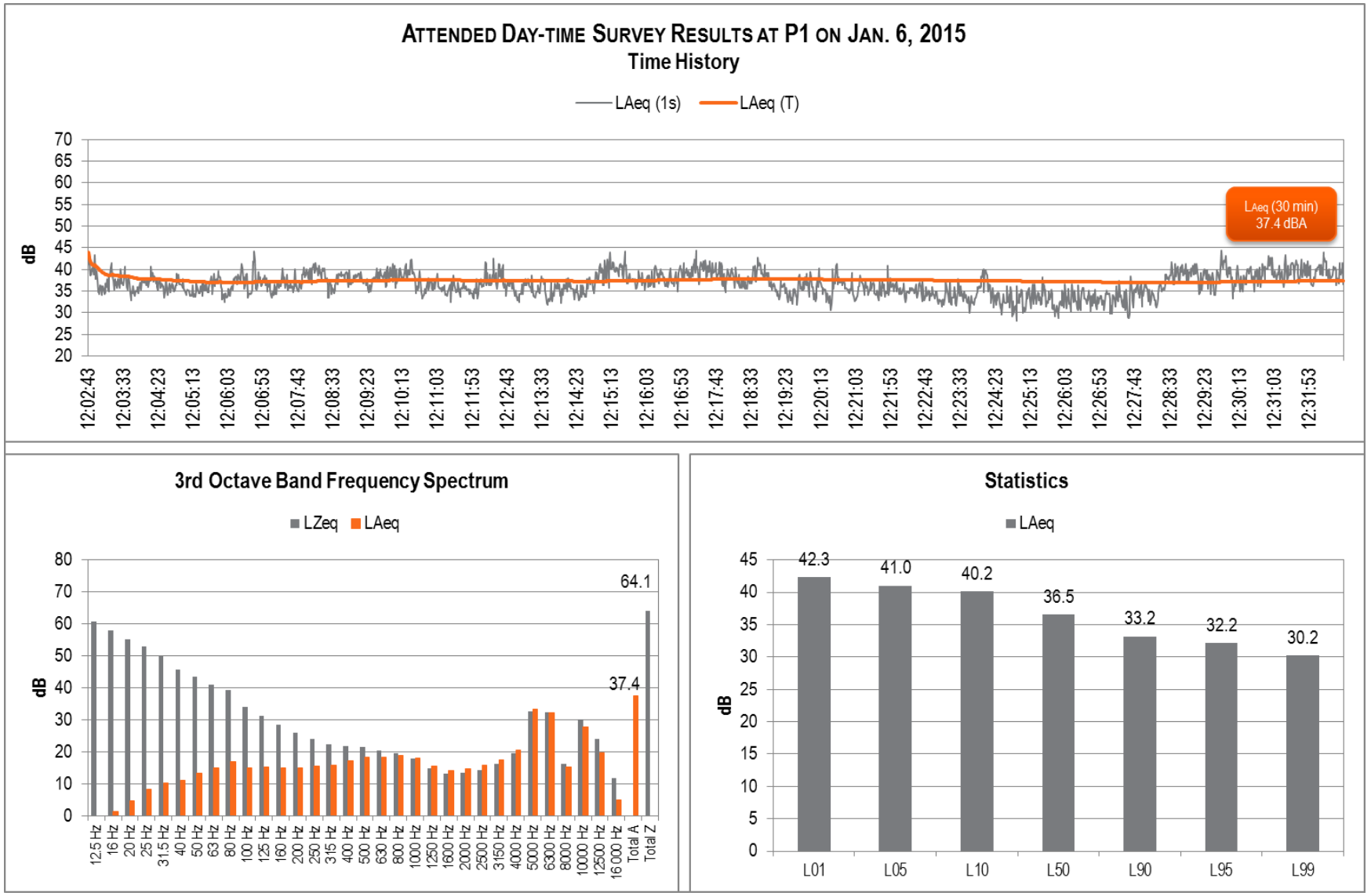
SANS 10357, 2004. *The Calculation of Sound Propagation by the Concawe Method.* s.l.:Standards South Africa.

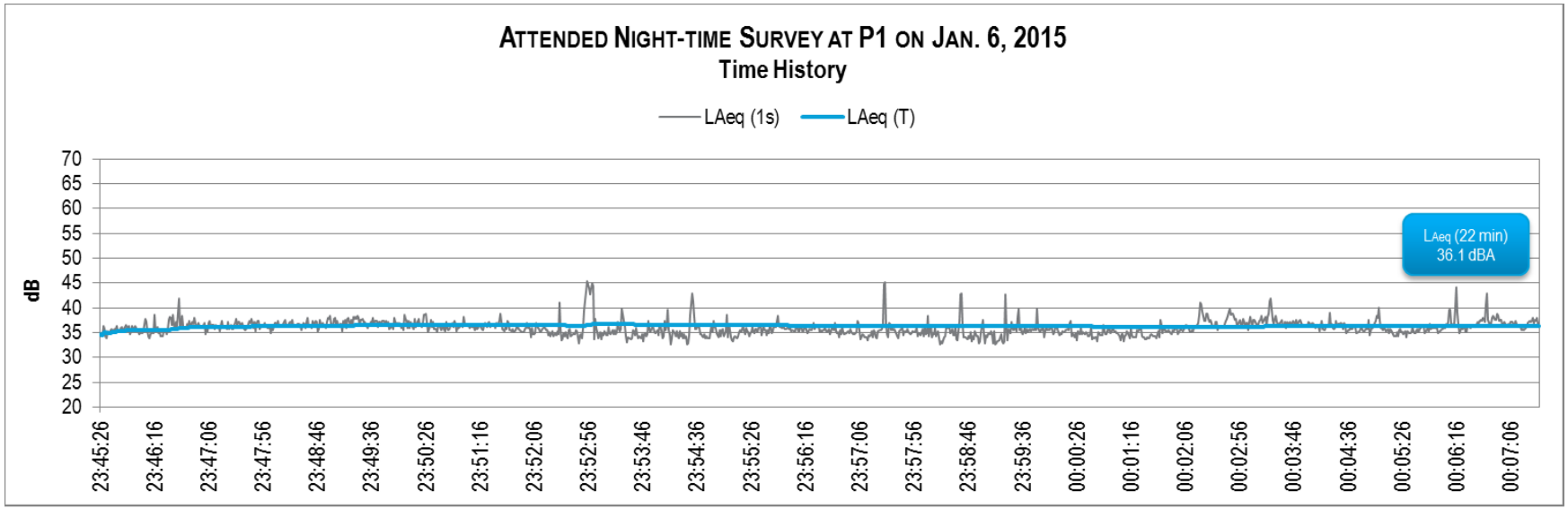
The Gauteng Provincial Government, 1999. *Noise Control Regulations under Section 25 of the Environment Conservation Act (Act No. 73 of 1989).* s.l.:s.n.

The Republic of South Africa, 1992. *Noise Control Regulations in terms of Section 25 of the Environment Conservation Act, Notice R154, Government Gazette 13717, 10 January 1992.* s.l.:Government Printing Works.

WHO, 1999. *Guidelines to Community Noise.* s.l.:s.n.

8 ANNEX A - DETAILED BASELINE SAMPLING RESULTS


ATTENDED DAY-TIME SURVEY RESULTS AT P1 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
dB
LAeq (30 min)
37.4 dBA
12:02:43
12:03:33
12:04:23
12:05:13
12:06:03
12:06:53
12:07:43
12:08:33
12:09:23
12:10:13
12:11:03
12:11:53
12:12:43
12:13:33
12:14:23
12:15:13
12:16:03
12:16:53
12:17:43
12:18:33
12:19:23
12:20:13
12:21:03
12:21:53
12:22:43
12:23:33
12:24:23
12:25:13
12:26:03
12:26:53
12:27:43
12:28:33
12:29:23
12:30:13
12:31:03
12:31:53
3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
64.1
37.4
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z
Statistics
LAeq
dB
42.3
41.0
40.2
36.5
33.2
32.2
30.2
L01
L05
L10
L50
L90
L95
L99


ATTENDED NIGHT-TIME SURVEY AT P1 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
dB
70
65
60
55
50
45
40
35
30
25
20
LAeq (22 min)
36.1 dBA
23:45:26
23:46:16
23:47:06
23:47:56
23:48:46
23:49:36
23:50:26
23:51:16
23:52:06
23:52:56
23:53:46
23:54:36
23:55:26
23:56:16
23:57:06
23:57:56
23:58:46
23:59:36
00:00:26
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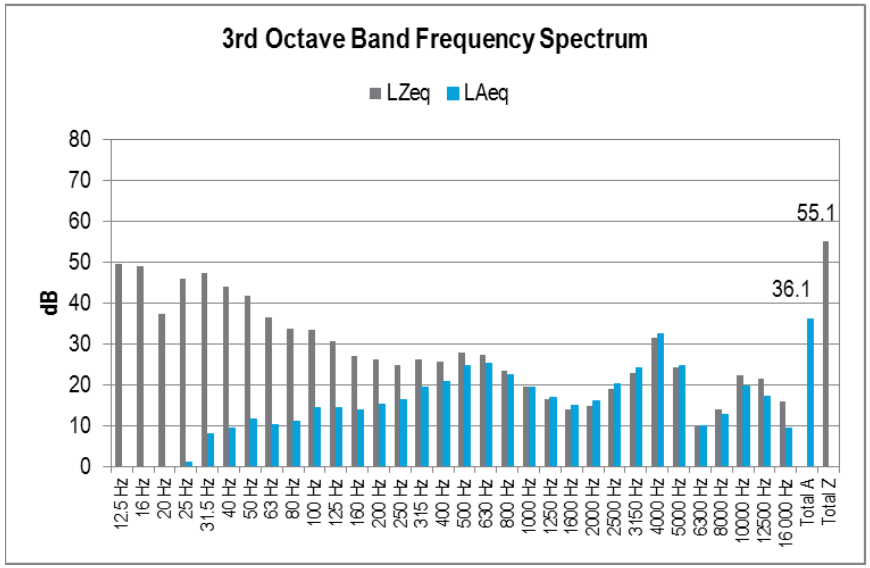
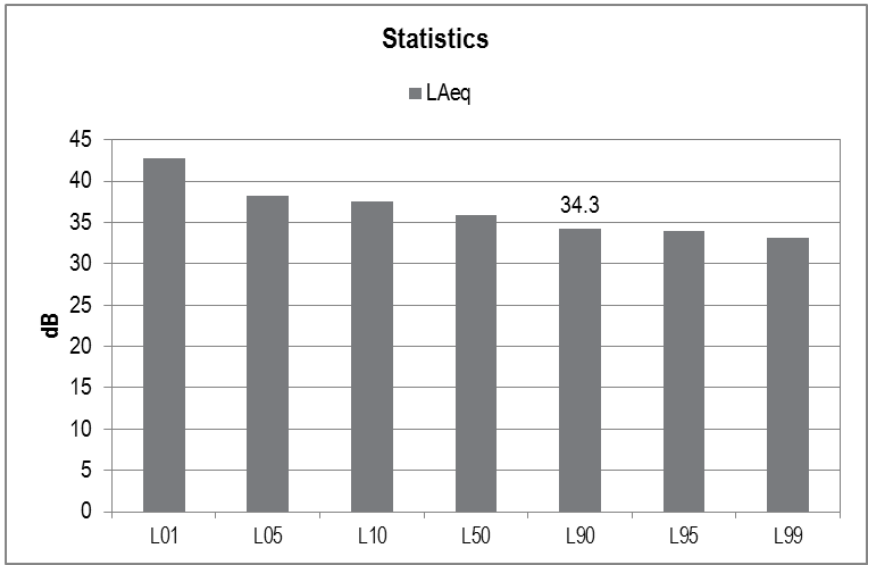
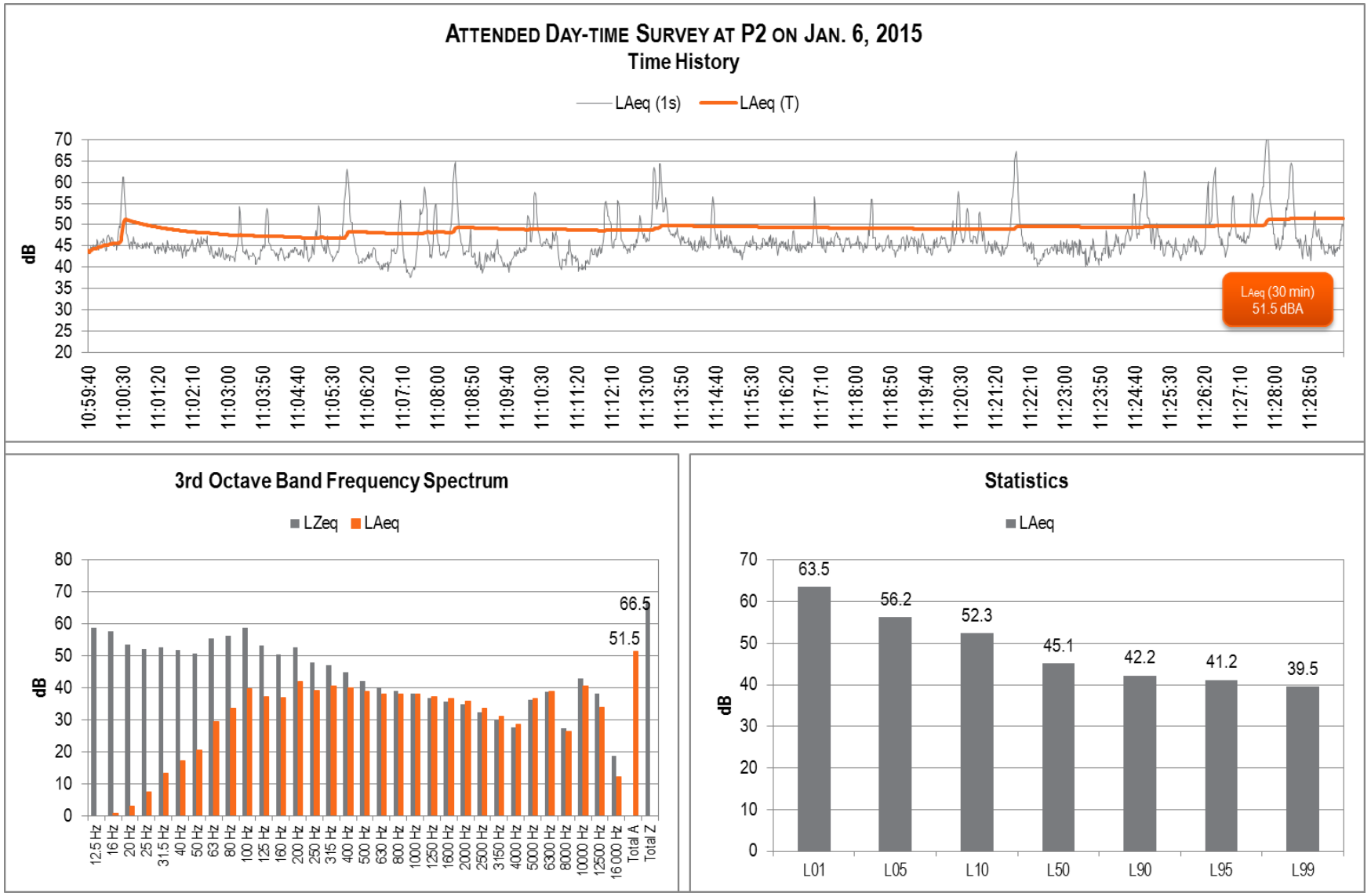
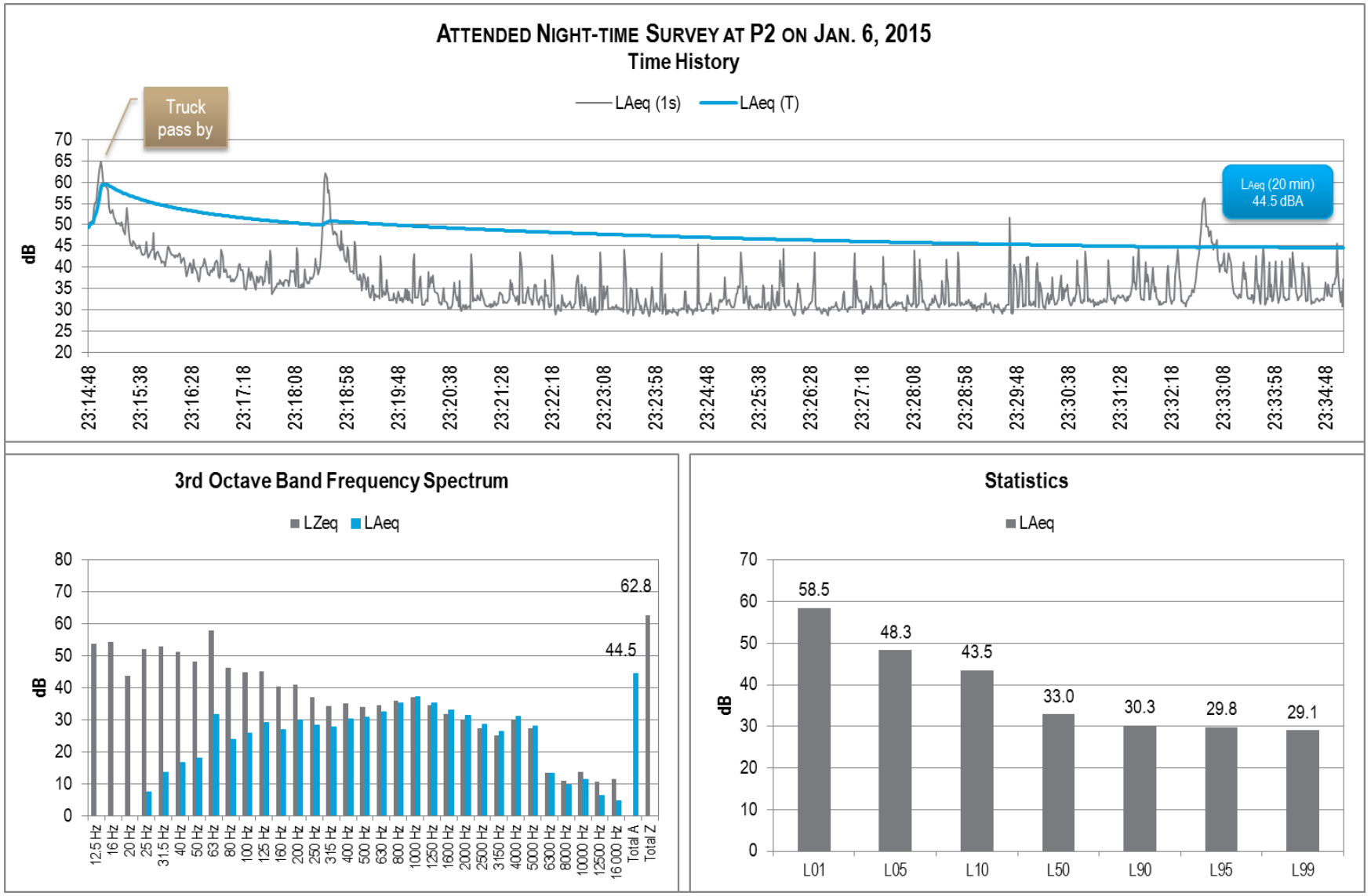
00:06:16
00:07:06


3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
80
70
60
50
40
30
20
10
0
55.1
36.1
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z


Statistics
LAeq
dB
45
40
35
30
25
20
15
10
5
0
34.3
L01
L05
L10
L50
L90
L95
L99


ATTENDED DAY-TIME SURVEY AT P2 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
dB
LAeq (30 min)
51.5 dBA
3rd Octave Band Frequency Spectrum
LZeq
LAeq
66.5
51.5
Statistics
LAeq
63.5
56.2
52.3
45.1
42.2
41.2
39.5
L01
L05
L10
L50
L90
L95
L99


ATTENDED NIGHT-TIME SURVEY AT P2 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
Truck pass by
LAeq (20 min) 44.5 dBA
dB
70
65
60
55
50
45
40
35
30
25
20
23:14:48
23:15:38
23:16:28
23:17:18
23:18:08
23:18:58
23:19:48
23:20:38
23:21:28
23:22:18
23:23:08
23:23:58
23:24:48
23:25:38
23:26:28
23:27:18
23:28:08
23:28:58
23:29:48
23:30:38
23:31:28
23:32:18
23:33:08
23:33:58
23:34:48
3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
80
70
60
50
40
30
20
10
0
62.8
44.5
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z
Statistics
LAeq
dB
70
60
50
40
30
20
10
0
58.5
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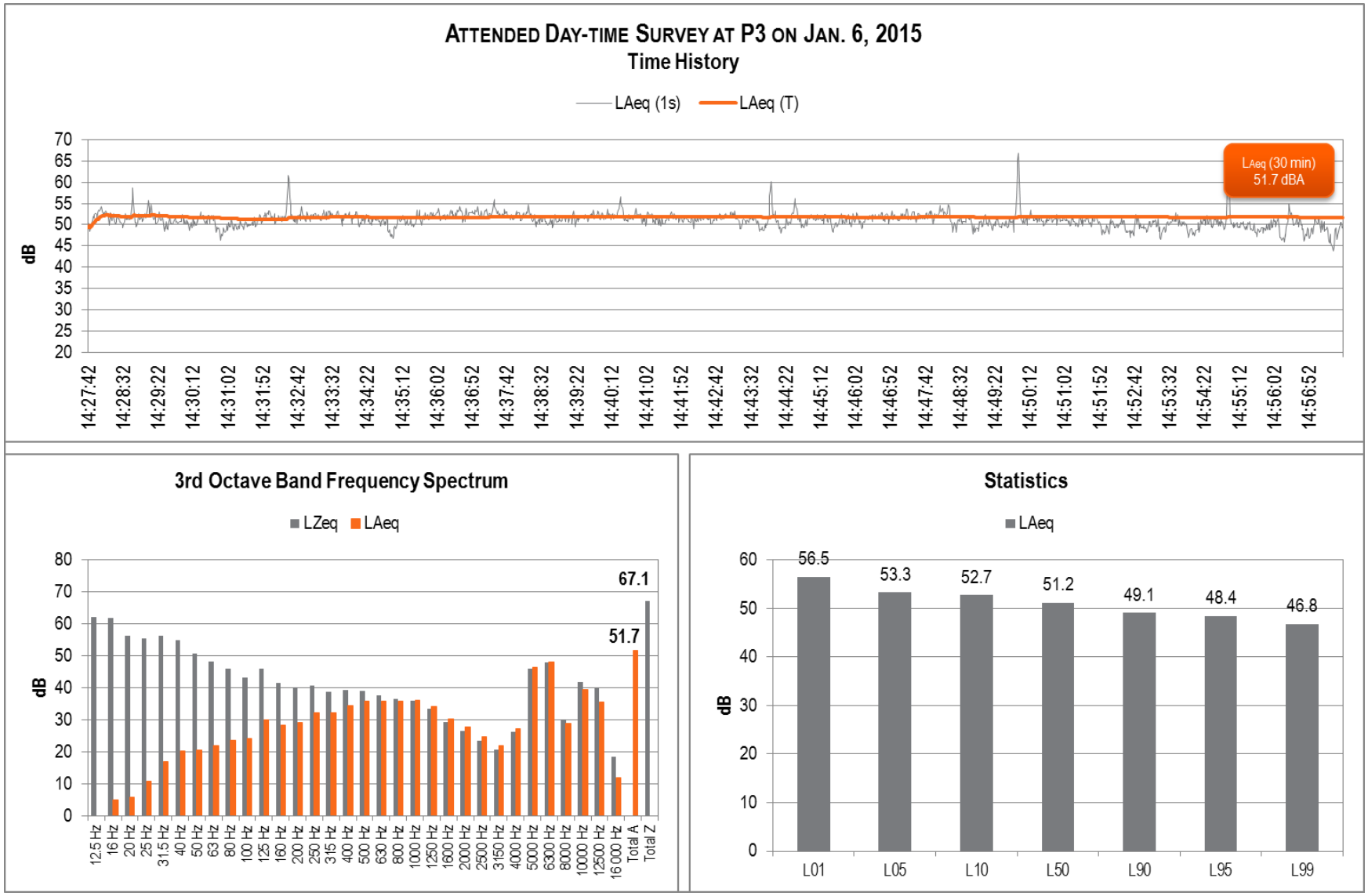
L01
L05
L10
L50
L90
L95
L99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Time History
LAeq (1s)
LAeq (T)
dB
LAeq (30 min)
51.7 dBA
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14:28:32
14:29:22
14:30:12
14:31:02
14:31:52
14:32:42
14:33:32
14:34:22
14:35:12
14:36:02
14:36:52
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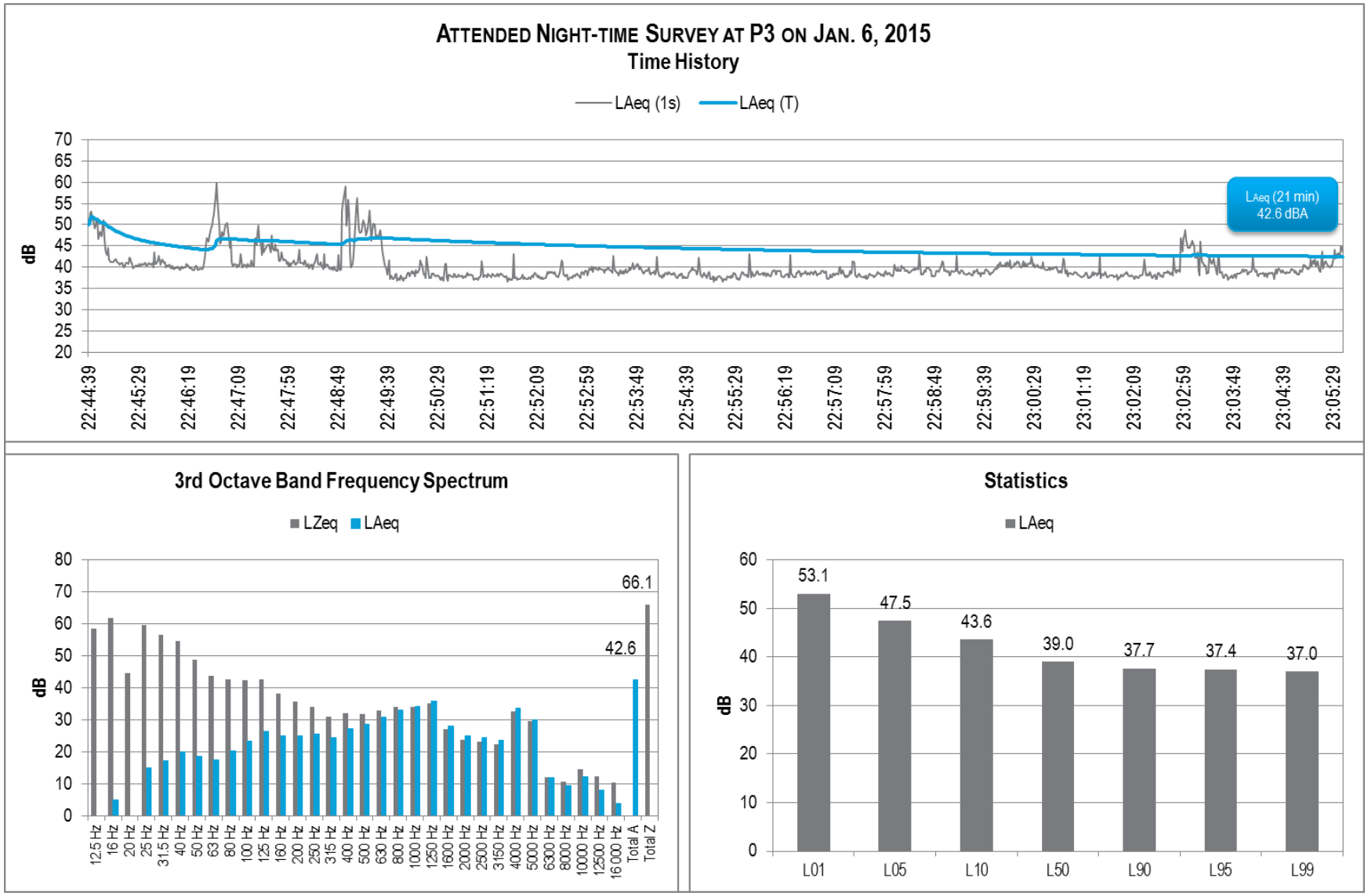
14:51:52
14:52:42
14:53:32
14:54:22
14:55:12
14:56:02
14:56:52
3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
67.1
51.7
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z
Statistics
LAeq
dB
56.5
53.3
52.7
51.2
49.1
48.4
46.8
L01
L05
L10
L50
L90
L95
L99


ATTENDED NIGHT-TIME SURVEY AT P3 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
dB
LAeq (21 min)
42.6 dBA
22:44:39
22:45:29
22:46:19
22:47:09
22:47:59
22:48:49
22:49:39
22:50:29
22:51:19
22:52:09
22:52:59
22:53:49
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22:59:39
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23:01:19
23:02:09
23:02:59
23:03:49
23:04:39
23:05:29
3rd Octave Band Frequency Spectrum
LZeq
LAeq
66.1
42.6
Statistics
LAeq
53.1
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37.7
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L01
L05
L10
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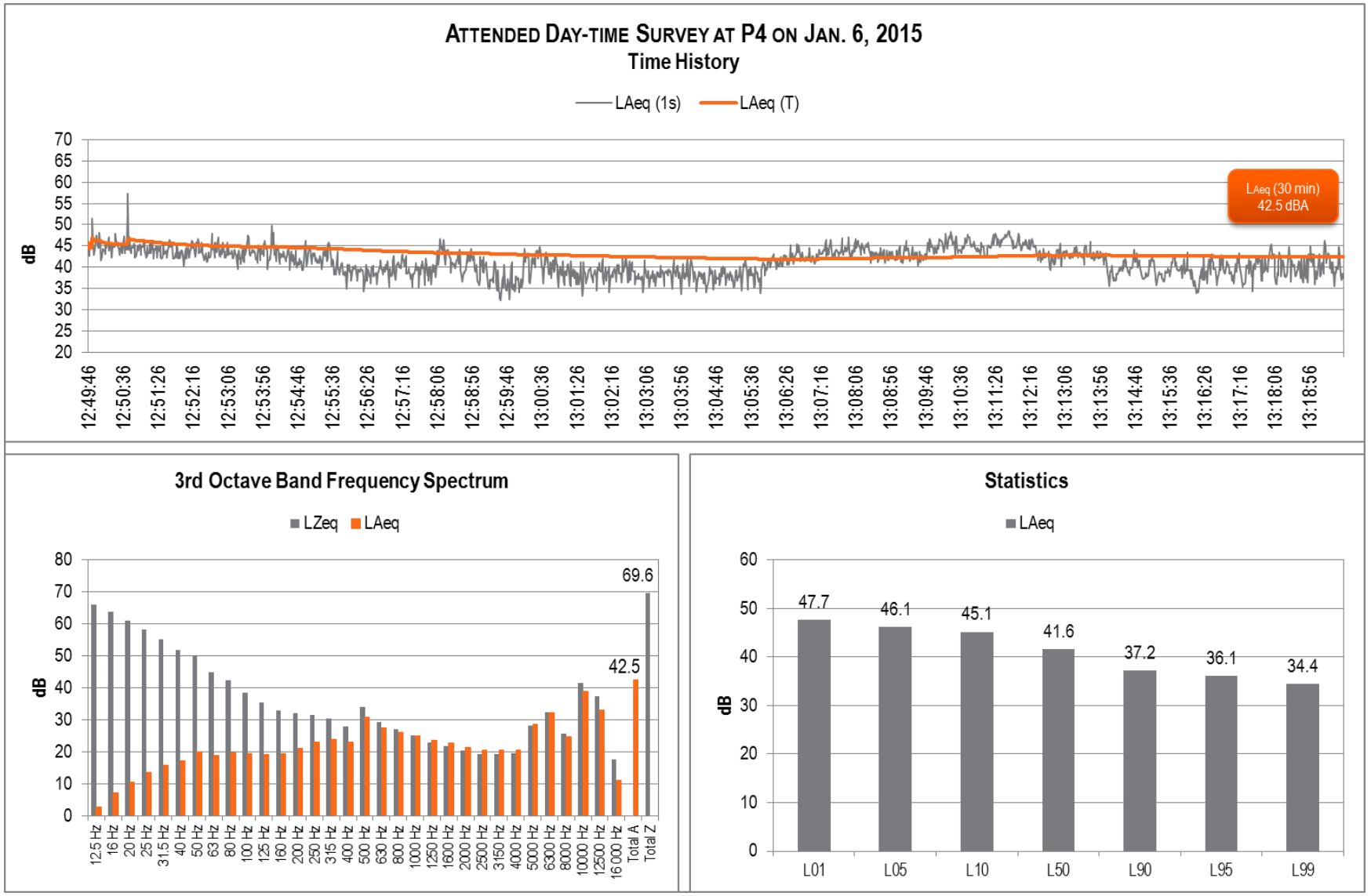
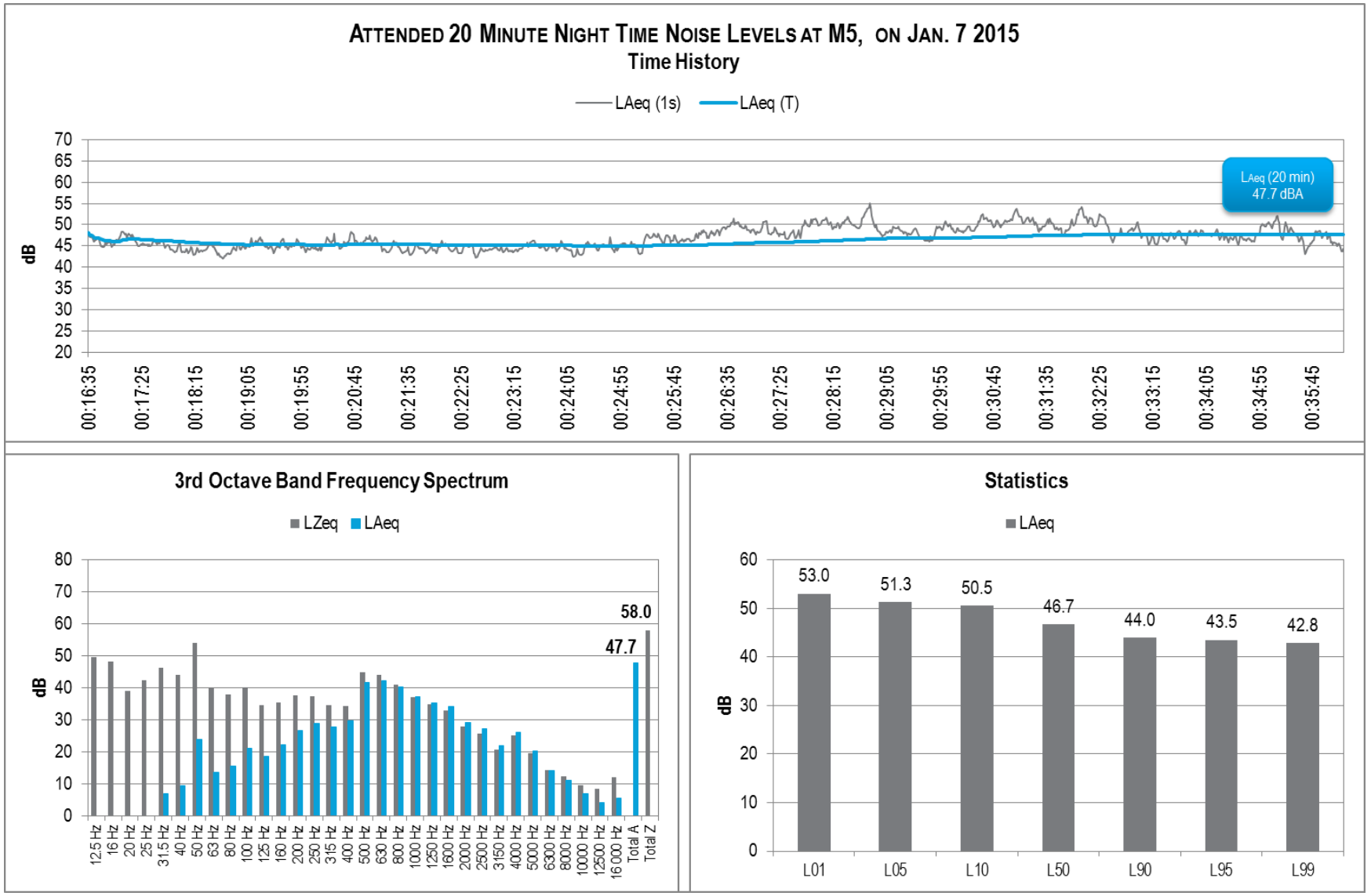
L99


ATTENDED DAY-TIME SURVEY AT P4 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
dB
LAeq (30 min)
42.5 dBA
3rd Octave Band Frequency Spectrum
LZeq
LAeq
69.6
42.5
Statistics
LAeq
47.7
46.1
45.1
41.6
37.2
36.1
34.4
L01
L05
L10
L50
L90
L95
L99


ATTENDED 20 MINUTE NIGHT TIME NOISE LEVELS AT M5, ON JAN. 7 2015
Time History
LAeq (1s)
LAeq (T)
dB
LAeq (20 min)
47.7 dBA
00:16:35
00:17:25
00:18:15
00:19:05
00:19:55
00:20:45
00:21:35
00:22:25
00:23:15
00:24:05
00:24:55
00:25:45
00:26:35
00:27:25
00:28:15
00:29:05
00:29:55
00:30:45
00:31:35
00:32:25
00:33:15
00:34:05
00:34:55
00:35:45
3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
58.0
47.7
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z
Statistics
LAeq
dB
53.0
51.3
50.5
46.7
44.0
43.5
42.8
L01
L05
L10
L50
L90
L95
L99

9 ANNEX B – CV – NICK GROBLER

Name	Nick Brian Grobler
Date of Birth	14 August 1986
Nationality	South African
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Senior Air Quality and Noise Specialist
Profession	Chemical Engineer employed as an Air Quality and Noise Specialist
Years with Firm	10.5 Years

Education

- BEng (Chemical Engineering) University of Pretoria – Completed in 2009
- BEng (Hons) (Environmental Engineering) University of Pretoria – Completed in 2010

Membership of Professional Societies

- Institution of Chemical Engineers (IChemE) – Associate Member – 2014 to present.
- Golden Key International Honour Society - 2011 to present.

Experience

- Project management, proposal preparation and project invoicing.
- Emissions inventory compilation. Proficient in quantifying emissions using:
  - Engineering calculations, isokinetic and continuous stack sampling results, US EPA AP42 emission factors, Australian NPI emission factors, IPCC emission factors, ADDAS model (wind erosion), US EPA TANKS, Water9, GasSim.
- Meteorological, topographical and land use data processing and preparation.
- Dispersion modeling: experienced in SCREEN, AERMOD, ADMS, CALPUFF, SLAB and HAWK dispersion models.
- Proficient with the following specialist air quality / noise software: R, OpenAir, WRPlot, Surfer, ADDAS, TANKS, GasSim, CadnaA.
- Impact and compliance assessment.
- Air quality and dust management plan preparation.
- Air quality monitoring program design and implementation.
- Air quality monitoring set-up, training, processing and interpretation of:
  - SO2, NO2, CO, CH4, O3, HCl, VOCs, BTEX, H2S, NH3, PAHs, PM10, PM2.5, dust fallout, salt deposition, chloride deposition and meteorological parameters.
- Environmental noise monitoring campaign design.
- Environmental noise monitoring and data processing.
- Noise source monitoring and sound power level estimation.
- Ground vibration and overblast monitoring and reporting.
- Compilation of noise source inventories.
- Noise impact and compliance assessments.
- Atmospheric Emission License application.
- Greenhouse gas emissions inventories and pollution prevention plan preparation.
- Experienced in the compilation of:
  - Monthly, quarterly and annual air quality monitoring reports,
  - Noise survey reports,
  - Baseline, scoping and air quality impact assessment reports,
  - Air quality management plans,
  - Emission reduction plans, pollution prevention plans, greenhouse gas and climate change impact assessments
  - Health impact assessments, odour assessments and radiation studies.
- Online NAEIS (National Atmospheric Emissions Inventory System) and SAGERS (South African Greenhouse Gas Emissions Reporting System) completion and submission.
- Industry sectors in which experience have been gained with specific reference to air quality include:
  - Opencast and underground mining of: copper, platinum, chrome, gold, iron, coal, limestone, potash, graphite, lead, mineral sands, aggregate stone, clay and zinc.

- Production of: copper, platinum, PGM metals, gold, base metals, iron, steel, coal, coke, heavy mineral sands, vanadium, solder, lime, urea, chrome, gypsum, asphalt, acetylene, LNG liquefaction, vegetable oil, fertilizer, explosives, wood pulp, cement, grease, oil recycling, tyre and general waste pyrolysis, power generation, fuel storage as well as crematoriums, general waste landfills, meat processing and rendering at abattoirs and animal waste incineration.

Courses Completed

- Spreadsheets as an Engineering Tool, Presented by the University of Pretoria, RSA (September 2012)

Courses Presented

- NWU Centre for Environmental Management Essential Air Quality Management Course
- NWU Centre for Environmental Management Integrated Waste Law Course – Air Quality Aspects

Countries of Work Experience

South Africa, Zimbabwe, Namibia, Mozambique, Zambia, Democratic Republic of Congo, Republic of Congo, Ghana, Liberia, Morocco, Mali, Guinea, Suriname, Saudi Arabia

Languages

Language	Proficiency
English	Full proficiency
Afrikaans	Full proficiency