APPENDIX J: NOISE ASSESSMENT

Noise Specialist Study for Two New Vent Shafts at the Marula Platinum Mine in Limpopo

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

Report compiled by:
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Report Details

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Revision Record

Version	Date	Comments
Rev 0	September 2020	For client review
Rev 0.1	November 2020	Incorporation of client's comments
Rev 0.2	November 2020	Incorporation of client's comments
Rev 0.3	January 2022	Assessment of noise berms

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
BAC	Bulk Air Cooler
CCT	Condenser Cooling Tower
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.
DC	Derek Cosijn
EIA	Environmental Impact Assessment
Hz	Frequency in Hertz
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
kW	Power in kilowatt
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_{AIeq} (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)
$L_{Req,d}$	The L_{Aeq} rated for impulsive sound 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 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 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.
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)
Ltd	Limited
L_W	Sound Power Level (in dB)

masl	Meters above sea level
m^2	Area in square meters
MM5	Fifth-Generation Penn State/NCAR Mesoscale Model
m/s	Speed in meters per second
MW	Power in megawatt
NACA	National Association for Clean Air
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management Air Quality Act
NLG	Noise level guideline
NSR	Noise sensitive receptor
p	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Pty	Proprietary
SABS	South African Bureau of Standards
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
SLM	Sound Level Meter
SoW	Scope of Work
STRM	Shuttle Radar Topography Mission
USGS	United States Geological Survey
WHO	World Health Organisation
%	Percentage

Executive Summary

The Marula Platinum Mine in Limpopo is proposing to develop two new vent shafts, both of which will have aboveground fans. There will also be three shafts which will have additional infrastructure of bulk air coolers and refrigeration plants. The proposed operations are hereafter referred to as the project.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (South Africa) (Pty) Ltd to undertake a specialist environmental noise impact study for the project as input to the Environmental Impact Assessment.

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the development of the proposed project and to recommend suitable management and mitigation measures. To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available 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 NSRs from available maps and field observations;
    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 surveys conducted on 17 and 18 August 2020.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

In the assessment of simulated noise levels, reference was made to the IFC noise level guidelines for residential, institutional and educational receptors (55 dBA during the day (06:00-22:00) and 45 dBA during the night (22:00-06:00)) which is in line with the SANS 10103 rating for urban districts.

The baseline acoustic environment was described in terms of the location of NSRs, the ability of the environment to attenuate noise over long distances, as well as existing background and baseline noise levels. The following was found:

- The closest NSRs include residential developments of Winnaarshoek (~80 m from project activities), Diphale (~600 m from project activities) and Galane (~300 m from project activities).
- The average baseline noise levels (as measured during the field survey) were 43 dBA during the day and 33.8 dBA during the night.

Noise emissions from mobile and non-mobile equipment were estimated using L_W predictions for industrial machinery (Bruce & Moritz, 1998), where L_W estimates are a function of the power rating of the equipment engine.

The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 6.25 km east-west by 6.5 km north-south. The area was divided into a grid matrix with a 25-m resolution.

The main findings of the impact assessment are:

- A general management and mitigation plan, as stipulated in Section 5, is recommended to minimise noise impacts from the project on the surrounding area.
- The simulated equivalent continuous day-time rating level ($L_{Req,d}$) due to project operations of 55 dBA (IFC guideline level) extends ~450 m from the project operations.
- The simulated equivalent continuous night-time rating level ($L_{Req,n}$) of 45 dBA (IFC guideline level) due to project operations extends ~450 m to ~730 m from the project operations.
- Construction and closure phase impacts are expected to be similar or slightly lower than simulated noise impacts of the operational phase.
- The significance of the project operations is high for unmitigated and medium for mitigated activities due to the close proximity of sensitive receptors.

Based on the findings of the assessment and provided the recommended management and mitigation measures are in place, it is the specialist's opinion that the project may be authorised.

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1 Introduction

The Marula Platinum Mine in Limpopo is proposing to develop two new vent shafts, both of which will have aboveground fans. There will also be three ventilation shafts which will have additional infrastructure of bulk air coolers and refrigeration plants. A summary of the proposed infrastructure (hereafter referred to as the project) is provided in Table 1.

Table 1: Summary of the proposed infrastructure

Shaft	EMPr Status	Additional requirements that need approval
DRIEKOP SHAFT COMPLEX		
V#6	Existing and approved shaft	Requires a new bulk air cooler, refrigeration plant and condenser cooling towers.
V#9	New shaft	New vent shaft with surface main fans and electrical rooms.
CLAPHAM SHAFT COMPLEX		
V#5	Existing and approved shaft	Requires a new Bulk Air Cooler.
V#7	Approved shaft but not yet established	Authorisation is needed for surface main fans, electrical rooms, refrigeration plant and condenser cooling towers.
V#8	New shaft	Authorisation is needed for the new vent shaft with bulk air cooler.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (South Africa) (Pty) Ltd to undertake a specialist environmental noise impact study for the project as an input to the Environmental Impact Assessment (EIA).

The location of the project is provided in Figure 1. The proposed layout for the Driekop and Clapham complexes are provided in Figure 2 and Figure 3 respectively.

1.1 Study Objective

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the operations at the project site and to recommend suitable management and mitigation measures.

Figure 1: Location of the proposed project

Figure 2: Layout of the Driekop complex (provided by BEE Consulting)

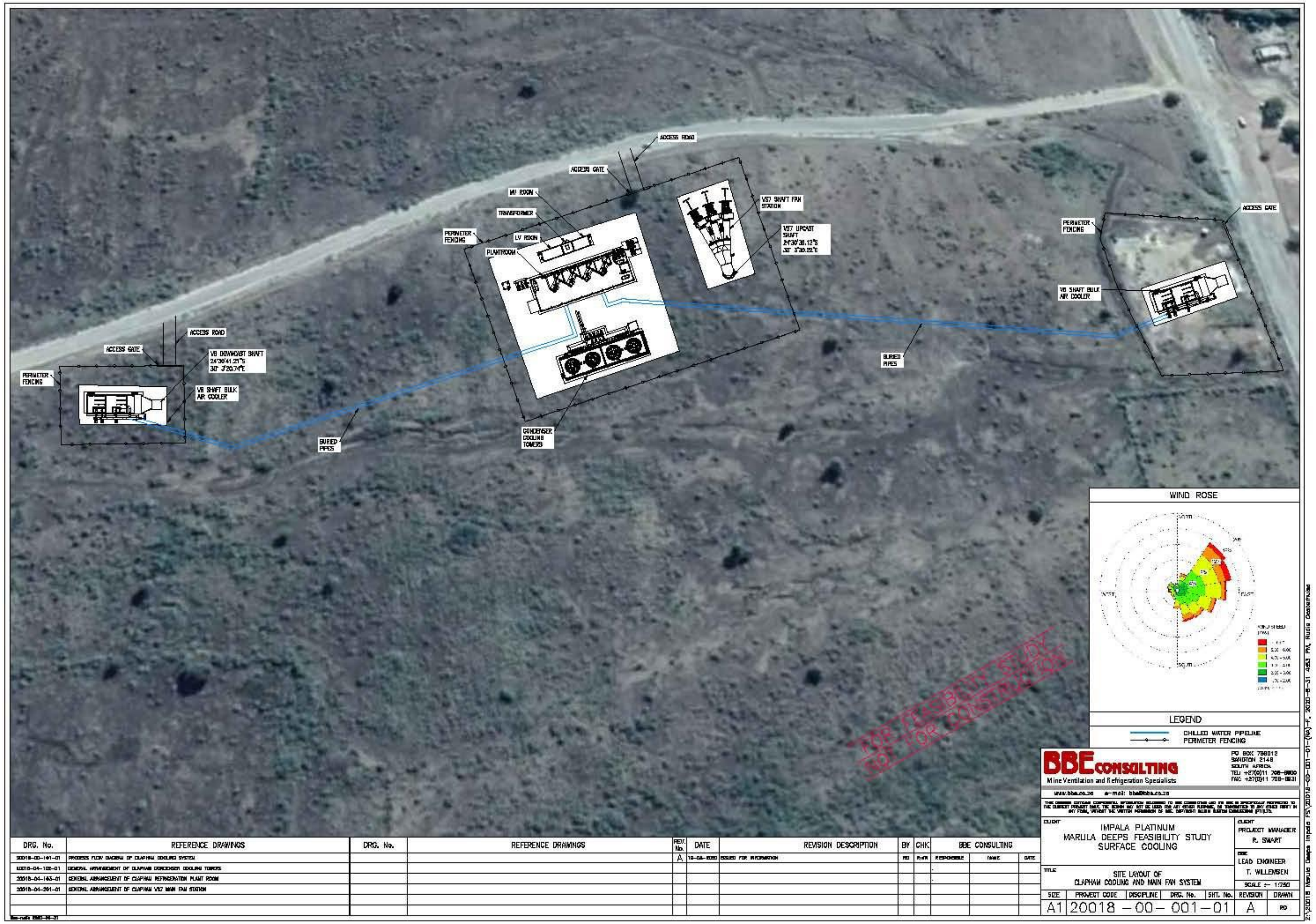


Figure 3: Layout of the Clapham complex (provided by BEE Consulting)

1.2 Scope of Work

To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available 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 NSRs from available maps and field observations.
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources.
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from survey conducted on 17 and 18 August 2020.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project activities.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

1.3 Specialist Details

1.3.1 Specialist Details

Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference. A Declaration of Independence is provided in Appendix B.

1.3.2 Competency Profile of Specialist

Reneé von Gruenewaldt is a Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP) and a member of the National Association for Clean Air (NACA).

Following the completion of her bachelor's degree in atmospheric sciences in 2000 and honours degree (with distinction) with specialisation in Environmental Analysis and Management in 2001 at the University of Pretoria, her experience in air pollution started when she joined Environmental Management Services (now Airshed Planning Professionals) in 2002. Reneé von Gruenewaldt later completed her master's degree (with distinction) in Meteorology at the University of Pretoria in 2009.

Reneé von Gruenewaldt became a partner of Airshed Planning Professionals in September 2006. Airshed Planning Professionals is a technical and scientific consultancy providing scientific, engineering, and strategic air pollution impact assessment and management services and policy support to assist clients in addressing a wide variety of air pollution and environmental noise related assessments.

She has experience on the various components of environmental noise assessments from 2015 to present. Her project experience range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to noise impacts.

A comprehensive curriculum vitae of Reneé von Gruenewaldt is provided in Appendix A.

1.4 Description of Activities from a Noise Perspective

Sources of noise at the proposed project operational phase are expected to include:

- Vents.
- Compressors.
- Cranes and crawls.
- Rotating machinery such as motors, pumps, fans, etc. For a given machine, the sound pressure level ('emission') depends on the proportion of the total mechanical or electrical energy that is transformed into acoustical energy.

It is understood that the refrigeration plant will be in a building with concrete floor and metal sheeting. The motor to drive the surface fans will also be enclosed. This will provide acoustic shielding to the outside through absorption of acoustic energy and transmission losses.

Construction and decommissioning will also contribute to noise levels. The significance of impacts due to these phases have been provided in Section 5.

1.5 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.

A direct application of linear scales (in pascal (Pa)) to the measurement and calculation of sound pressure leads to large and unwieldy numbers. As the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a decibel or dB. The advantage of using dB can be clearly seen in Figure 4. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micropascals (µPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

As explained, noise is reported in 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).

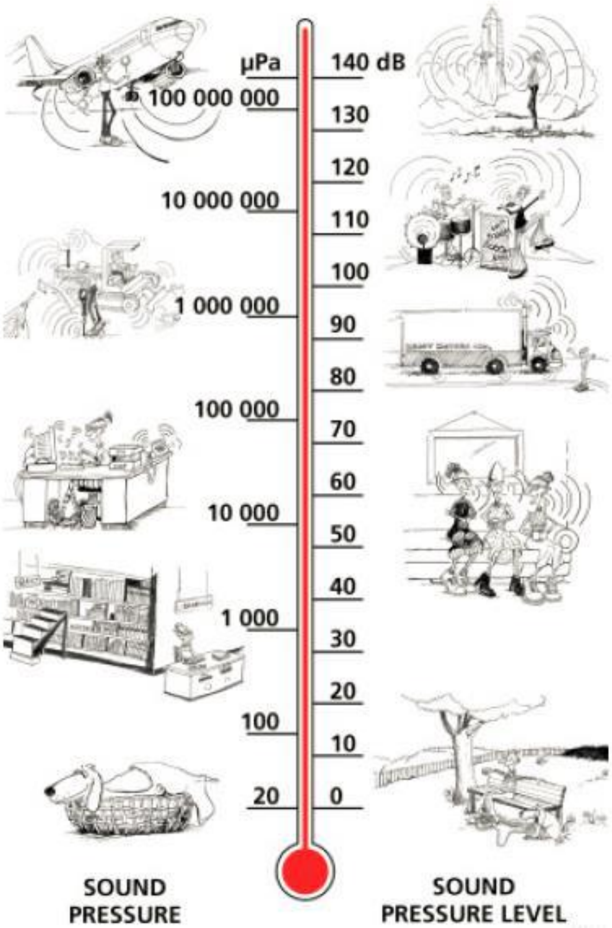


Figure 4: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

1.5.1 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 frequency 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).

1.5.2 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 5). "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) and have been A-weighted.

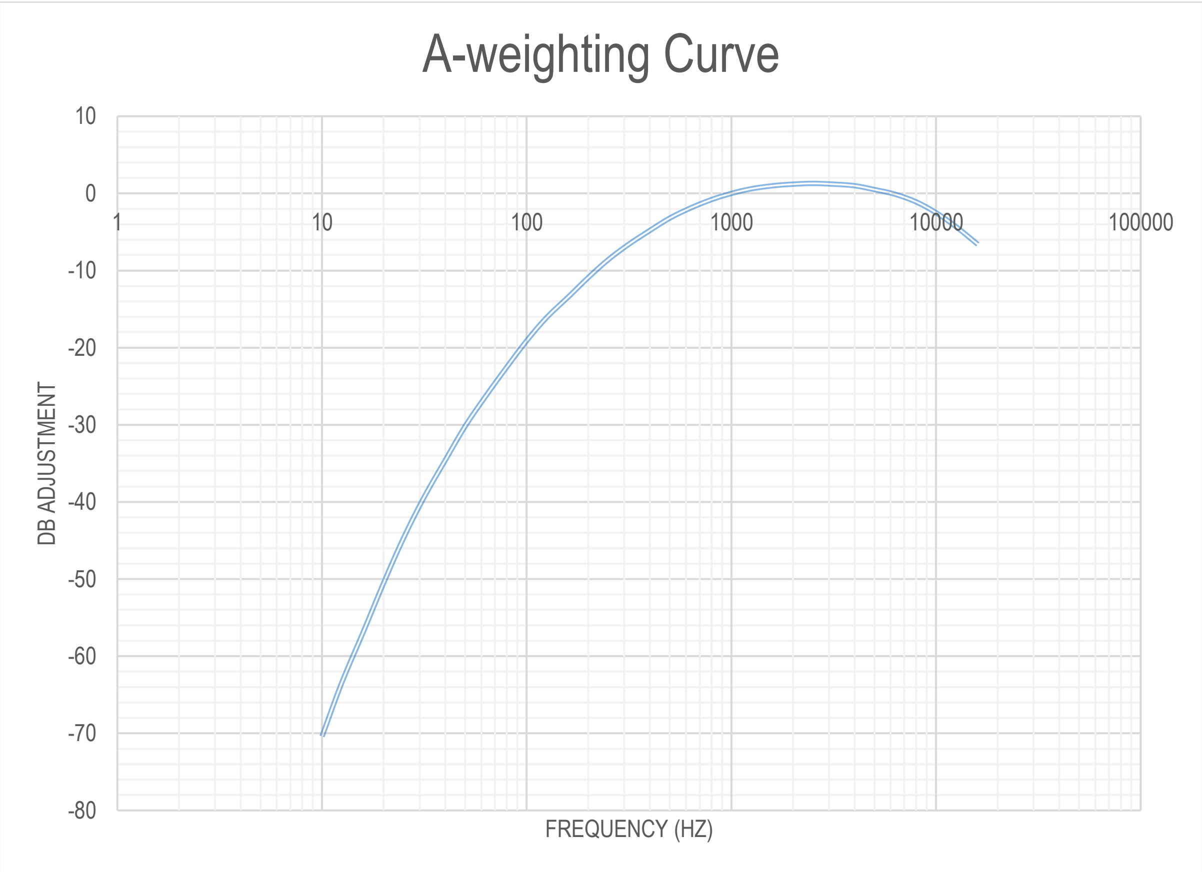


Figure 5: A-weighting curve

1.5.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot 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).

1.5.4 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).

1.5.5 Environmental Noise Indices

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

- **L_{Zeq} (T)** – The unweighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **L_{Aeq} (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **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.

1.6 Approach and Methodology

The assessment included a study of the legal requirements pertaining to environmental 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 operational phase. 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.

1.6.1 Information Review

An information requirements list was sent to SLR Consulting (South Africa) (Pty) Ltd at the onset of the project. In response to the request, the following information was supplied:

- Layout maps;
- Project equipment details.

1.6.2 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (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*'. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. These guidelines, which are in line with those published by the IFC in their *General EHS Guidelines* (IFC 2007) and World Health Organisation (WHO) *Guidelines for Community Noise* (WHO 1999), were considered in the assessment.

1.6.3 Study of the Receiving Environment

NSRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside an industrial facility's property.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain.

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/) accessed on August 2020. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

1.6.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an 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 a baseline noise survey conducted on 17 and 18 August 2020 was studied to determine current noise levels within the area.

The survey methodology, which closely followed guidance provided by the IFC (2007) and SANS 10103 (2008), is summarised below:

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to calibration by an accredited laboratory (Appendix C). Equipment details are included in Table 2.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session.
- Samples, 10 to 30 minutes in duration, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. Samples representative of the day- and night-time acoustic environment were taken. SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008).
- L_{Aleq} (T), L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{90} and 3^{rd} octave frequency spectra were recorded.
- 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.
- A detailed log and record were kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site (Appendix D).

Table 2: Sound level meter details

Equipment	Serial Number	Purpose	Last Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 60-minute sampling.	24 October 2019
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 3177677	Attended 60-minute sampling.	24 October 2019
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 43170	Testing of the acoustic sensitivity before and after each daily sampling session.	25 October 2019
Kestrel 4000 Pocket Weather Tracker	S/N 559432	Determining wind speed, temperature and humidity during sampling.	Not Applicable

1.6.5 Source Inventory

To determine the change in noise impacts associated with the project, a source inventory was developed. A list of processing plant mechanical equipment was made available for study. L_W's for these were calculated using predictive equations for industrial machinery as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998).

L_W's for the crane and crawl were obtained from the database of Derek Cosijn (DC) based on source measurements for similar operations. All source measurements were carried out in accordance with the procedures specified in SANS 10103.

Construction and decommissioning activities are expected to result in noise impacts similar to or less significant than impacts associated with the operational phase. Due to the nature of these phases, the noise levels would also vary from one day to the next. A source inventory was therefore only developed for the operational phase of the project.

1.6.6 Noise Propagation Simulations

The propagation of noise from proposed activities was 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.

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation to 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, as would 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 mid-band 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.

1.6.6.1 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 were 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.

The propagation of noise was calculated over an area of 6.25 km east-west by 6.5 km north-south and encompasses the proposed project site. The area was divided into a grid matrix with a 25 m resolution. The model was set to calculate L_P’s at each grid and discrete receptor point at a height of 1.5 m above ground level.

1.6.7 Presentation of Results

Results are presented in tabular and isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case sound pressure, 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, the increase in noise levels above the baseline at NSRs were calculated and compared to guidelines published in SANS 10103.

1.6.8 Recommendations of Management and Mitigation

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

1.6.9 Impact Significance Assessment

The significance of environmental noise impacts was assessed according to the methodology provided by SLR Consulting (South Africa) (Pty) Ltd and considered both an unmitigated and mitigated scenario. Refer to Appendix F of this report for the methodology.

1.7 Management of Uncertainties

The following limitations and assumptions should be noted:

- Meteorological data set was based on MM5 data for the period 2008-2010. This limitation is not found to be significant, however, as the meteorological conditions within the study area have not shown any significant historical changes.
- The quantification of sources of noise was limited to the operational phase of the project. Construction and closure phase activities are expected to be similar or less significant and its impacts only assessed qualitatively. Noise impacts will cease post-closure.
- The assessment is based on the list of equipment and information provided by BBE Consulting. The assumption is that this information is correct and reflects the routine operational phase of the project.
- Process activities were assumed to be 24 hours per day, 7 days per week.
- Although other existing sources of noise within the area were identified during the survey, such sources were not quantified but were taken into account during the baseline sampling.

2 Legal Requirements and Noise Level Guidelines

2.1 National Noise Control Regulations

The 1992 Noise Control Regulations (The Republic of South Africa, 1992) published in terms of Section 25 of the Environment Conservation Act (Act no. 73 of 1989) defines a "disturbing noise" as a 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.

2.2 South African National Standards

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but legally enforceable environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to the South African Bureau of Standards (SABS) standard SANS 10103 (2008) *'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.* This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. The standard is also fully aligned with the WHO guidelines for Community Noise (WHO, 1999). It should be noted that the values given in Table 3 are typical rating levels that it is recommended should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be annoying to the community.

Table 3: Typical rating levels for outdoor noise

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} 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:

- "Δ ≤ 0 dB: There will be no community reaction;
- 0 dB < Δ ≤ 10 dB: There will be 'little' reaction with 'sporadic complaints';
- 5 dB < Δ ≤ 15 dB: There will be a 'medium' reaction with 'widespread complaints'. Δ = 10 dB is subjectively perceived as a doubling in the loudness of the noise;
- 10 dB < Δ ≤ 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.

2.3 International Finance Corporation 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 4**, 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 4: IFC noise level guidelines

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

2.4 Summary of Assessment Criteria

Simulated noise levels were assessed according to guidelines published by the IFC. To assess annoyance at nearby places of residence, the increase in noise levels above the baseline at NSRs were calculated and compared to guidelines published in SANS 10103.

2.5 Regulations Regarding Report Writing

This report complies with the requirements of the National Environmental Management Act, 1998 (NEMA, No 107 of 1998) and the Environmental Impact Assessment (EIA) regulations(EIA Regulations, 2014 (GN R 982, as amended in 2016, 2017, 2018 and 2020)).. The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 5: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014), as amended in 2017

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 (as amended in 2017) must contain:	Relevant section in report
Details of the specialist who prepared the report	Section 1.3
The expertise of that person to compile a specialist report including a curriculum vitae	Section 1.3.2 Appendix A
A declaration that the person is independent in a form as may be specified by the competent authority	Section 1.3.1 Appendix B
An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
An indication of the quality and age of base data used for the specialist report;	Section 3.2 Section 3.3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.3 Section 4.2
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 1.6
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 3.1
An identification of any areas to be avoided, including buffers	Section 3.1 Section 4.2
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 4.2
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.7
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 6
Any conditions for inclusion in the environmental authorisation	Section 6
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 6
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 7
Regarding the acceptability of the proposed activity or activities; and	Section 4.2
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 4.2 Section 6 Section 7
A description of any consultation process that was undertaken during the course of carrying out the study	Not applicable

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 (as amended in 2017) must contain:	Relevant section in report
A summary and copies if any comments that were received during any consultation process	None received
Any other information requested by the competent authority.	None received

2.6 Procedures for the Assessment

This report complies with protocols for the assessment and minimum report content in terms of sections 24(5)(a), (h) and 44 of the National Environmental Management Act, 1998 (NEMA, No 107 of 1998) (Government Gazette No. 43110) published on 20 March 2020. The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 6: Specialist assessment requirements in terms of Government Gazette No. 43110 (2020)

Assessment and Reporting on Noise Impacts	Section in Report
The assessment must be undertaken by a noise specialist	Section 1.3 and Appendix A
The assessment must be undertaken based on a site inspection as well as applying the noise standards and methodologies stipulated in SANS 10103:2008 and SANS 10328:2008 (or latest versions) for residential and non -residential areas as defined in these standards.	Section 2, Section 3.3 and Section 4
A baseline description must be provided of the potential receptors and existing ambient noise levels. The receptors could include places of residence or tranquillity that have amenity value associated with low noise levels. As a minimum, this description must include the following:	
• current ambient sound levels recorded at relevant locations (e.g. receptors and proposed new noise sources) over a minimum of two nights and that provide a representative measurement of the ambient noise climate, with each sample being a minimum of ten minutes and taken at two different times of the night (such as early evening and late at night) on each night, in order to record typical ambient sound levels at these different times of night;	Section 3.3
• records of the approximate wind speed at the time of the measurement;	Section 3.3 and Appendix D
• mapped distance of the receiver from the proposed development that is the noise source; and	Section 3.1
• discussion on temporal aspects of baseline ambient conditions.	Section 3.3
Assessment of impacts done in accordance to SANS 10103:2008 and SANS 10328:2008 (or latest versions) must include the following aspects which must be considered as a minimum in the predicted impact of the proposed development:	
• characterisation and determination of noise emissions from the noise source, where characterization could include types of noise, frequency, content, vibration and temporal aspects;	Section 4.1
• projected total noise levels and changes in noise levels as a result of the construction, commissioning and operation of the proposed development for the nearest receptors using industry accepted models and forecasts; and,	Section 4.2
• desired noise levels for the area.	Section 4.2 and Section 5
The findings of the Noise Specialist Assessment must be written up in a Noise Specialist Report that must contain as a minimum the following information:	
• details and relevant qualifications and experience of the noise specialist preparing the assessment including a curriculum vitae;	Section 1.3 and Appendix A

Assessment and Reporting on Noise Impacts	Section in Report
• a signed statement of independence by the specialist;	Appendix B
• the duration and date of the site inspection and the relevance of the season and weather conditions to the outcome of the assessment;	Section 3.2 and Section 3.3
• a description of the methodology used to undertake the on-site assessment inclusive of the equipment and models used, as relevant, together with results of the noise assessment;	Section 1.6.4, Section 1.6.6 and Section 4
• a map showing the proposed development footprint (including supporting infrastructure) with a 50m buffered development envelope;	Figure 2 and Figure 3
• confirmation from the specialist that all reasonable measures have been considered, or not, in the micro- siting of the proposed development to minimise disturbance of receptors;	The site layout was provided for the assessment. Siting recommendations are provided in 6.1.4.
• a substantiated statement from the specialist on the acceptability, or not, of the proposed development and a recommendation on the approval, or not, of the proposed development;	Section 7
• any conditions to which this statement is subjected;	Section 6 and Section 7
• the assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered;	Section 4. No alternative development footprints were provided for the assessment.
• a motivation must be provided if there were development footprints identified as per paragraph 2.5.9. above that were identified as having a "low" noise sensitivity and that were not considered appropriate;	Not applicable
• where identified, proposed impact management outcomes, mitigation measures for noise emissions during the construction and commissioning phases that may be of relative short duration, or any monitoring requirements for inclusion in the Environmental Management Programme (EMPr); and,	Section 6
• a description of the assumptions made and any uncertainties or gaps in knowledge or data.	Section 1.7

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
- Current noise levels and the existing acoustic climate.

3.1 Noise Sensitive Receptors

Noise sensitive receptors generally include places of residence and areas where members of the public may be affected by noise generated by the project.

As mentioned in Section 1.5.4, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source. Potential noise sensitive receptors within the project area (indicated in Figure 6), include residential areas (i.e. Winnaarshoek, Diphale and Galane). Residential areas further from the project activities, but not likely to be impacted, include Ga Makhwae and Bothashoek and areas of industrial activities.

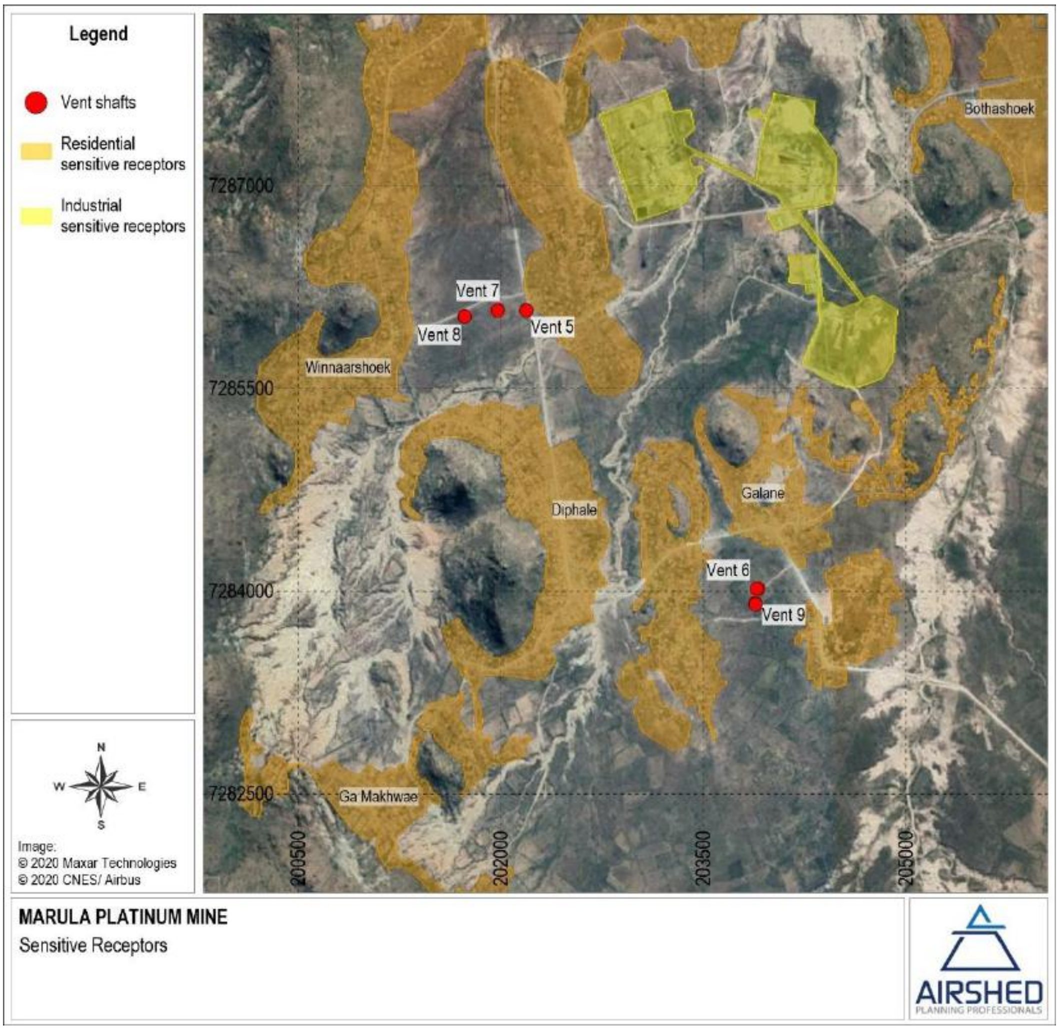


Figure 6: Sensitive receptors within the study area

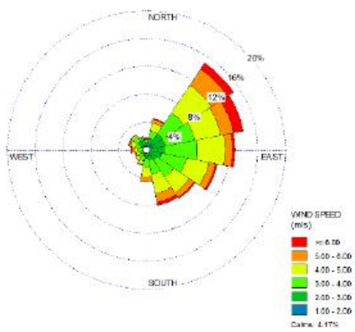
3.2 Environmental Noise Propagation and Attenuation potential

3.2.1 Atmospheric Absorption and Meteorology

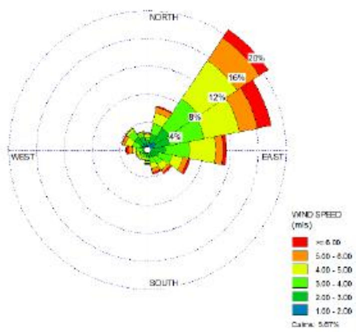
Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation of noise from a source to receiver (Section 1.5.4). The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These along with other parameters such as relative humidity, air pressure, solar radiation and cloud cover affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy.

Wind speed increases with altitude, resulting 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.

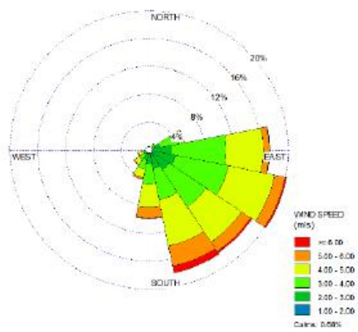
Weather Research and Forecasting (MM5)[1] data for the period 2008 to 2010 was used for the assessment. The modelled data set indicates wind flow primarily from the eastern sector (Figure 7 (a)). During the day, the predominant wind direction is from the northeast sector while during the night the predominant wind direction is from the south eastern sector. On average, noise impacts are expected to be more notable to the northwest and west of the project activities during the night and to the southwest and west of the project activities during the day.



(a) Period average wind rose



(b) Day-time wind rose (06:00 – 22:00)



(c) Night-time wind rose (22:00 – 06:00)

Figure 7: Wind rose for MM5 data, 1 January 2008 to 31 December 2010

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

[1]The MM5 (short for Fifth-Generation Penn State/NCAR Mesoscale Model) is a regional mesoscale model used for creating weather forecasts and climate projections. It is a community model maintained by Penn State University and the National Center for Atmospheric Research. The MM5 is a limited-area, terrain-following sigma coordinate model that is used to replicate or forecast mesoscale and regional scale atmospheric circulation.

night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night (Figure 8).

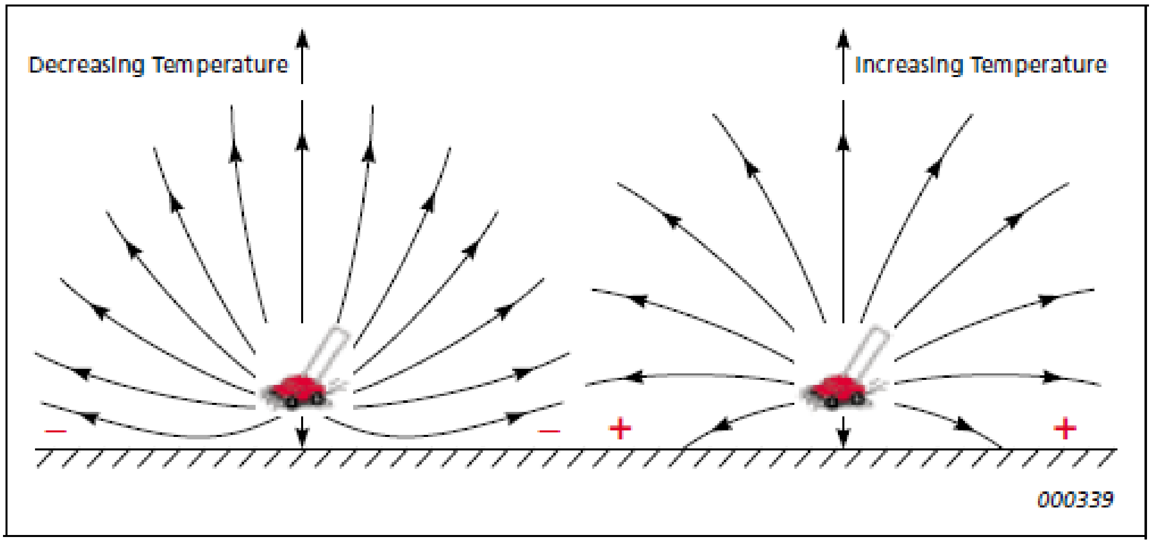


Figure 8: Bending the path of sound during typical day time conditions (image provided on the left) and night-time conditions (image provided on the right)

3.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) feature 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 topography for the study area is provided in Figure 9.

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). Based on observations made during the visit to site, ground cover was found to be acoustically mixed.

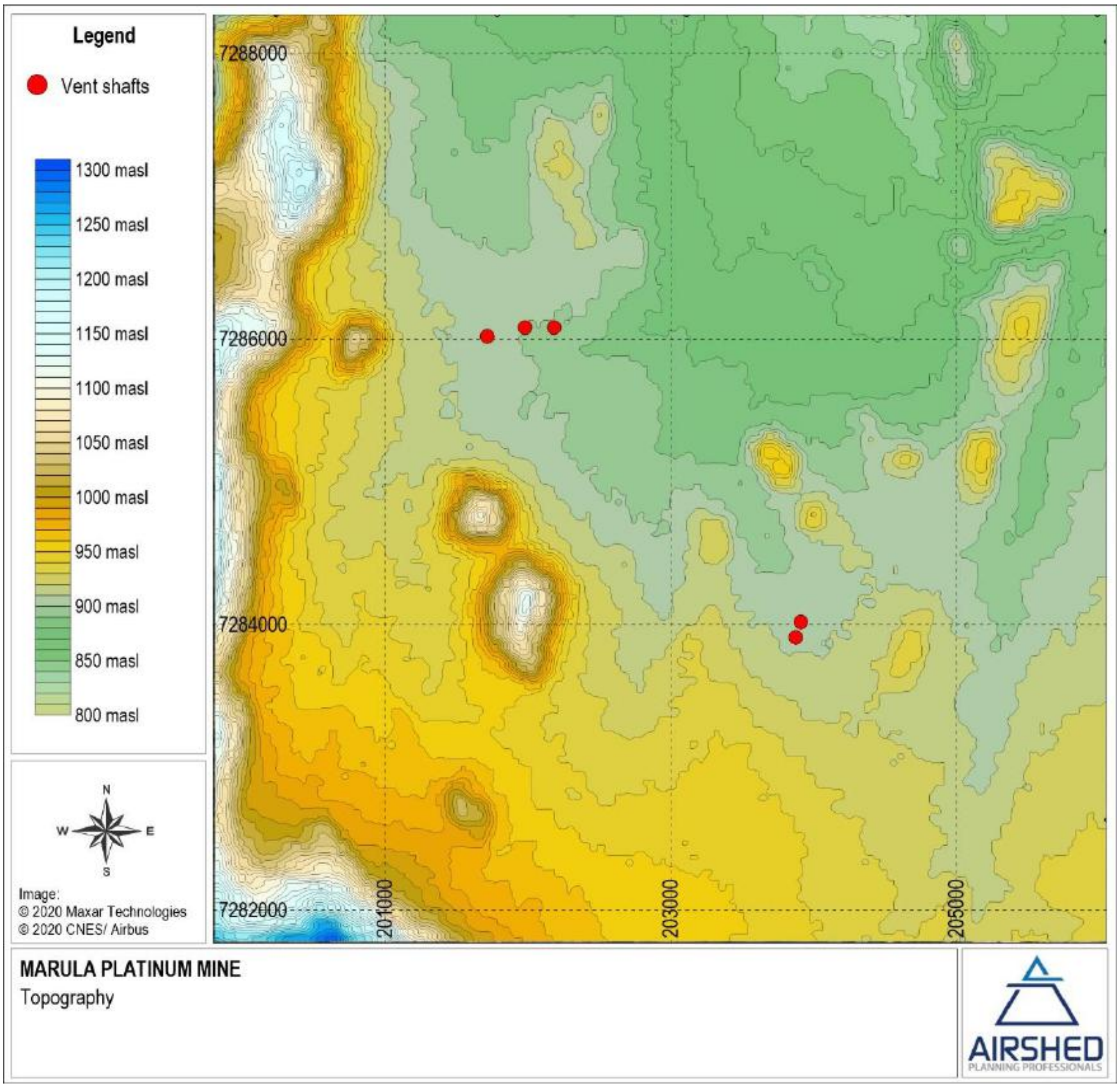


Figure 9: Topography for the study area

3.3 Baseline Noise Survey and Results

Sampling points were selected based on proposed project activities and position of sensitive receptors (Figure 10). Survey results for the campaign undertaken on 17 and 18 August 2020 are summarised in Table 7 and for comparison purposes, visually presented in Figure 11 (day-time results) and Figure 12 (night-time results).

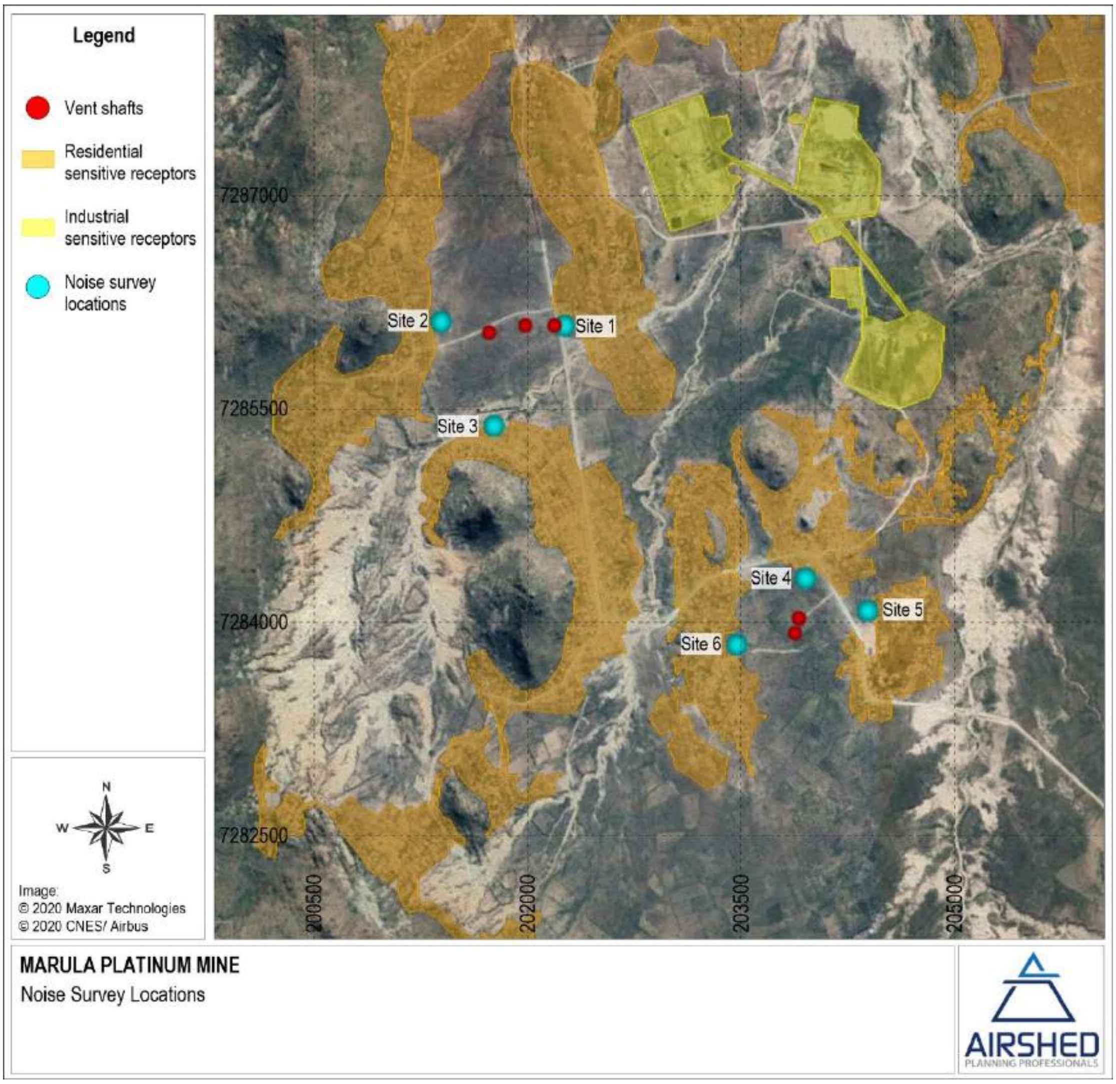


Figure 10: Locations of environmental baseline noise survey sites

The following is noted:

- Measurements were conducted on 17 and 18 August 2020.
- Weather conditions:
    - During the day (06:00-22:00), weather conditions were as follows:
        - Mid-day measurements on 17 August 2020 consisted of cloudy skies with temperatures between 17.6°C and 20.2°C. Slight to moderate wind conditions (including gusts) with wind speeds between 1.1 and 6 m/s from the northerly direction, prevailed.
        - Evening measurements on 17 August 2020 consisted of cloudy skies with temperatures between 22.4°C and 25.1°C. Slight to moderate wind conditions with wind speeds between 1 and 4.1 m/s from the south easterly direction, prevailed.
        - Evening measurements on 18 August 2020 consisted of cloudless skies with temperatures between 21°C and 24°C. Slight to moderate wind conditions with wind speeds between 1 and 3 m/s from the southerly direction, prevailed.
    - During the night (22:00-06:00), weather conditions were as follows:

- Night-time measurements on 17 August 2020 consisted of cloudless skies with temperatures between 16.9°C and 18°C. Slight wind conditions with wind speeds between 0.1 and 1.9 m/s from the south easterly direction, prevailed.
- Night-time measurements on 18 August 2020 consisted of cloudless skies with temperatures between 16.8°C and 19°C. Slight wind conditions with wind speeds between 0.1 and 1.4 m/s from the southerly direction, prevailed.

- Day-time baseline noise levels:
  - Measurements indicate day-time ambient noise levels that are influenced by vehicles, mining operations and community activity.
  - L_{Aeq}'s ranged between 40 dBA and 46 dBA which is considered typical of rural areas according to SANS 10103.
  - Recorded L_{Aeq}'s during the day were within IFC guidelines for residential, institutional and educational receptors (55 dBA).
- Night-time baseline noise levels:
  - Measurements indicate night-time ambient noise levels that are influenced by vehicles, mining operations and community activity.
  - L_{Aeq}'s ranged between 27 dBA and 39 dBA which is considered typical of rural to suburban areas according to SANS 10103.
  - Recorded L_{Aeq}'s during the night were within IFC guidelines for residential, institutional and educational receptors (45 dBA).

For detailed time-series, frequency spectra and statistical results, the reader is referred to Appendix E. Field log sheets containing weather records and a summary of events recorded during the measurements are included in Appendix D.

Ambient baseline noise levels for all noise sampling surveys conducted in the study area are provided in Figure 13. In order to illustrate the increase in ambient noise levels as a result of the project, the following representative background noise levels (based on an average of the survey measurements) were used:

- $L_{Req,d}$ – 43 dBA; and,
- $L_{Req,n}$ – 33.8 dBA.

Table 7: Project baseline environmental noise survey results summary

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{AIeq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Day-time (06:00 – 22:00)							
Site 1	17/08/2020 9:42	30	63.2	50.0	45.6	37.7	Semi cultivated open land near road with community activity, mining activities and vehicles.
Site 2	17/08/2020 10:27	30	62.6	47.0	39.7	32.2	Gusty winds throughout the measurements, with birds audible.
Site 3	17/08/2020 11:19	30	65.7	47.0	41.4	36.3	Gusty winds throughout the measurements, traffic from the road and brick plant activities audible.
Site 4	17/08/2020 12:09	30	66.2	46.9	39.8	32.0	Vehicles and community activities audible.
Site 5	17/08/2020 12:56	30	75.5	53.6	43.1	32.6	Open land with lots of trees and shrubs. Vehicles, community activity and birds audible.
Site 6	17/08/2020 13:40	30	64.6	46.5	38.3	29.9	Goats, birds and vehicles audible.
Site 1	17/08/2020 18:22	10	67.2	51.3	48.0	38.4	Gusty winds throughout the measurements, with vehicles audible.
Site 2	17/08/2020 18:39	10	63.5	48.6	44.7	30.0	Gusty winds throughout the measurements, with community activity and vehicles audible.
Site 3	17/08/2020 18:58	10	63.9	44.6	41.1	26.3	Vehicles audible.
Site 4	17/08/2020 19:19	10	74.6	54.0	39.2	22.8	Vehicles audible.
Site 5	17/08/2020 19:35	10	62.0	45.8	42.5	31.9	Insects and vehicles audible.
Site 6	17/08/2020 19:52	10	59.9	41.8	30.7	21.4	Insects and community activity audible.
Site 1	18/08/2020 18:50	10	65.7	47.8	45.9	32.2	Existing vent shaft, vehicles and mining operations audible.

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{AIeq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Site 2	18/08/2020 19:21	10	65.2	48.8	43.3	27.7	Birds, insects, barking dogs, community activity and vehicles audible.
Site 3	18/08/2020 19:45	10	62.6	46.2	43.7	29.6	Barking dogs, generator to pump water for the community, vehicles and birds audible.
Site 4	18/08/2020 19:13	10	69.3	48.7	45.3	34.1	Existing shaft vents, vehicles and barking dogs audible.
Site 5	18/08/2020 19:33	10	64.5	48.7	45.3	35.9	Barking dogs, birds, vehicles and insects audible.
Site 6	18/08/2020 19:05	10	66.8	51.2	43.7	30.0	Barking dogs, vehicles and insects audible.
Night-time (22:00 – 06:00)							
Site 1	17/08/2020 22:28	10	50.6	38.4	33.5	27.7	Vehicles and barking dogs audible.
Site 2	17/08/2020 22:52	10	51.7	37.2	31.0	25.2	Community activity, birds and vehicles audible.
Site 3	17/08/2020 23:15	10	45.1	32.6	29.0	25.4	Vehicles, insects, and generator for pumping water audible.
Site 4	17/08/2020 23:40	10	60.5	47.0	41.6	28.8	Barking dogs, mining activities and vehicles audible.
Site 5	18/08/2020 00:02	10	49.1	32.8	25.7	21.1	Community activity, birds and insects audible.
Site 6	18/08/2020 00:21	10	50.8	34.9	24.5	19.2	Community activity audible.
Site 1	18/08/2020 22:07	10	59.4	40.6	36.6	21.8	Barking dogs, mining activities, vehicles, birds and insects audible.
Site 2	18/08/2020 22:38	10	59.6	39.8	28.6	18.8	Barking dogs, chickens, vehicles, birds and insects audible.
Site 3	18/08/2020 22:10	10	55.8	35.5	24.9	18.5	Barking dogs, insects, birds and mining activity audible.

Site	Date	Duration (minutes)	L_{AFmax} (dBA)	L_{Aleq} (dBA)	L_{Aeq} (dBA)	L_{AF90} (dBA)	Observations
Site 4	18/08/2020 22:45	10	47.8	34.3	26.9	19.1	Vehicles and mining activity audible.
Site 5	18/08/2020 23:15	10	57.6	39.9	34.2	23.8	Birds and vehicles audible.
Site 6	18/08/2020 23:55	10	54.6	36.7	29.0	20.0	Vehicles and insects audible.

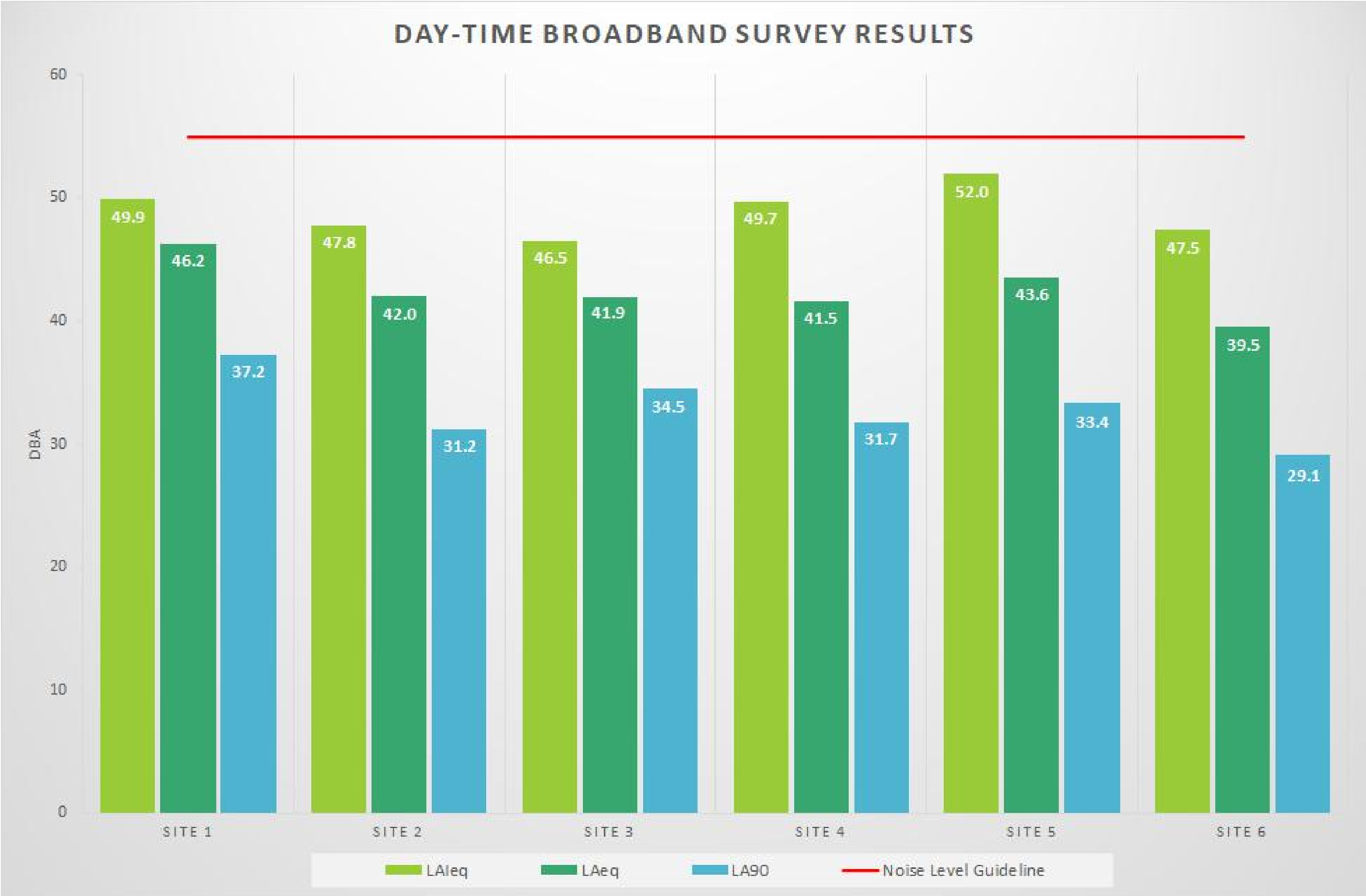


Figure 11: Day-time broadband survey results

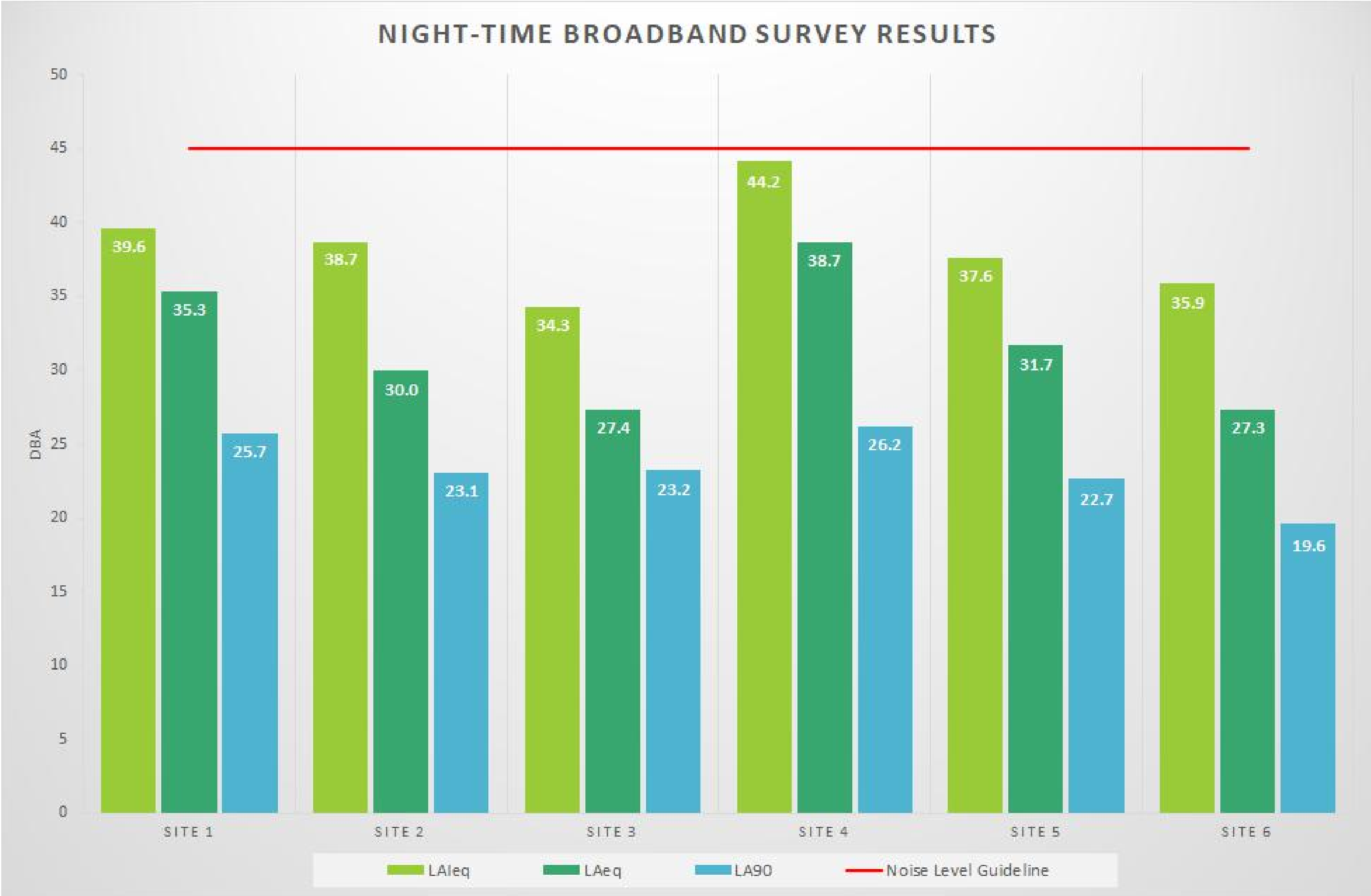


Figure 12: Night-time broadband survey results

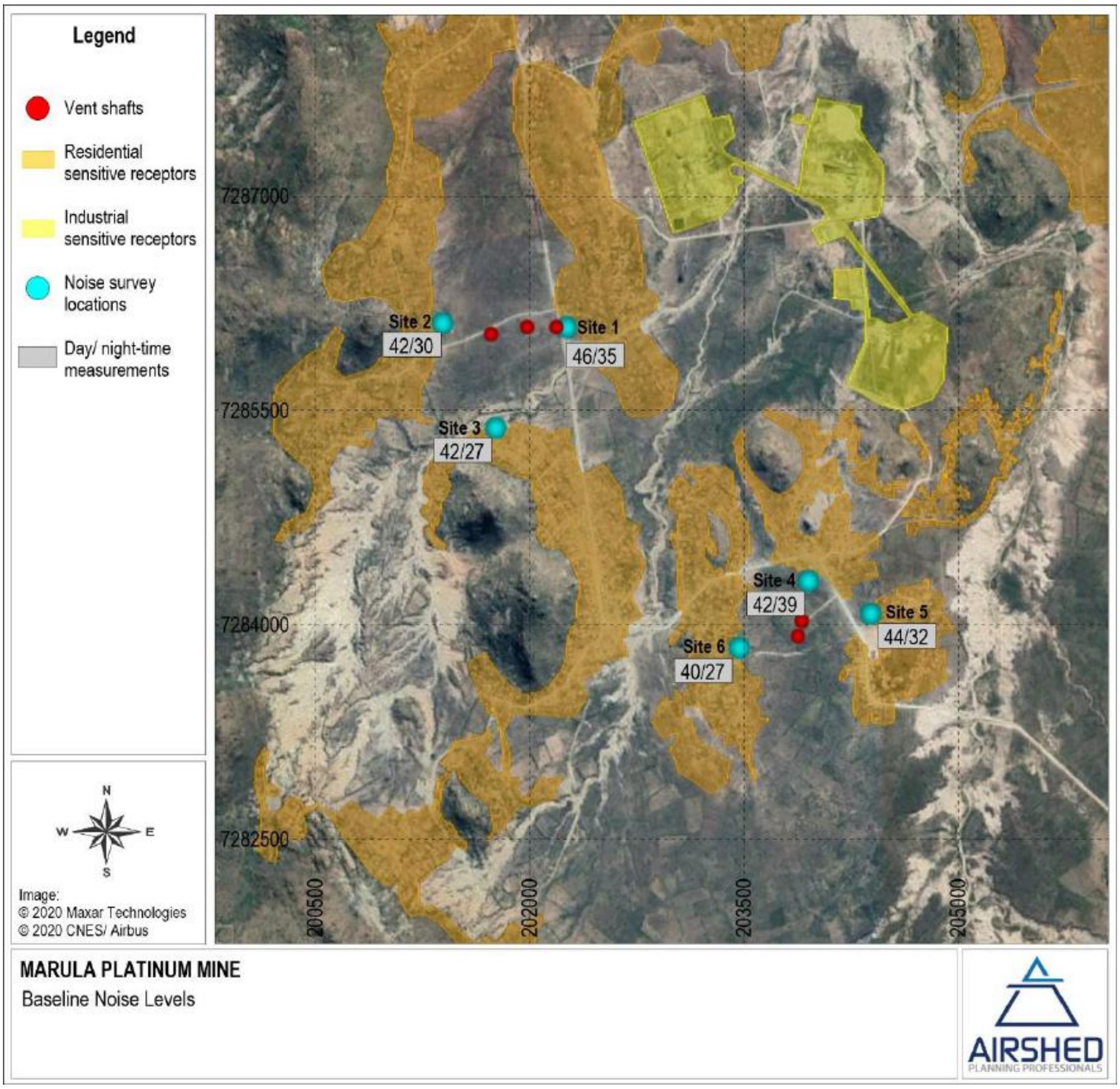


Figure 13: Average baseline noise levels

4 Impact Assessment

The noise source inventory, noise propagation modelling and results are discussed in Section 4.1 and Section 4.2 respectively.

4.1 Noise Sources and Sound Power Levels

A list of equipment (Table 8 and Table 9) was provided for the project which included pumps, fans, etc. Noise sound pressure levels were calculated for all the equipment with the total octave band frequency spectra L_W's provided in Table 10 and Table 11. The directivity of the vents is provided in Table 12.

Table 8: List of equipment for the Driekop complex

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Stand-by (Sby)	Run (kW)
Refrigeration Plant						
Lead Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1340	2	Run	1111
Lag Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1340	2	Run	1111
Plantroom Overhead Crane	12.5-ton		15	4	Run	10
Bulk Air Cooler Circuit						
BAC-03 Circuit						
BAC-03 Return Pump No. 1	212 l/s @ 485 kPa	End suction	185	4	Run	129
BAC-03 Return Pump No. 2	212 l/s @ 485 kPa	End suction	185	4	Sby	0
BAC-03 Respray Pump No. 1	210 l/s @ 305 kPa	End suction	110	4	Run	80
Condenser Cooling Towers						
CCT No. 1	6.3 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	142
CCT No. 1	6.3 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	142
Condenser Circuit						
CCT Pump No. 1	248 l/s @ 350 kPa	End suction	90	4	Run	71
CCT Pump No. 2	248 l/s @ 350 kPa	End suction	90	4	Run	71
CCT Pump No. 3	248 l/s @ 350 kPa	End suction	90	4	Sby	0
Bulk Air Coolers						
BAC	8.8 MW thermal					
BAC Fan No. 1	125 m³/s @ 650 Pa	Axial	150	6	Run	124

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Stand-by (Sby)	Run (kW)
BAC Fan No. 2	125 m³/s @ 650 Pa	Axial	150	6	Run	124
Waste Water Pump						
Waste Water Sump Pump No. 1			8	4	Run	6
Surface Main Fans						
Main Fan No. 1	140 m³/s @ 3.5 kPa	Centrifugal	700	8	Run	605
Crawl	5-ton		5	4	Run	4
Main Fan No. 2	140 m³/s @ 3.5 kPa	Centrifugal	700	8	Run	605
Crawl	5-ton		5	4	Run	4
Motor			700	8	Run	700

Table 9: List of equipment for the Clapham complex

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Sby	Run (kW)
Refrigeration Plant						
Lead Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Lag Configuration						
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Refrigeration Machine Compressor	5.0 MW thermal	Centrifugal, R134a	1230	2	Run	1022
Plantroom Overhead Crane	12.5-ton		15	4	Run	10
Bulk Air Coolers						
BAC (no fans)	6.6 MW thermal					
BAC (no fans)	9.6 MW thermal					
Bulk Air Cooler Circuit						
BAC-01 Circuit						
BAC-01 Return Pump No. 1	137 Vs @ 65 kPa	End suction	15	6	Run	11
BAC-01 Return Pump No. 2	137 Vs @ 65 kPa	End suction	15	6	Sby	0
BAC-01 Respray Pump No. 1	135 Vs @ 300 kPa	End suction	75	4	Run	61
BAC-01 Supply Pump No. 1	135 Vs @ 310 kPa	End suction	90	4	Run	65
BAC-01 Supply Pump No. 2	135 Vs @ 310 kPa	End suction	90	4	Sby	0
BAC-02 Circuit						
BAC-02 Return Pump No. 1	125 Vs @ 45 kPa	End suction	9	6	Run	7
BAC-02 Return Pump No. 2	125 Vs @ 45 kPa	End suction	9	6	Run	7
BAC-02 Return Pump No. 3	125 Vs @ 45 kPa	End suction	9	6	Sby	0
BAC-02 Respray Pump No. 1	250 Vs @ 300 kPa	End suction	110	4	Run	85
BAC-02 Supply Pump No. 1	125 Vs @ 235 kPa	End suction	55	4	Run	42
BAC-02 Supply Pump No. 2	125 Vs @ 235 kPa	End suction	55	4	Run	42
BAC-02 Supply Pump No. 3	125 Vs @ 235 kPa	End suction	55	4	Sby	0
Evaporator Pumps No. 1	193 @ 150 kPa	End suction	55	4	Run	38

Description	Duty	Other Details	Motor Size (kW)	Poles	Run/ Sby	Run (kW)
Evaporator Pumps No. 2	193 @ 150 kPa	End suction	55	4	Run	38
Evaporator Pumps No. 3	193 @ 150 kPa	End suction	55	4	Sby	38
Condenser Cooling Towers						
CCT No. 1	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
CCT No. 2	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
CCT No. 3	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
CCT No. 4	5.8 MW thermal	Induced draft, counter flow				
Fan No. 1		Prefabricated	185	6	Run	131
Condenser Circuit						
CCT Pump No. 1	303 Vs @ 300 kPa	End suction	90	4	Run	70
CCT Pump No. 2	303 Vs @ 300 kPa	End suction	90	4	Run	70
CCT Pump No. 3	303 Vs @ 300 kPa	End suction	90	4	Run	70
CCT Pump No. 4	303 Vs @ 300 kPa	End suction	90	4	Sby	0
Waste Water Pump						
Waste Water Sump Pump No. 1			8	4	Run	6
Surface Main Fans						
Main Fan No. 1	167 m³/s @ 5.3 kPa	Centrifugal	1300	8	Run	1080
Crawl	5-ton		5	4	Run	4
Main Fan No. 2	167 m³/s @ 5.3 kPa	Centrifugal	1300	8	Run	1080
Crawl	5-ton		5	4	Run	4
Main Fan No. 3	167 m³/s @ 5.3 kPa	Centrifugal	1300	8	Run	1080
Crawl	5-ton		5	4	Run	4
Motor			1200	8	Run	1200

Table 10: Octave band frequency spectra L_W's for the project equipment at the Driekop complex

Description	Type	LW octave band frequency spectra (dB)								L_W (dB)	L_{WA} (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Refrigeration Plant												
Lead Configuration												
Refrigeration Machine Compressor	L_W	100.5	99.5	97.5	97.5	99.5	103.5	102.5	98.5	109.4	108.4	L_W Predictions (Bruce & Moritz, 1998)
Lag Configuration												
Refrigeration Machine Compressor	L_W	100.5	99.5	97.5	97.5	99.5	103.5	102.5	98.5	109.4	108.4	L_W Predictions (Bruce & Moritz, 1998)
Plantroom Overhead Crane	L_W	81.0	77.0	66.0	62.0	59.0	57.0	51.0	46.0	82.6	66.5	Lw Database (DC)
Bulk Air Cooler Circuit												
BAC-03 Circuit												
BAC-03 Return Pump No. 1	L_W	92.1	93.1	95.1	95.1	98.1	95.1	91.1	85.1	103.3	101.7	L_W Predictions (Bruce & Moritz, 1998)
BAC-03 Respray Pump No. 1	L_W	91.5	92.5	94.5	94.5	97.5	94.5	90.5	84.5	102.7	101.0	L_W Predictions (Bruce & Moritz, 1998)
Condenser Cooling Towers												
CCT + Fan No. 1	L_W	111.5	111.5	108.5	105.5	101.5	98.5	95.5	87.5	116.2	107.7	L_W Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 1	L_W	111.5	111.5	108.5	105.5	101.5	98.5	95.5	87.5	116.2	107.7	L_W Predictions (Bruce & Moritz, 1998)
Condenser Circuit												
CCT Pump No. 1	L_W	91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	L_W Predictions (Bruce & Moritz, 1998)
CCT Pump No. 2	L_W	91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	L_W Predictions (Bruce & Moritz, 1998)
Bulk Air Coolers												
BAC Fan No. 1	L_W	109.0	110.0	111.0	111.0	111.0	109.0	105.0	104.0	118.4	115.7	L_W Predictions (Bruce & Moritz, 1998)
BAC Fan No. 2	L_W	109.0	110.0	111.0	111.0	111.0	109.0	105.0	104.0	118.4	115.7	L_W Predictions (Bruce & Moritz, 1998)
Waste Water Pump												
Waste Water Sump Pump No. 1	L_W	76.7	77.7	79.7	79.7	82.7	79.7	75.7	69.7	87.9	86.2	L_W Predictions (Bruce & Moritz, 1998)
Surface Main Fans												
Main Fan No. 1	L_W	105.1	104.1	100.1	95.1	93.1	89.1	85.1	78.1	108.8	98.6	L_W Predictions (Bruce & Moritz, 1998)
Crawl	L_W	81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Main Fan No. 2	L_W	105.1	104.1	100.1	95.1	93.1	89.1	85.1	78.1	108.8	98.6	L_W Predictions (Bruce & Moritz, 1998)

Description	Type	LW octave band frequency spectra (dB)								Lw (dB)	LWA (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Crawl	Lw	81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Electric Motor	Lw	91.9	93.9	93.9	94.9	91.9	88.9	82.9	73.9	100.8	96.7	Lw Predictions (Bruce & Moritz, 1998)

Table 11: Octave band frequency spectra L_W's for the project equipment at the Clapham complex

Description	Type	Lw octave band frequency spectra (dB)									Lw (dB)	LWA (dBA)	Source
		31.5	63	125	250	500	1000	2000	4000	8000			
Refrigeration Plant													
Lead Configuration													
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Lag Configuration													
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Refrigeration Machine Compressor	Lw		100.1	99.1	97.1	97.1	99.1	103.1	102.1	98.1	109.0	108.0	Lw Predictions (Bruce & Moritz, 1998)
Plantroom Overhead Crane	Lw		81.0	77.0	66.0	62.0	59.0	57.0	51.0	46.0	82.6	66.5	Lw Database (DC)
Bulk Air Coolers													
BAC (no fans)	Lw			105	104	106	108	110	112	110	117.1	116.9	Lw Predictions (Bruce & Moritz, 1998)
BAC (no fans)	Lw			105	104	106	108	110	112	110	117.1	116.9	Lw Predictions (Bruce & Moritz, 1998)
Bulk Air Cooler Circuit													
BAC-01 Circuit													
BAC-01 Return Pump No. 1	Lw		83.2	84.2	86.2	86.2	89.2	86.2	82.2	76.2	94.4	92.7	Lw Predictions (Bruce & Moritz, 1998)
BAC-01 Respray Pump No. 1	Lw		91.1	92.1	94.1	94.1	97.1	94.1	90.1	84.1	102.3	100.7	Lw Predictions (Bruce & Moritz, 1998)
BAC-01 Supply Pump No. 1	Lw		84.9	85.9	87.9	87.9	90.9	87.9	83.9	77.9	96.1	94.4	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Circuit													

Description	Type	Lw octave band frequency spectra (dB)									Lw (dB)	LWA (dBA)	Source
		31.5	63	125	250	500	1000	2000	4000	8000			
BAC-02 Return Pump No. 1	Lw		81.2	82.2	84.2	84.2	87.2	84.2	80.2	74.2	92.4	90.8	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Return Pump No. 2	Lw		81.2	82.2	84.2	84.2	87.2	84.2	80.2	74.2	92.4	90.8	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Respray Pump No. 1	Lw		91.6	92.6	94.6	94.6	97.6	94.6	90.6	84.6	102.8	101.1	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Supply Pump No. 1	Lw		89.0	90.0	92.0	92.0	95.0	92.0	88.0	82.0	100.2	98.6	Lw Predictions (Bruce & Moritz, 1998)
BAC-02 Supply Pump No. 2	Lw		89.0	90.0	92.0	92.0	95.0	92.0	88.0	82.0	100.2	98.6	Lw Predictions (Bruce & Moritz, 1998)
Evaporator Pumps No. 1	Lw		88.6	89.6	91.6	91.6	94.6	91.6	87.6	81.6	99.8	98.1	Lw Predictions (Bruce & Moritz, 1998)
Evaporator Pumps No. 2	Lw		88.6	89.6	91.6	91.6	94.6	91.6	87.6	81.6	99.8	98.1	Lw Predictions (Bruce & Moritz, 1998)
Evaporator Pumps No. 3	Lw		88.6	89.6	91.6	91.6	94.6	91.6	87.6	81.6	99.8	98.1	Lw Predictions (Bruce & Moritz, 1998)
Condenser Cooling Towers													
CCT + Fan No. 1	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 2	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 3	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
CCT + Fan No. 4	Lw		111.2	111.2	108.2	105.2	101.2	98.2	95.2	87.2	115.8	107.4	Lw Predictions (Bruce & Moritz, 1998)
Condenser Circuit													
CCT Pump No. 1	Lw		91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	Lw Predictions (Bruce & Moritz, 1998)
CCT Pump No. 2	Lw		91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	Lw Predictions (Bruce & Moritz, 1998)
CCT Pump No. 3	Lw		91.3	92.3	94.3	94.3	97.3	94.3	90.3	84.3	102.5	100.9	Lw Predictions (Bruce & Moritz, 1998)
Waste Water Pump													
Waste Water Sump Pump No. 1	Lw		76.7	77.7	79.7	79.7	82.7	79.7	75.7	69.7	87.9	86.2	Lw Predictions (Bruce & Moritz, 1998)
Surface Main Fans													
Main Fan No. 1	Lw		109.5	108.5	104.5	99.5	97.5	93.5	89.5	82.5	113.1	103.0	Lw Predictions (Bruce & Moritz, 1998)
Crawl	Lw		81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Main Fan No. 2	Lw		109.5	108.5	104.5	99.5	97.5	93.5	89.5	82.5	113.1	103.0	Lw Predictions (Bruce & Moritz, 1998)
Crawl	Lw		81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)

Description	Type	Lw octave band frequency spectra (dB)									Lw (dB)	LWA (dBA)	Source
		31.5	63	125	250	500	1000	2000	4000	8000			
Main Fan No. 3	Lw		109.5	108.5	104.5	99.5	97.5	93.5	89.5	82.5	113.1	103.0	Lw Predictions (Bruce & Moritz, 1998)
Crawl	Lw		81.0	81.0	78.0	76.0	74.0	72.0	68.0	63.0	86.1	79.4	Lw Database (DC)
Electric Motor	Lw	88	90	92	93	93	96	96	88	81	101.8	100.6	Lw Predictions (Bruce & Moritz, 1998)

Table 12: Directivity of the vents

Source name	Number of vents at shaft	Height of Release Above Ground (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Exit Velocity (m/s)
Driekop new vents	2	10	3.66	30	14
Clapham new vents	3	10	3.66	30	17

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. Site specific acoustic parameters as discussed in Section 3.2 along with source data discussed in Section 4.1, were applied in the model.

As a conservative approach, buildings have not been included in the propagation modelling. Buildings (such as the refrigeration plant and motors to drive the surface fans) will provide acoustic shielding to the outside through absorption of acoustic energy and transmission losses.

Results are presented in isopleth form (Figure 14 to Figure 19). The simulated equivalent continuous day-time rating level ($L_{Req,d}$) due to project operations of 55 dBA (IFC guideline level) extends ~450 m from the project operations. The simulated equivalent continuous night-time rating level ($L_{Req,n}$) of 45 dBA (IFC guideline level) due to project operations extends ~450 m to ~730 m from the project operations.

The proposed operational phase related noise due to the project is predicted to exceed IFC guidelines at Galane during day-time hours and at Winnaarshoek and Galane during night-time hours (Table 13).

For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. With the approach adopted for the assessment (detailed in Section 1.6), the predicted increase in noise levels of 3 dBA above baseline (i.e. notable increase in noise) due to the project operations are expected up to a distance of ~500 m to ~700 m (day-time) and ~1500 m (night-time) from the project operations (Figure 17 and Figure 18). In accordance with the SANS 10103, a “medium” reaction with “sporadic” complaints are expected from Winnaarshoek and Diphale during the day-time due to project operations (Table 13). “Strong” reaction is expected from Galane due to day-time project operations. “Very strong” reaction is expected from Winnaarshoek, Diphale and Galane due to night-time project operations.

The 1992 Noise Control Regulations defines a “disturbing noise” as a 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. The predicted increase in noise levels due to project operations at NSRs are provided in Table 13.

Table 13: Summary of simulated noise levels (provided as dBA) due to the project and baseline noise levels within the study area

Noise Sensitive Receptor	Day-time			Night-time		
	Simulated noise levels due to project operations (dBA)	Increase in noise levels above baseline[c] (dBA)	Expected Community Response due to Maximum Increase Above Baseline of more than 3 dBA[d][e]	Simulated noise levels due to project operations (dBA)	Increase in noise levels above baseline[c] (dBA)	Expected Community Response due to Maximum Increase Above Baseline of more than 3 dBA[d][e]
Winnaarshoek	52	6.8		53[b]	16.7	✓
Diphale	46	5.5		44	16.7	✓
Galane	60[a]	13.6	✓	60[b]	20.3	✓

a. Exceeds day-time IFC guideline of 55 dBA for residences.

b. Exceeds night-time IFC guideline of 45 dBA for residences.

c. Based on measurements obtained during the survey undertaken on 17 and 18 August 2020

d. Likely community response:

(light blue)	3 to 5 dBA – There will be 'little' reaction with 'sporadic complaints'.
(green)	5 to 10 dBA – There will be 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints.
(yellow)	10 to 15 dBA – There will be a 'strong' reaction with 'threats of community action'.
(red)	> 15 dBA – There will be a 'very strong' reaction with 'vigorous community action'.

e. Noise levels greater than 7dBA indicated with a tick.

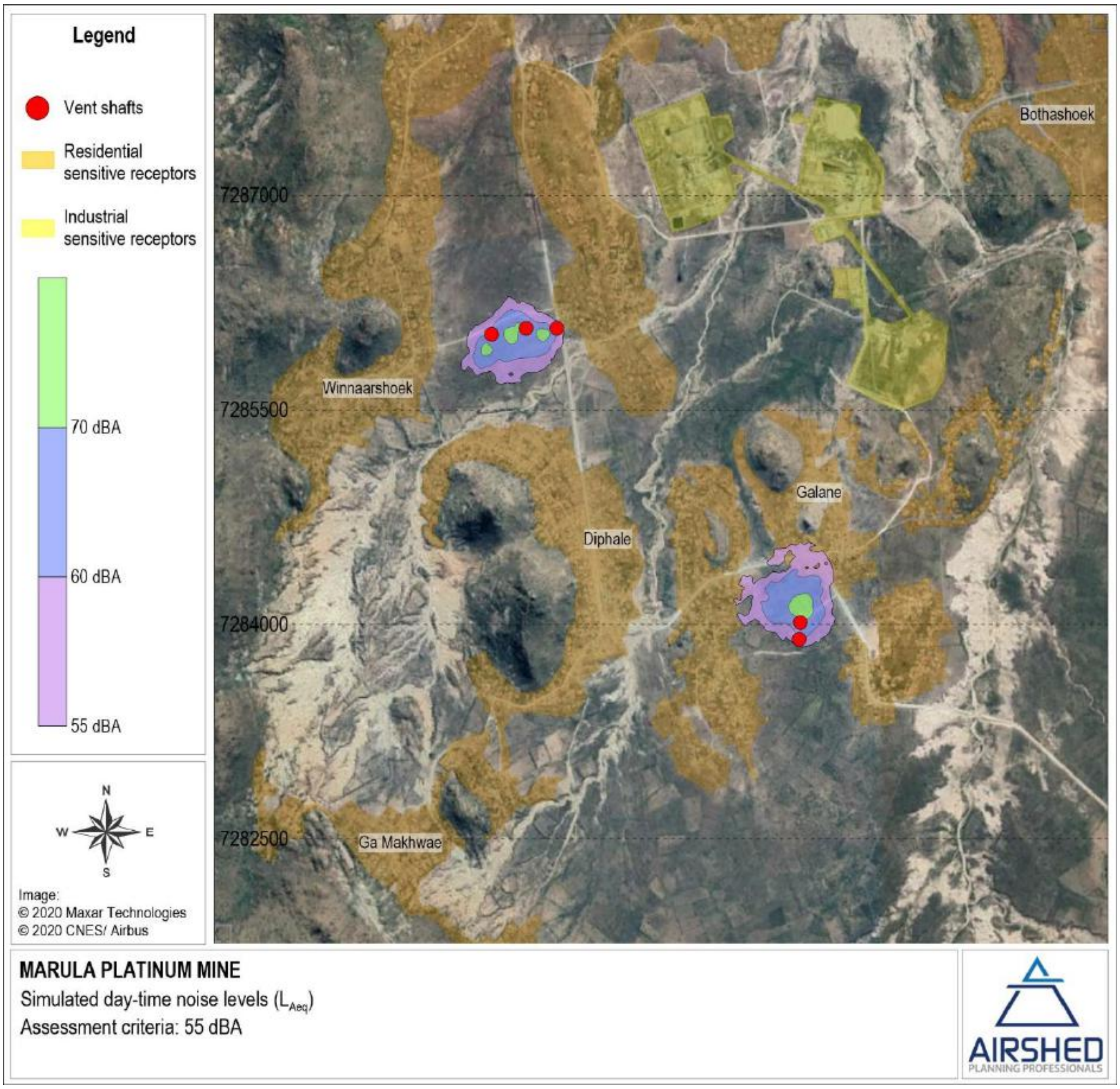


Figure 14: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for project activities

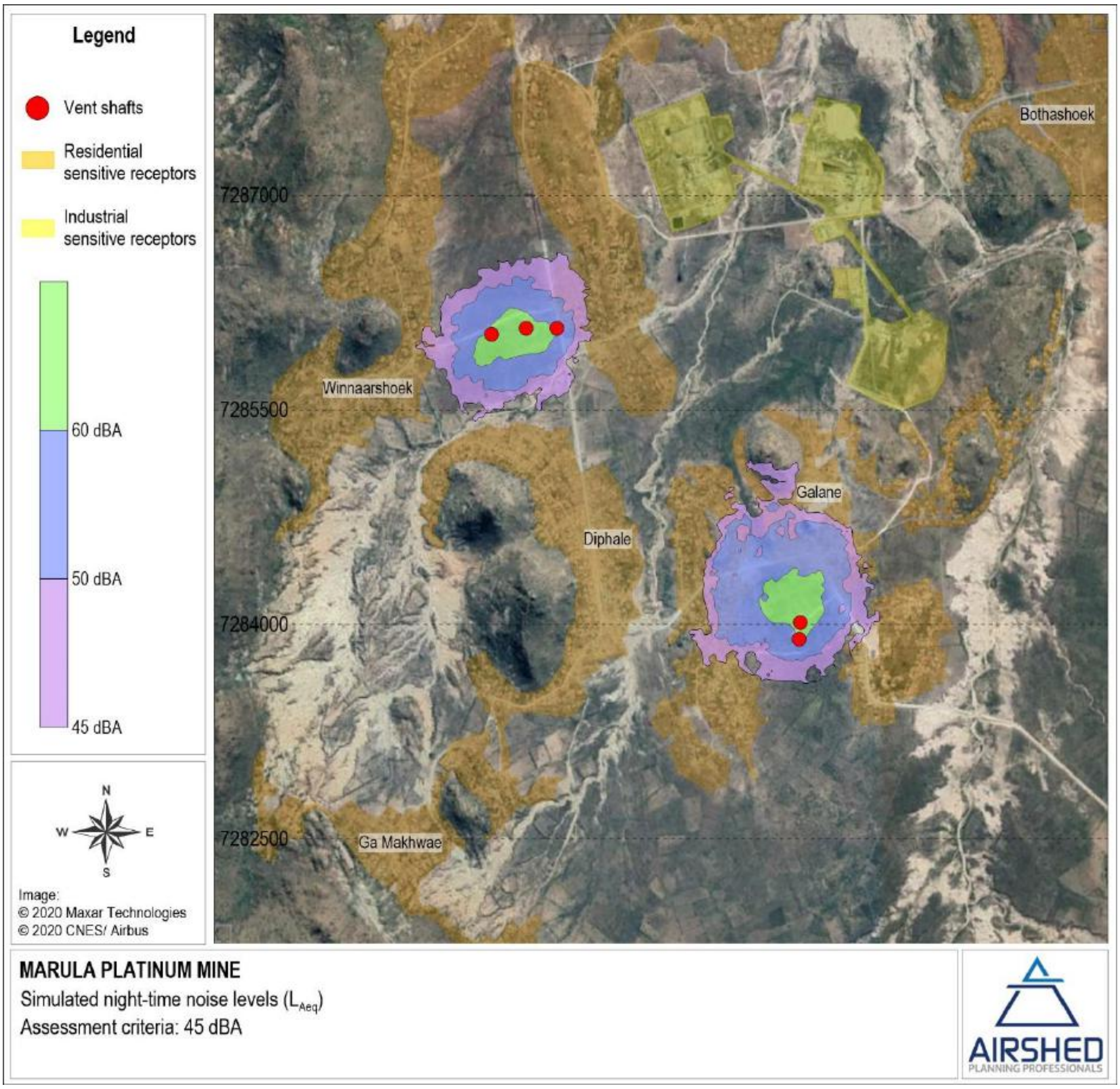


Figure 15: Simulated equivalent continuous night-time rating level ($L_{Req,n}$) for project activities

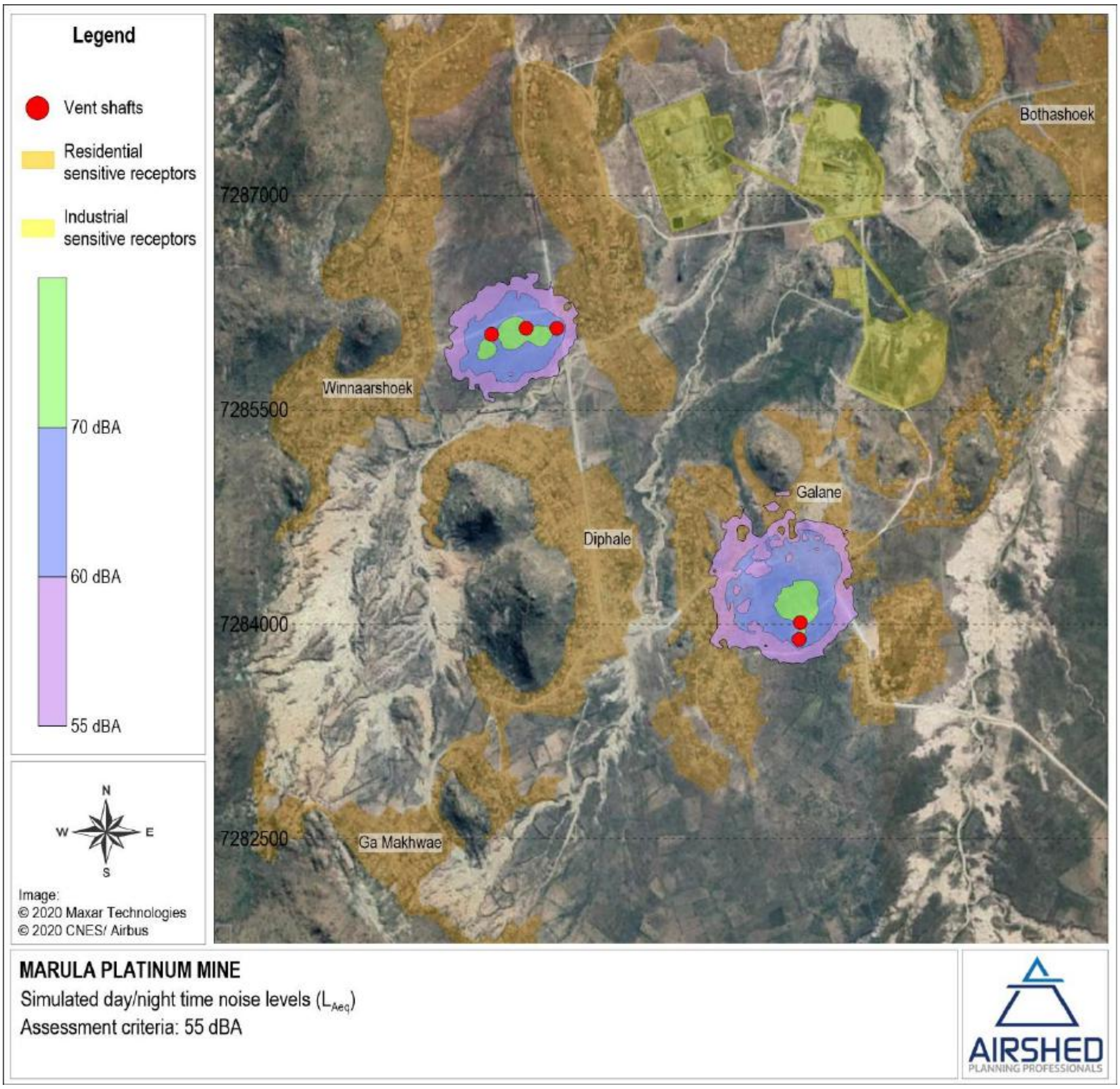


Figure 16: Simulated equivalent continuous day/night-time rating level ($L_{Req,dn}$) for project activities

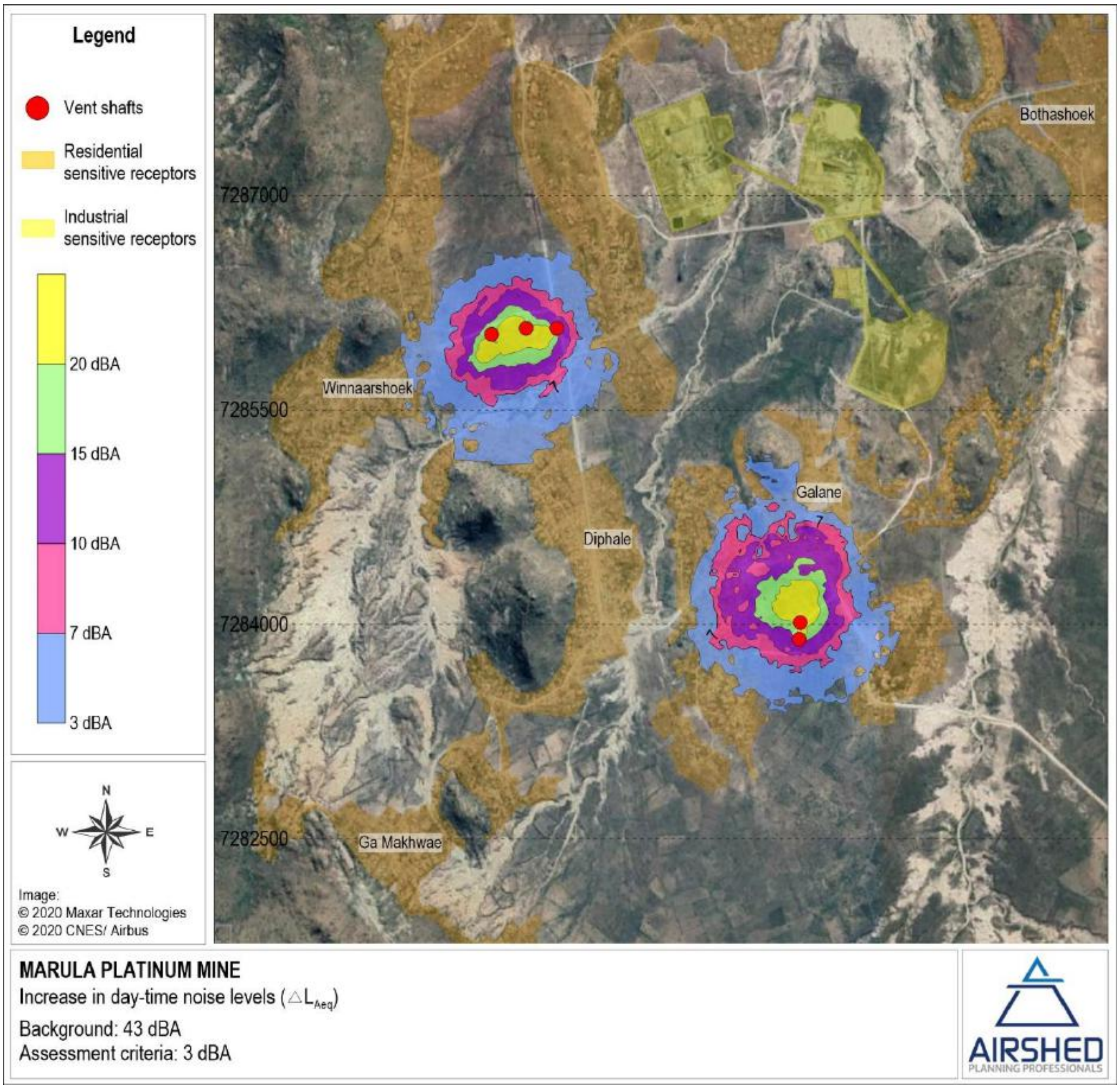


Figure 17: Simulated increase in equivalent continuous day-time rating level ($\Delta L_{Req,d}$) above the baseline

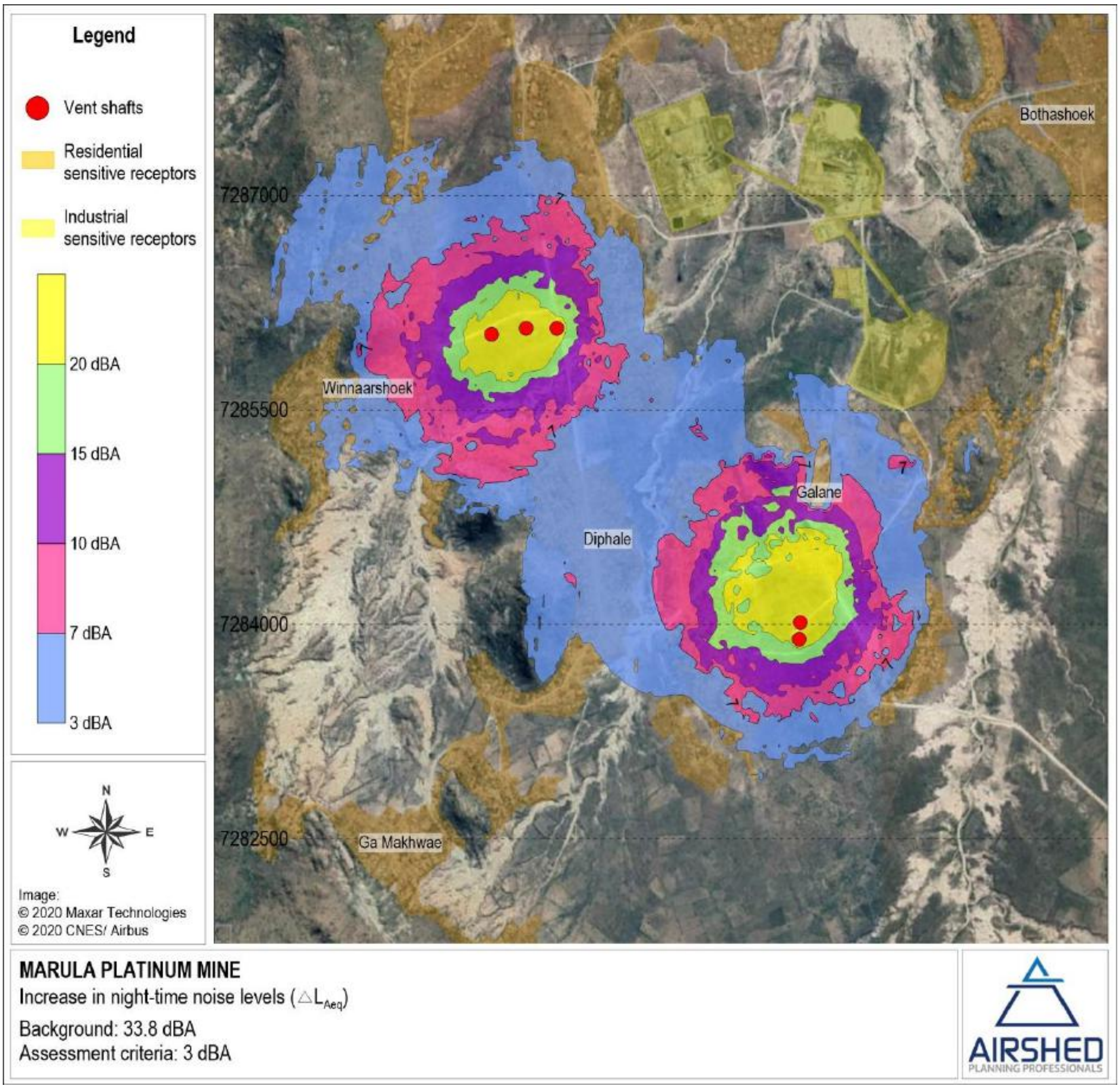


Figure 18: Simulated increase in equivalent continuous night-time rating level ($\Delta L_{Req,n}$) above the baseline

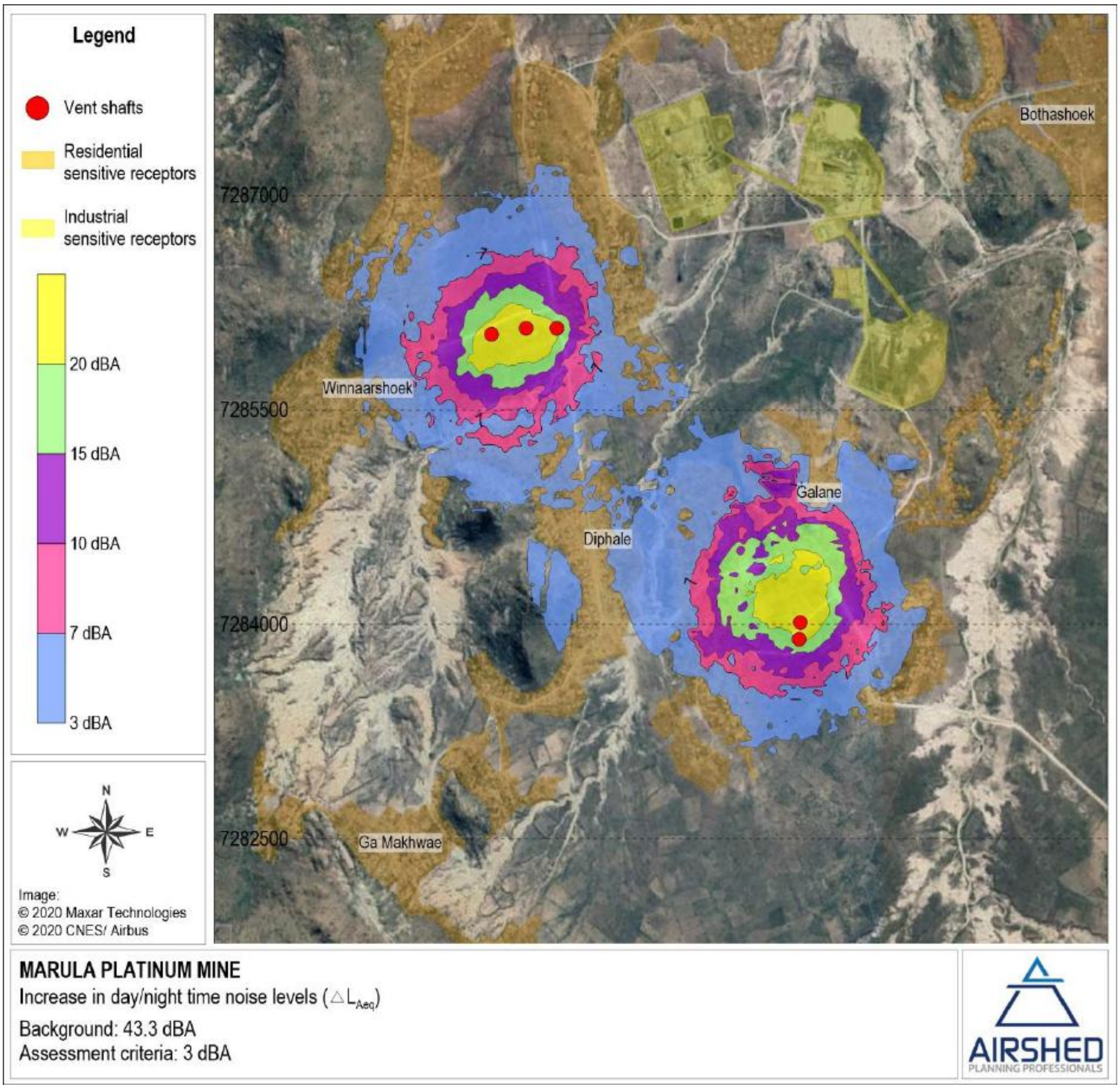


Figure 19: Simulated increase in equivalent continuous day/night-time rating level ($\Delta L_{Req,dn}$) above the baseline

5 Impact Significance Rating

The significance of environmental noise impacts was assessed according to the methodology adopted by SLR Consulting Africa (Pty) Ltd refer to Appendix E of this report for the methodology.

The significance of the noise impacts due to project activities were found to be ***high*** (Table 14). Assuming the adoption of good practice noise mitigation and management measures as recommended, the significance of project noise impacts may be reduced to ***medium*** (Table 14).

No noise impacts are expected post-closure.

Table 14: Significance rating for noise impacts due to project activities

Project Activity	Noise		Probability	Consequence				Significance Rating
	Description	Impacts		Intensity	Duration	Extent	Consequence	
Project activities only								
Project construction activities	Impact from construction activities associated with the project	Increased noise on NSR's due to construction activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low
Project operation activities	Impact from operational activities associated with the project	Increased noise on NSR's due to operational activities.	Without Mitigation					
			H	H (a)	H	M (b)	M	High
			With Mitigation					
			H	M	H	M	M	Medium
Project closure activities	Impact from closure activities associated with the project	Increased noise on NSR's due to closure activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low
Cumulative (project activities as well as baseline noise levels)								
Project construction activities	Impact from construction activities associated with the project	Increased noise on NSR's due to construction activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low
Project operation activities	Impact from operational activities associated with the project	Increased noise on NSR's due to operational activities.	Without Mitigation					
			H	H	H	M	M	High
			With Mitigation					
			H	M	H	M	M	Medium
Project closure activities	Impact from closure activities associated with the project	Increased noise on NSR's due to closure activities.	Without Mitigation					
			M	M	L	M	M	Low
			With Mitigation					
			M	L	L	L	L	Very Low

(a) The intensity of the impact is high given the noise criteria is exceeded at NSRs and "very strong" community response is expected (refer to Section 4.2).

(b) The extent is moderate as the noise impacts will extend beyond the site boundary, affecting immediate neighbours.

6 Management Measures

In the quantification of noise emissions and simulation of noise levels as a result of the project, it was found that environmental noise evaluation criteria for residential, educational, and institutional receptors are expected to be exceeded off-site at noise sensitive receptors.

From a noise perspective, the project may proceed provided that mitigation measures be implemented to ensure minimal impacts on the surrounding environment.

6.1 Controlling Noise at the Source

6.1.1 General Good Practice Measures

For general activities, the following good engineering practice **should** be applied to **all project phases**:

- Equipment with lower sound power levels must be selected. Vendors should be required to guarantee optimised equipment design noise levels.
- Where possible, other non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A **noise complaints register must be kept**.

6.1.2 Specifications and Equipment Design

Equipment to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.

6.1.3 Enclosures

As far as is practically possible, sources of significant noise should be enclosed. The extent of enclosure will depend on the nature of the machine and their ventilation requirements. Pumps and motors are examples of such equipment.

The compressors will also be enclosed in the refrigeration plant building. This will provide acoustic shielding to the outside through absorption of acoustic energy and transmission losses.

It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g. noise should be directed into a partial enclosure and not out of it, there should not be any reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.

6.1.4 Use and Siting of Equipment and Noise Sources

The following good practice should be implemented:

a) Machines used intermittently, during construction and closure phases, should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.
b) Equipment from which noise generated is known to be particularly directional, should be orientated so that the noise is directed away from NSRs as far as possible.
c) Acoustic covers of engines should be kept closed when in use or idling.
d) Doors to pump houses should be kept closed when in use.

6.1.5 Maintenance

Regular and effective maintenance of equipment are essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection.

6.2 Controlling the Spread of Noise Using Barriers or Berms

If noise can be controlled at the source to meet IFC guidelines at the NSR, then no further attenuation measures will be required. However, if IFC guidelines are still exceeded at the NSR after source attenuation has been implemented, noise reduction screens, barriers, or berms must be installed.

The effectiveness of a noise barrier is dependent on its length, effective height, and position relative to the source and receiver as well as material of construction. To optimize the effect of screening, screens should be located close (**within 50 m**) to either the source of the noise, or the receiver.

The careful placement of barriers such as screens or berms can significantly reduce noise impacts but may result in additional visual impacts. Although vegetation such as shrubs or trees may improve the visual impact of construction sites, it will not significantly reduce noise impacts and should not be considered as a control measure.

Earth berms can be built to provide screening for large scale earth moving operations and can be landscaped to become permanent features once construction is completed. **Care should be taken when constructing earth berms since it may become a significant source dust.**

If exceedances of IFC guidelines are measured at the NSR, the following earth berm construction is recommended:

- Clapham Shaft Complex:
    - Height of earth berm preferably <u>10 m</u>
    - Constructed not more than 50 m from the main noise sources at the Clapham Shaft Complex
- Driekop Shaft Complex:
    - Height of earth berm preferably <u>15 m</u>
    - Constructed not more than 50 m from the main noise sources at the Driekop Shaft Complex

Berms can be constructed from waste rock material. It is recommended that noise sampling be undertaken at the NSRs once the berm is constructed in order to understand the effectiveness of the noise barrier. If IFC guidelines are still exceeded, the berm should be covered with topsoil and then vegetated. The vegetated berms will reduce their acoustic "hardness" and increase their attenuation potential. An unvegetated berm constructed solely from waste rock could compound impacts by reflecting noise.

The potential day- and night-time noise levels with the implementation of noise berms of 10 m at the Clapham Shaft Complex and 15 m at the Driekop Shaft Complex is provided in Figure 20 and Figure 21 respectively.

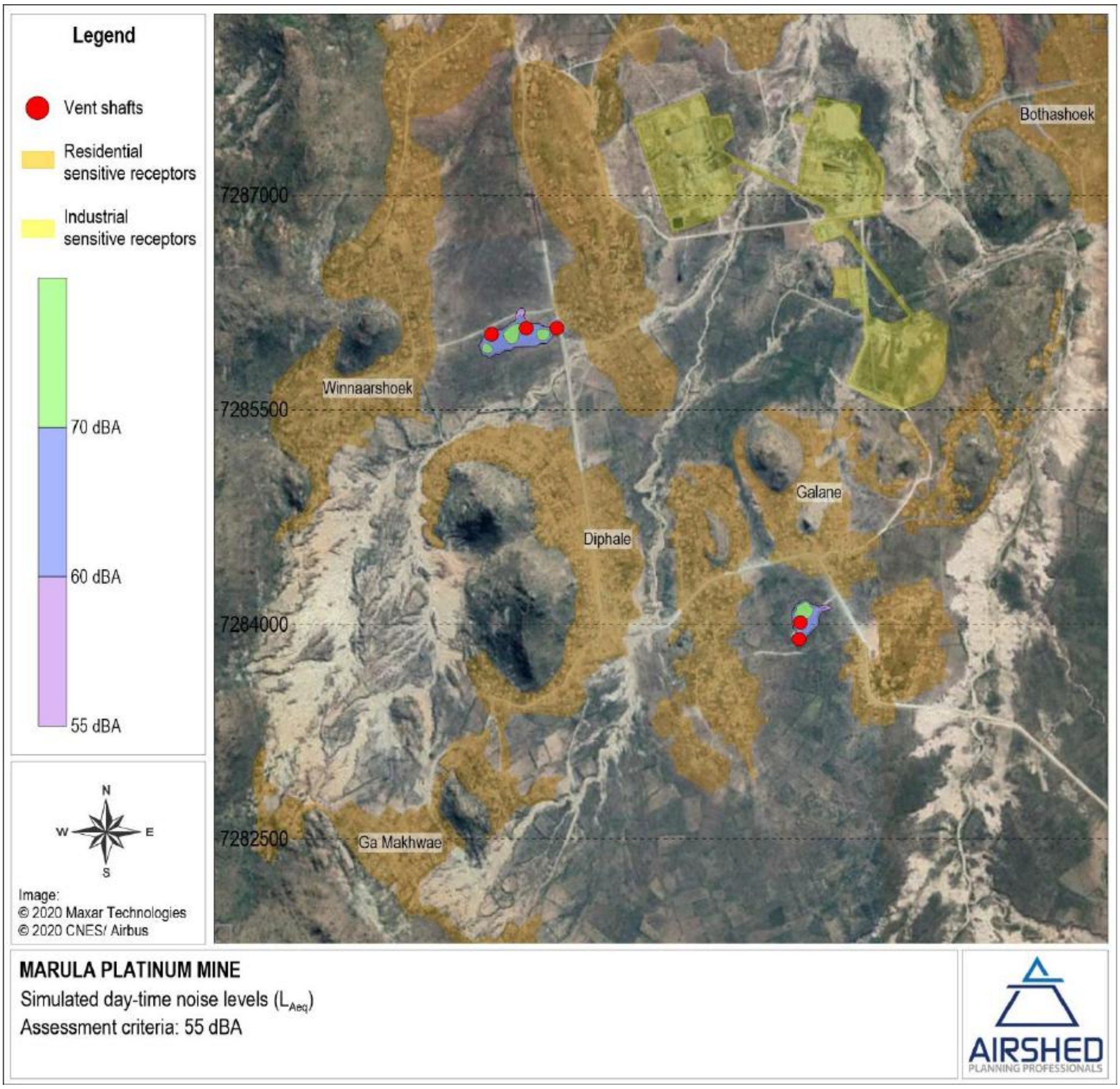


Figure 20: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for project activities assuming a 10 m berm at the Clapham Shaft Complex and a 15 m berm at the Driekop Shaft Complex

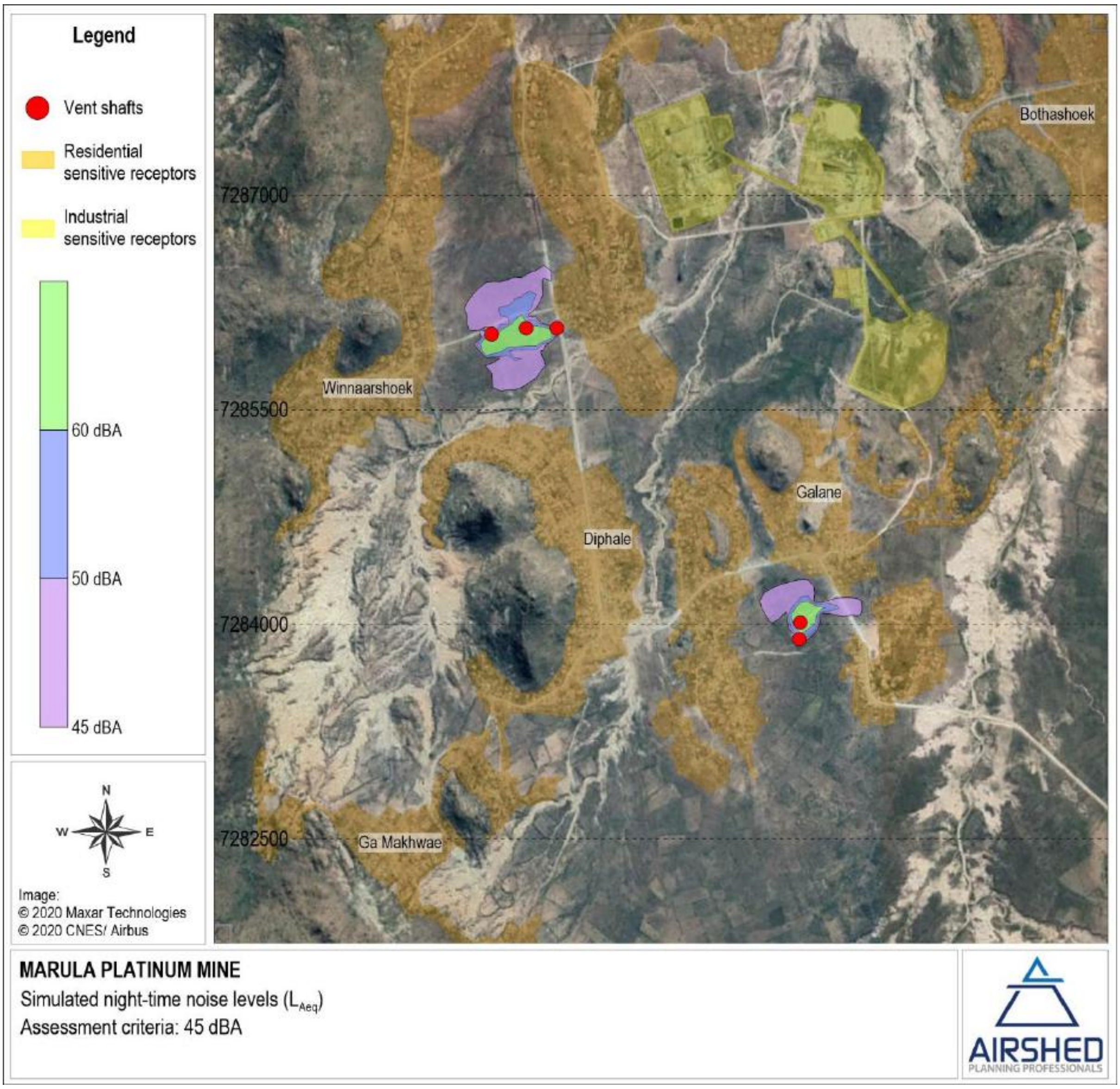


Figure 21: Simulated equivalent continuous night-time rating level ($L_{Req,n}$) for project activities assuming a 10 m berm at the Clapham Shaft Complex and a 15 m berm at the Driekop Shaft Complex

6.3 Monitoring

In the event that noise related complaints are received short term ambient noise measurements, at the complainant, should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions. The investigation of complaints should include an investigation into equipment or machinery that likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

The following procedure should be adopted for all noise surveys (for complaints):

- Any surveys should be designed and conducted by a **trained specialist**.

- Sampling should be carried out using a **Type 1** SLM that meets all appropriate 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 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 environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), statistical noise level L_{A90}, L_{AFmin} and L_{AFmax}, 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 environment of each site.

In addition to the above ad-hoc sampling campaigns for complaints, annual noise sampling campaigns should be conducted at Site 1, Site 2 and Site 4 (Figure 10) to understand the impacts of the project operations on the surrounding NSRs and to determine whether noise guidelines are being met. The same procedures as stipulated above should be followed.

7 Conclusion

Based on the findings of the assessment, IFC guidelines may be exceeded at NSRs within the vicinity. Provided the recommended management and mitigation measures are in place, it is the specialist opinion that the project may be authorised. A complaints register must be kept throughout the life of the operations, including during the construction of the project.

8 References

Bruce, R. D. & Moritz, C. T., 1998. Sound Power Level Predictions for Industrial Machinery. In: M. J. Crocker, ed. *Handbook of Acoustics.* Hoboken: John Whiley & Sons, Inc, pp. 863-872.

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

BSI, 2008. *Code of practice for noise and vibration control on construction and open sites - Part 1: Noise.* s.l.:s.n.

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

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

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.

Appendix A – Specialist Curriculum Vitae

FULL CURRICULUM VITAE

Name of Firm	Airshed Planning Professionals (Pty) Ltd
Name of Staff	René von Gruenewaldt (*nee* Thomas)
Profession	Air Quality Scientist
Date of Birth	13 May 1978
Years with Firm	More than 15 years
Nationalities	South African

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP)
- Member of the National Association for Clean Air (NACA)

KEY QUALIFICATIONS

René von Gruenewaldt (Air Quality Scientist): René joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over fifteen (15) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and seven (7) years of experience in the field of noise assessments. As an environmental practitioner, she has provided solutions to both large-scale and smaller projects within the mining, minerals, and process industries.

She has developed technical and specialist skills in various modelling packages including the AMS/EPA Regulatory Models (AERMOD and AERMET), UK Gaussian plume model (ADMS), EPA Regulatory puff based model (CALPUFF and CALMET), puff based HAWK model and line based models. Her experience with emission models includes Tanks 4.0 (for the quantification of tank emissions), WATER9 (for the quantification of waste water treatment works) and GasSim (for the quantification of landfill emissions). Noise propagation modelling proficiency includes CONCAWE, South African National Standards (SANS 10210) for calculating and predicting road traffic noise and CadnaA.

Having worked on projects throughout Africa (i.e. South Africa, Mozambique, Malawi, Kenya, Angola, Democratic Republic of Congo, Namibia, Madagascar and Egypt) René has developed a broad experience base. She has a good understanding of the laws and regulations associated with ambient air quality and emission limits in South Africa and various other African countries, as well as the World Bank Guidelines, European Community Limits and World Health Organisation.

RELEVANT EXPERIENCE

Mining and Ore Handling

René has undertaken numerous air quality impact assessments and management plans for coal, platinum, uranium, copper, cobalt, chromium, fluorspar, bauxite, manganese and mineral sands mines. These include: compilation of emissions databases for Landau and New Vaal coal collieries (SA), impact assessments and management plans for numerous mines over Mpumalanga (viz. Schoonoord, Belfast, Goedgevonden, Mbila, Evander South, Driefontein, Hartogshoop, Belfast, New Largo, Geluk, etc.), Mmamabula Coal Colliery (Botswana), Moatize Coal Colliery (Mozambique), Revuboe Coal Colliery (Mozambique), Toliera Sands Heavy Minerals Mine and Processing (Madagascar), Corridor Sands Heavy Minerals Mine monitoring assessment, El Burullus Heavy Minerals Mine and processing (Egypt), Namakwa Sands Heavy Minerals Mine (SA), Tenke Copper Mine and Processing Plant (DRC), Rössing Uranium (Namibia), Lonmin platinum mines including operations at Marikana, Baobab, Dwaalkop and Doornvlei (SA), Impala Platinum (SA), Pilannesburg Platinum (SA), Aquarius Platinum, Hoogland Platinum Mine (SA), Tamboti PGM Mine (SA), Sari Gunay Gold Mine (Iran), chrome mines in the Steelpoort Valley (SA), Mecklenburg Chrome Mine (SA), Naboom Chrome Mine (SA), Kinsenda Copper Mine (DRC), Kassinga Mine (Angola) and Nokeng Flourspar Mine (SA), etc.

Mining monitoring reviews have also been undertaken for Optimum Colliery's operations near Hendrina Power Station and Impunzi Coal Colliery with a detailed management plan undertaken for Morupule (Botswana) and Glencor (previously known as Xstrata Coal South Africa).

Air quality assessments have also been undertaken for mechanical appliances including the Durban Coal Terminal and Nacala Port (Mozambique) as well as rail transport assessments including BHP-Billiton Bauxite transport (Suriname), Nacala Rail Corridor (Mozambique and Malawi), Kusile Rail (SA) and WCL Rail (Liberia).

Metal Recovery

Air quality impact assessments have been carried out for Highveld Steel, Scaw Metals, Lonmin's Marikana Smelter operations, Saldanha Steel, Tata Steel, Afro Asia Steel and Exxaro's Manganese Pilot Plant Smelter (Pretoria).

Chemical Industry

Comprehensive air quality impact assessments have been completed for NCP (including Chloorkop Expansion Project, Contaminated soils recovery, C3 Project and the 200T Receiver Project), Revertex Chemicals (Durban), Stoppani Chromium Chemicals, Foskor (Richards Bay), Straits Chemicals (Coega), Tenke Acid Plant (DRC), and Omnia (Sasolburg).

Petrochemical Industry

Numerous air quality impact assessments have been completed for Sasol (including the postponement/exemption application for Synfuels, Infrachem, Natref, MIBK2 Project, Wax Project, GTL Project, re-commissioning of boilers at Sasol Sasolburg and Ekandustria), Engen Emission Inventory Functional Specification (Durban), Sapref refinery (Durban), Sasol (at Elrode) and Island View (in Durban) tanks quantification, Petro SA and Chevron (including the postponement/exemption application).

Pulp and Paper Industry

Air quality studies have been undertaken or the expansion of Mondi Richards Bay, Multi-Boiler Project for Mondi Merebank (Durban), impact assessments for Sappi Stanger, Sappi Enstra (Springs), Sappi Ngodwana (Nelspruit) and Pulp United (Richards Bay).

Power Generation

Air quality impact assessments have been completed for numerous Eskom coal fired power station studies including the ash expansion projects at Kusile, Kendal, Hendrina, Kriel and Arnot; Fabric Filter Plants at Komati, Grootvlei, Tutuka, Lethabo and Kriel Power Stations; the proposed Kusile, Medupi (including the impact assessment for the Flue Gas Desulphurization) and Vaal South Power Stations. René was also involved and the cumulative assessment of the existing and return to service Eskom power stations assessment and the optimization of Eskom's ambient air quality monitoring network over the Highveld.

In addition to Eskom's coal fired power stations, various Eskom nuclear power supply projects have been completed including the air quality assessment of Pebble Bed Modular Reactor and nuclear plants at Duynefontein, Bantamsklip and Thyspunt.

Apart from Eskom projects, power station assessments have also been completed in Kenya (Rabai Power Station) and Namibia (Paratus Power Plant).

Waste Disposal

Air quality impact assessments, including odour and carcinogenic and non-carcinogenic pollutants were undertaken for the Waste Water Treatment Works in Magaliesburg, proposed Waterval Landfill (near Rustenburg), Tutuka Landfill, Mogale General Waste Landfill (adjacent to the Leipardsvlei Landfill), Cape Winelands District Municipality Landfill and the Tsoeneng Landfill (Lesotho). Air quality impact assessments have also been completed for the BCL incinerator (Cape Town), the Ergo Rubber Incinerator and the Ecorevert Pyrolysis Plant.

Cement Manufacturing

Impact assessments for ambient air quality have been completed for the Holcim Alternative Fuels Project (which included the assessment of the cement manufacturing plants at Ulco and Dudfield as well as a proposed blending platform in Roodepoort).

Management Plans

René undertook the quantification of the baseline air quality for the first declared Vaal Triangle Airshed Priority Area. This included the establishment of a comprehensive air pollution emissions inventory, atmospheric dispersion modelling, focusing on impact area "hotspots" and quantifying emission reduction strategies. The management plan was published in 2009 (Government Gazette 32263).

René has also been involved in the Provincial Air Quality Management Plan for the Limpopo Province.

Other Experience (2001)

Research for B.Sc Honours degree was part of the "Highveld Boundary Layer Wind" research group and was based on the identification of faulty data from the Majuba Sodar. The project was THRIP funded and was a joint venture with the University of Pretoria, Eskom and Sasol (2001).

EDUCATION

M.Sc Earth Sciences	University of Pretoria, RSA, Cum Laude (2009) Title: *An Air Quality Baseline Assessment for the Vaal Airshed in South Africa*
B.Sc Hons. Earth Sciences	University of Pretoria, RSA, Cum Laude (2001) Environmental Management and Impact Assessments
B.Sc Earth Sciences	University of Pretoria, RSA, (2000) Atmospheric Sciences: Meteorology

ADDITIONAL COURSES

CALMET/CALPUFF	Presented by the University of Johannesburg, RSA (March 2008)
Air Quality Management	Presented by the University of Johannesburg, RSA (March 2006)
ARCINFO	GIMS, Course: Introduction to ARCINFO 7 (2001)

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Malawi, Liberia, Kenya, Angola, Democratic Republic of Congo, Lesotho, Namibia, Madagascar, Egypt, Suriname and Iran.

EMPLOYMENT RECORD

January 2002 - Present

Airshed Planning Professionals (Pty) Ltd, (previously known as Environmental Management Services cc until March 2003), Principal Air Quality Scientist, Midrand, South Africa.

2001

University of Pretoria, Demi for the Geography and Geoinformatics department and a research assistant for the Atmospheric Science department, Pretoria, South Africa.

Department of Environmental Affairs and Tourism, assisted in the editing of the Agenda 21 document for the world summit (July 2001), Pretoria, South Africa.

1999 - 2000

The South African Weather Services, vacation work in the research department, Pretoria, South Africa.

CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

- Understanding the Synoptic Systems that lead to Strong Easterly Wind Conditions and High Particulate Matter Concentrations on The West Coast of Namibia, H Liebenberg-Enslin, R von Gruenewaldt, H Rauntenbach and L Burger. National Association for Clean Air (NACA) conference, October 2017.
- Topographical Effects on Predicted Ground Level Concentrations using AERMOD, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2011.
- Emission Factor Performance Assessment for Blasting Operations, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2009.
- Vaal Triangle Priority Area Air Quality Management Plan – Baseline Characterisation, R.G. Thomas, H Liebenberg-Enslin, N Walton and M van Nierop. National Association for Clean Air (NACA) conference, October 2007.
- A High-Resolution Diagnostic Wind Field Model for Mesoscale Air Pollution Forecasting, R.G. Thomas, L.W. Burger, and H Rautenbach. National Association for Clean Air (NACA) conference, September 2005.
- Emissions Based Management Tool for Mining Operations, R.G. Thomas and L.W. Burger. National Association for Clean Air (NACA) conference, October 2004.
- An Investigation into the Accuracy of the Majuba Sodar Mixing Layer Heights, R.G. Thomas. Highveld Boundary Layer Wind Conference, November 2002.

LANGUAGES

	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Fair	Good	Good

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

______________________	10/06/2020
Signature of staff member	Date (Day / Month / Year)

Full name of staff member: René Georgeinna von Gruenewaldt

Appendix B – Declaration of Independence

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: René von Gruenewaldt
Name of Registration Body: South African Council for Natural Scientific Professions
Professional Registration No.: 400304/07

Declaration of independence and accuracy of information provided:
Atmospheric Impact Report in terms of section 30 of the Act.
I, René von Gruenewaldt, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The additional information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Midrand on this 3rd of September 2020

SIGNATURE
Principal Noise Scientist
CAPACITY OF SIGNATORY

Appendix C – Sound Level Meter Calibration Certificates

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250-L, 4950
Serial number:	2731851, 3177677
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD 480 Smuts Drive Halfway Gardens Midrand 1682
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	23 – 24 October 2019

1 PROCEDURE

The sound level meter was electrically calibrated according to the relevant clauses of SANS 656 and 658 specifications. The microphone with the sound level meter was acoustically calibrated according to the relevant clauses of SANS 656 specifications. The instrument complete with filters was electrically calibrated according to IEC 61260 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-52)
Inline Capacitor	(AS-98)
Madgetech PRHTemp 2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by H Potgieter Metrologist (Technical Signatory)	Checked by R Nel Metrologist	For Chief Executive Officer
Date of Issue 25 October 2019	Page 1 of 3	Certificate number AV\AS-4915

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2 RESULTS

2.1 The following parameters of the sound level meter were calibrated and conformed to the SANS 656 and SANS 658 specifications, type 1:

Indication under reference conditions (SANS 656 clause 11.2)			U = 0,20 dB
Electrical self generated noise			
	A-weighted	(14,2 dB)	U = 0,30 dB
	C-weighted	(13,6 dB)	U = 0,30 dB
	Linear	(19,2 dB)	U = 0,30 dB
Linearity range (primary indicator range) (SANS clause 9.9, table 11)			
	1 kHz		U = 0,23 dB
	4 kHz		U = 0,23 dB
	8 kHz		U = 0,23 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)			
	A-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
	C-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
	Linear	(25 Hz – 16 kHz)	U = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)			
	Slow and Fast		U = 0,11 dB
	Impulse		U = 0,11 dB
	Peak		U = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)			U = 0,12 dB
Impulse weighted time averaging, L_{AIeq} (SANS 658 Annex C, table C1)			U = 0,12 dB
Overload indication (SANS 656 clause 11.3)			U = 0,31 dB

2.2 The following parameter of the microphone with the sound level meter were calibrated and conformed to the SANS 656 specifications, type 1:

Frequency response
(SANS 656 clauses 8.1, tables 4 & 5)
31,5 Hz – 12,5 kHz — U = 0,20 dB @ 1 kHz

Calibrated by	Checked by	For Chief Executive Officer
H Potgieter **Metrologist (Technical Signatory)**	**R Nel** **Metrologist**	
Date of Issue **25 October 2019**	**Page 2 of 3**	Certificate number **AV\AS-4915**

2.3 The following parameter of the octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation $U = 0{,}10$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
16 Hz - 8 kHz

2.4 The following parameter of the third octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation $U = 0{,}10$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
12,5 Hz - 16 kHz

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, *U*, is stated as the standard uncertainty of measurement multiplied by a coverage factor of $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %. The reported expanded uncertainty of measurements is at the reference points.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 Only parameters given in 2.1, 2.2, 2.3 and 2.4 were calibrated.

3.6 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

3.7 The firmware versions of the sound measuring device at the time of calibration were: BZ7130 V4.7.4; BZ7131 V4.7.4; BZ7132 V4.7.4.

------------------ *end of certificate* ------------------

Calibrated by H Potgieter **Metrologist (Technical Signatory)**	Checked by **R Nel** **Metrologist**	For Chief Executive Officer
Date of Issue **25 October 2019**	**Page 3 of 3**	Certificate number **AV\AS-4915**

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND CALIBRATOR
Manufacturer:	SVANTEK
Model number:	SV 33
Serial number:	43170
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD 480 Smuts Drive Halfway Gardens Midrand 1682
Calibration procedure:	AV\AS-0008
Period of calibration:	25 October 2019

1 PROCEDURE

The sound calibrator was calibrated according to IEC 60942: 2003 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 2673 preamplifier	(AS-146)
MadgeTech PRHTemp2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)
Brüel & Kjær 4228 Pistonphone	(AS-WSTD-10)
Brüel & Kjær 4192 Pressure Microphone	(AS-WSTD-15)

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **25 October 2019**	**Page 1 of 2**	Certificate number **AV\AS-4916**

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2 RESULTS

2.1 The following parameters of the sound calibrator were calibrated and conformed to IEC 60942: 2003 specification, class 1:

Frequency (IEC 60942 clause B.3.5) 1 000 Hz	U = 0,10 Hz
Sound Pressure Level (IEC 60942 clause B.3.4) 114 dB	U = 0,15 dB
Total Distortion (IEC 60942 clause B.3.6)	U = 0,30 %

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

------------------ *end of certificate* ------------------

Calibrated by	Checked by	For Chief Executive Officer
R Nel **Metrologist (Technical Signatory)**	**H Potgieter** **Metrologist**	
Date of Issue **25 October 2019**	**Page 2 of 2**	Certificate number **AV\AS-4916**

Appendix D – Fieldwork Log Sheets and Photos

Day

SITE NUMBER: Site 1		SLM DATA RECORD: Marula 001
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.4 - 3.8	N	17.6	62.1	9/10	- Sound of goats @±50dB - Road traffic @±60dB - Could hear mine ops as noise bckg - Gusty winds
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other

Description: Village, shrubs & trees, open land, semi-cultivated, near road ± 80m

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
9:42:36	Vehicle from far away	48:53 -49:57	Mine ops.	03:41	Vehicle		
9:43:28	goats			07:57	hooter		
9:43:30 -44:13	Vehicle	51:15	Vehicle				
		53:01	Vehicle				
		53:43 -54:45	4				
44:56 -45:28	Vehicle						
45:44	goats	56:08 -56:27	Vehicle				
46:07	vehicle	10:00:05	man pushing wheel barrow				
47:21	goats	02:00					
48:17	vehicle						

Page __ of __

Day

SITE NUMBER: Site 2		SLM DATA RECORD: Marula002
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	2.1 - 6.5	N	17.9	62.9	9/5	-Gusty wind throughout -Birds@ ± 55dB - Could hear mine ops but far away
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: lots of shrubs and small trees, uncultivate land, open land

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
10:31:52 -32:38	Birds	53:19	Birds				
33:33 - 34:55	Birds.						
36:10 -39:17	Birds						
42:39 -44:09	Gusty wind						
48:46	hooter						

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Day

SITE NUMBER: Site 3		SLM DATA RECORD: Marula 003
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 4.8	N	18.1	60.2	9/10	- Vehicles @ ± 50 - Gusty winds - Noise background brick plant near by @ ± 50 dB
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Open land with shrubs & lots of trees, uncultivated, ± 600m to road

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
11:22:03	Vehicle passing	38:20	hooter				
24:07	"		} Vehicle				
	ops from						
24:24	brick making	47:00	Vehicle				
- 26:31	plant.		hooter				
30:50	Vehicle						
	passing & hooting						
32:45	Gusty winds						
- 33:59							
36:12	Birds						

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Day

SITE NUMBER: Site 4		SLM DATA RECORD: Marula 004
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2 - 6.0	N	19.1	56.5	9/10	- Goats @ ±55dB - Gusty - Vehicle @±50
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: shrubs & lots of trees, open land, uncultivate

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
	~~12:09:56~~	21:24	Vehicle	34:14	Vehicle		
12:09:54	Rooster	-22:28	passing		hooter		
10:34				35:27	Gusty		
		23:13	Gusty wind	-38:53	winds		
12:22	Birds	-23:48					
14:07	Vehicle	26:28	Vehicle				
-14:39		-27:06	passing & hooting				
15:06	Goats		~~Birds~~				
-17:13		27:59	Vehicle				
17:50	Vehicle (Taxi)	-29:30	passing				
-18:37	hooting						

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Day

SITE NUMBER: Site 5		SLM DATA RECORD: Marula005
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2 - 6.2	N	19.7	57.4	9/10	-Birds ≡ 60dB throughout - 55dB.
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: lots of trees & shrubs, uncultivated land, open land, 900m ≡ to road

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
12:56:25 -57:20	Bird	13:07:15 -08:10	Vehicle pass & hooting	[illegible]	Birds		
				21:26 -22:04	Birds		
57:35	Birds	11:25	Birds				
57:57	"	12:11	Birds				
		17:07 -18:46	Generator for pumping water for community				
58:50 -59:35	Vehicle pass						
13:00:36 -01:50	Birds	19:04 -20:07	Vehicles pass				
13:02:44 -04:04	people talk						

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Day

SITE NUMBER: Site 6		SLM DATA RECORD: Marula 006	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.3 - 3.0	N	20.2	55.2	9/10	- Goats 1 @ 55 - 60dB
Middle						- Birds throughout
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Village, trees & shrubs, small grass, open, uncultivated land

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
13:40:57	Vehicle pass.						
-41:39		14:00:20	Goats				
		-04:11					
43:04	Birds						
		06:55					
44:59	Birds	-08:17					
-48:59							
49:44	Goats						
-53:17							
56:41	Vehicle pass						
-57:25							

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Event 17/08/2020

SITE NUMBER: Site 1		SLM DATA RECORD: marulaev001
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 4.1	S.E	22.4	54.1	7	-Windy
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18:22:54	Hooter vel–						
24:25 – 24:12	Vehicle pass–						
25:22 – 26:08	"						
29:41	Vehicle passing						
30:39	"						

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17/05/2020

SITE NUMBER: Site 2		SLM DATA RECORD: Marulaapv002
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2 - 5.0	S.E	22.3	52.1	7	Windy th @ 45dB
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18:40:49 - 41:29	locals people cars						
41:48 - 42:41	"						
44:29 - 45:01	"						

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17/08/2020

SITE NUMBER: Site3		SLM DATA RECORD: marulaev 003
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.0 – 2.1	S.E	22.4	54.2	7	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18:59:46 – 00:15	Vehicle passing						
04:37 – 05:12	"						
06:02 – 06:34	"						
08:07	"						

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17/08/2020

SITE NUMBER: Site 4		SLM DATA RECORD: Marula ev 004
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.3	S.E	23	55.1	7	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:19:33 - 20:42	Vehicle pass						
21:52 - 22:55	Vehicle pass						
26:42 - 27:23	Vehicle pass						

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17/08/2020

SITE NUMBER: Site 5	SLM DATA RECORD: marulaev 005
Longitude/Easting:	Latitude/Northing:
Elevation:	
Short Location Description & Notes:	

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 3.7	S.E	25.1	55.1	6	Insects th...
Middle						- windy.
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:36:52							
42:15	} Vehicle						
~43:20	passing						

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17/08/2020

SITE NUMBER: Site6		SLM DATA RECORD: Marutaev 006
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.6	S.E.	~~[illegible]~~ 26.1	55.3	6	Insects.
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:52:28	Dog bark						
54:32 - 56:36	People talking						
59:14	1						

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Night 17/08/2020

SITE NUMBER: Site 1		SLM DATA RECORD: marulani001
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 – 1.9	S.E	18	59.5	–	
Middle						
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22:29:46	Dogs barking	35:57 – 37:05	Vehicle far away				
29:57	Dogs						
30:22 – 30:49	Vehicle passing						
~~[illegible]~~							
31:40	hooter						
32:28	Winds ~~[illegible]~~						
34:17 – 35:22	car from far away						

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2 17/08/2020

SITE NUMBER: Site 2		SLM DATA RECORD: Marulani 002
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.2 - 1.1	S.E	17.9	60.1	-	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
53:15	Birds	00:53	Man coughing				
53:20	Birds						
53:57	Winds						
55:16 - 55:57	Birds						
56:46	hooter from [illegible]						
57:45 - 00:43	People talking & walking						

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17/08/2020

SITE NUMBER: Site 3		SLM DATA RECORD: marulani003
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 – 1	S.E	17.5	61.1	–	
Middle						
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
23:16:55	Vehicle hoote						
19:44	Coughin						
22:13 – 25:28	Generator for pumping water						

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17/05/2020

SITE NUMBER: site 4		SLM DATA RECORD: marulani 004
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 – 1.1	S-E	18	60	–	
Middle						
End						

NOISE CLIMATE	☑ Birds	☒ Insects	☑ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
23:40:40	Dogs barking from far	49:00	hooter				
41:24	Vehicle hooter	50:08	Vehicle pass				
43:13 – 43:42	Vehicle pass						
43:43 – 46:29	Mine ops + Vehicle pass						
47:45 – 48:25	Mine ops Vehicle pass						

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Night 17/08/2020

SITE NUMBER: Site ~~4~~ 5		SLM DATA RECORD: marulani 005
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.3 – 1.3	S.E	16.9	62.3	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
00:02:59	Men laugh						
06:27 – 06:49	Dogs barking						
10:30 – 11:10	Dogs barking						

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17/08/2020 Night 6

SITE NUMBER: Site 6	SLM DATA RECORD: marulani006	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.0 - 1.1	SE.	~~17~~ 16.7	62.1	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☒ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
00:23:52	~~[illegible]~~						
00:23:53	Goats						
24:21	"						
25:56	Goats.						
26:22 - 26:39	Winds						
30:53	papers (logsheet)						

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18/08/2020

SITE NUMBER: Site 1		SLM DATA RECORD: marulae001	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1-3	S	23	52	–	Vent shaft as noise backgr.
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
18:50:19 - 51:01	Vehicle pass-by	57:37	Vehicle pass-by				
51:02 - 51:58	Vent shaft ops	59:41	"				
		19:00:01	Dogs				
51:58 - 52:26	Vehicle pass-by						
53:08	Vehicle pass-by						
53:25 - 54:52	Mine ops + Vehicle pass-by						

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18/08/2020

SITE NUMBER: Site 2		SLM DATA RECORD: Marulae 002
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 – 2.8	S	24	54	–	
Middle						
End						

NOISE CLIMATE	☒ Birds	☑ Insects	☒ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19: 21:18	Birds	26:10	Vehicle pass-by				
22:32		27:34	on gravel road				
22:44	Birds	28:09	Insects				
23:35		–29:06					
23:40	Dog	29:12	Vehicle local				
		–30:43	people on				
23:49	Gusty wind		gravel road				
24:17	People talking						
–26:07							

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18/08/2020

SITE NUMBER: Site3		SLM DATA RECORD: marulae003	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.6	S	22	56	–	- Generator as noise backround
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:45:46 - 46:01	Dogs	49:18 - 55:03	Generator				
46:03 - 46:48	Generator for pumping for community	55:10	Vehicle pass-by				
46:53 - 47:54	Vehicle passby						
47:56 - 49:18	Birds						

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18/08/2020

SITE NUMBER: Site 4		**SLM DATA RECORD:** Malulae 004	
Longitude/Easting:	**Latitude/Northing:**		**Elevation:**
Short Location Description & Notes:			

SETUP	**Start Date & Time:**	**End Date & Time:**	**Sensitivity Before:**	**Sensitivity After:**

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1 - 2.4	S	22	56	–	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19: 13:24	hooter vehicle						
14:20 –	Mine ops +						
-16:20	Shaft vent						
16:38	Vehicle passing by						
17:04	"						
18:07	Dogs						
20:54	Vehicle passing						
21:02	shaft vents						
- 22:30	~~noise~~						

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18/08/2020

SITE NUMBER: Site 5		SLM DATA RECORD: Marulae005
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.7	S	22	57	–	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
33:22	Dogs	37:50	hooter				
34:07 - 34:46	Birds	40:05 - 41:41	Dogs far away				
34:48 - 35:12	Vehicle passing	42:55 - 43:17	Vehicle passing				
35:29 - 36:49	Insect + Birds						
36:49 - 37:31	Vehicle passing						

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18/08/2020

SITE NUMBER: Site 6		SLM DATA RECORD: Marulae006
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.1 - 2.2	3	21	55	–	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
19:05:23	Insects	12:11	Vehicle				
-06:51		-13:09	passing				
07:18	Dogs	13:46	"				
-8:14		-14:47					
8:43	Dogs.						
-10:09							
	~~Water~~						
09:58	Vehicle water						
	passing						
-11:36							

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18/08/2020

SITE NUMBER: Site 1		SLM DATA RECORD: Marulan001	
Longitude/Easting:	Latitude/Northing:	Elevation:	
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 – 1.1	5	19	60.1	-	Insects & Bird - Mine ops @ background
Middle						
End						

NOISE CLIMATE	☐ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
~~22:~~							
22:07:35	Vehicle passiby						
07:50							
~~22~~							
10:14	Vehicle pa—						
-11:19							
12:36	Dogs bark						
15:24	Insect + Birds						

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14/08/2020

SITE NUMBER: Site 2		SLM DATA RECORD: Marula002	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 - 1.2	S	18.1	60	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22:40:31	Dogs						
41:47	Insects						
41:58	Dogs						
42:44							
42:18	Vehicle pa						
42:50	Sounds of chicken						
44:13	Birds + Insects						
-45:02							
45:34	Vehicle						
46:21							

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18/08/2020

SITE NUMBER: Site3		SLM DATA RECORD: marulan003	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 - 1.4	5	17	63	—	
Middle						
End						

NOISE CLIMATE	☒ Birds	☒ Insects	☒ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22: 12:26	Dogs						
12:49							
13:21	Insects						
14:49	Birds						
14:58	~~Birds~~ sounds						
	from mine						
15:14	Insects						
-16:38							

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18/08/2020

SITE NUMBER: Site 4		**SLM DATA RECORD:** marulan 004	
Longitude/Easting:	**Latitude/Northing:**		**Elevation:**
Short Location Description & Notes:			

SETUP	**Start Date & Time:**	**End Date & Time:**	**Sensitivity Before:**	**Sensitivity After:**

METEOROLOGY	**Wind Speed (m/s)**	**Wind Direction (°)**	**Temperature (°C)**	**Humidity (%)**	**Clouds (%)**	**Remarks:**
Start	0.1~1.4	5	17	62.1	—	- mine ops @ I 40dB - Insects + Birds throughout
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
		54:10	Vehicle pass				
46:47 - 47:36	Vehicle pass	55:09	Mine ops				
47:58	hooter						
48:50 - 49:23	Vehicle pass						
50:03 - 51:30	Mine ops + hooter						
51:59 - 53:25	Vehicle pass						

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18/08/2020 Date time stamp?? on the monitor

SITE NUMBER: Site 5		SLM DATA RECORD: marulan005	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1 - 1.0	S	16.8	64.1	—	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
23:17:10	Birds						
23:20:08	Vehicle pass						
-20:39	nearby						
21:15	hooter						

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Facing north

Facing east

Facing south

Facing west

Figure 22: Photographs of environmental noise survey Site 1

Facing north

Facing east

Facing south

Facing west

Figure 23: Photographs of environmental noise survey Site 2

Figure 24: Photographs of environmental noise survey Site 3

Figure 25: Photographs of environmental noise survey Site 4

Figure 26: Photographs of environmental noise survey Site 5

Figure 27: Photographs of environmental noise survey Site 6

Appendix E – Time-series, Statistical, and Frequency Spectrum Results

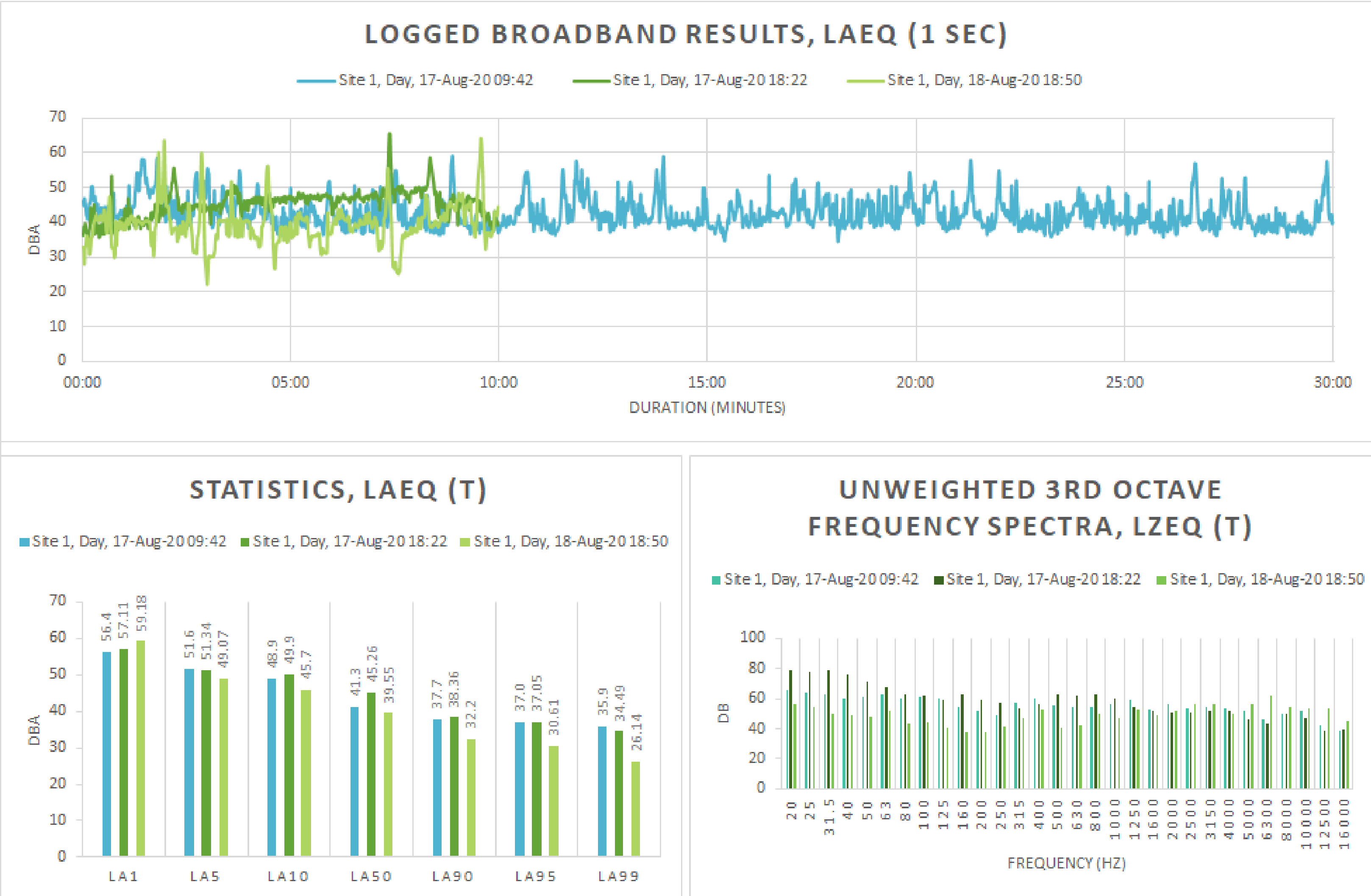

Figure 28: Detailed day-time survey results for Site 1

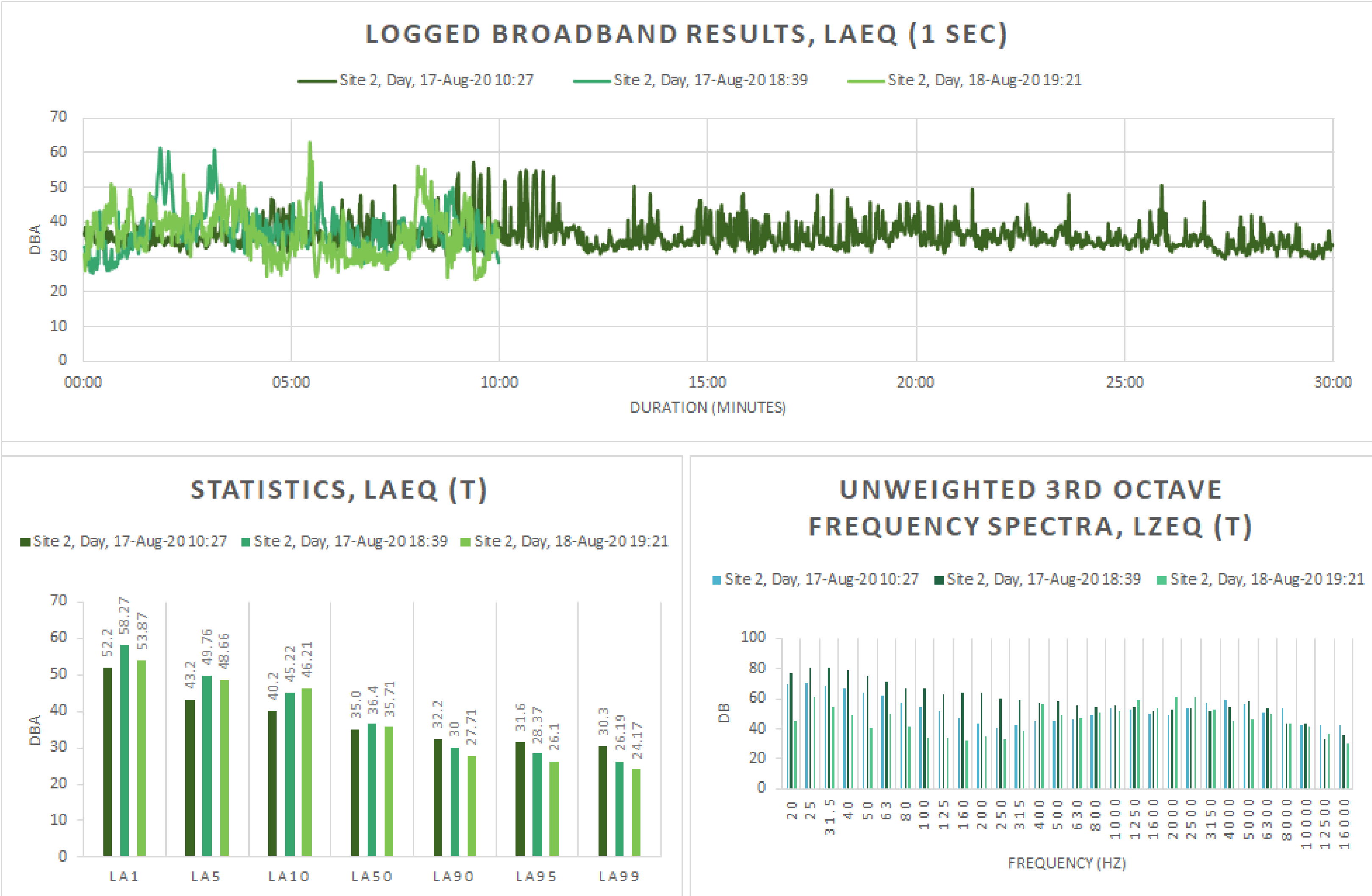

Figure 29: Detailed day-time survey results for Site 2

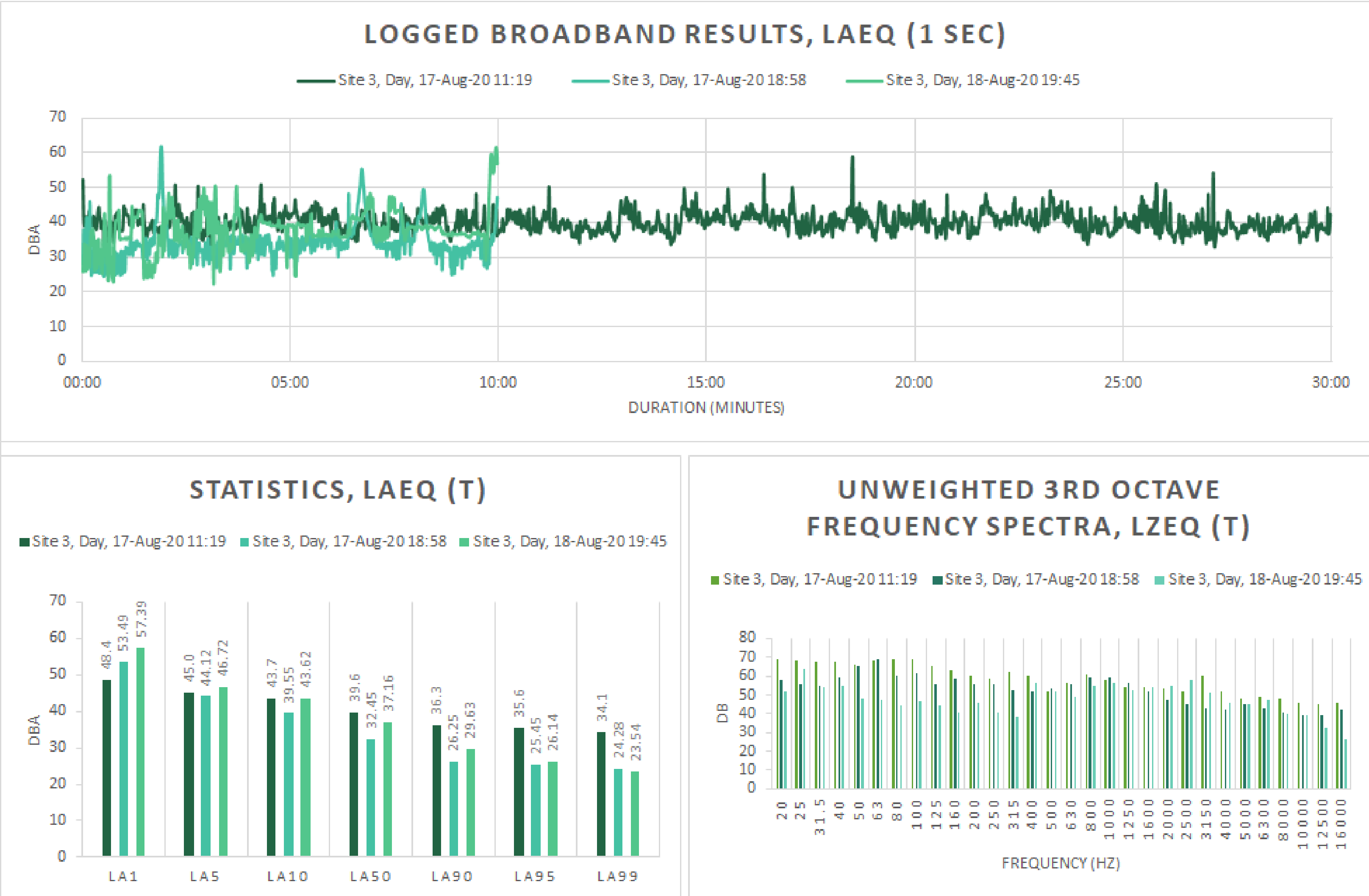

Figure 30: Detailed day-time survey results for Site 3

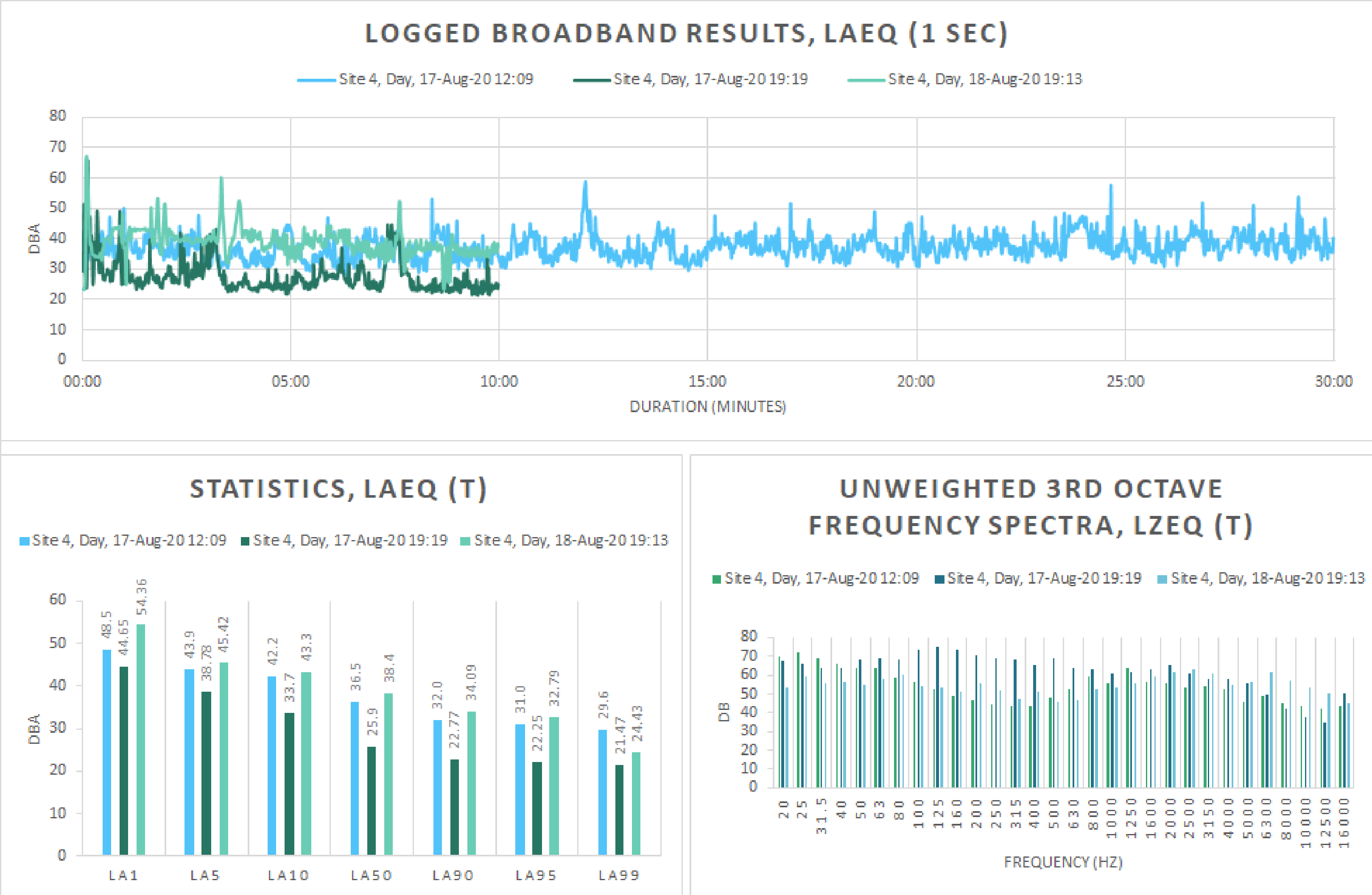

Figure 31: Detailed day-time survey results for Site 4

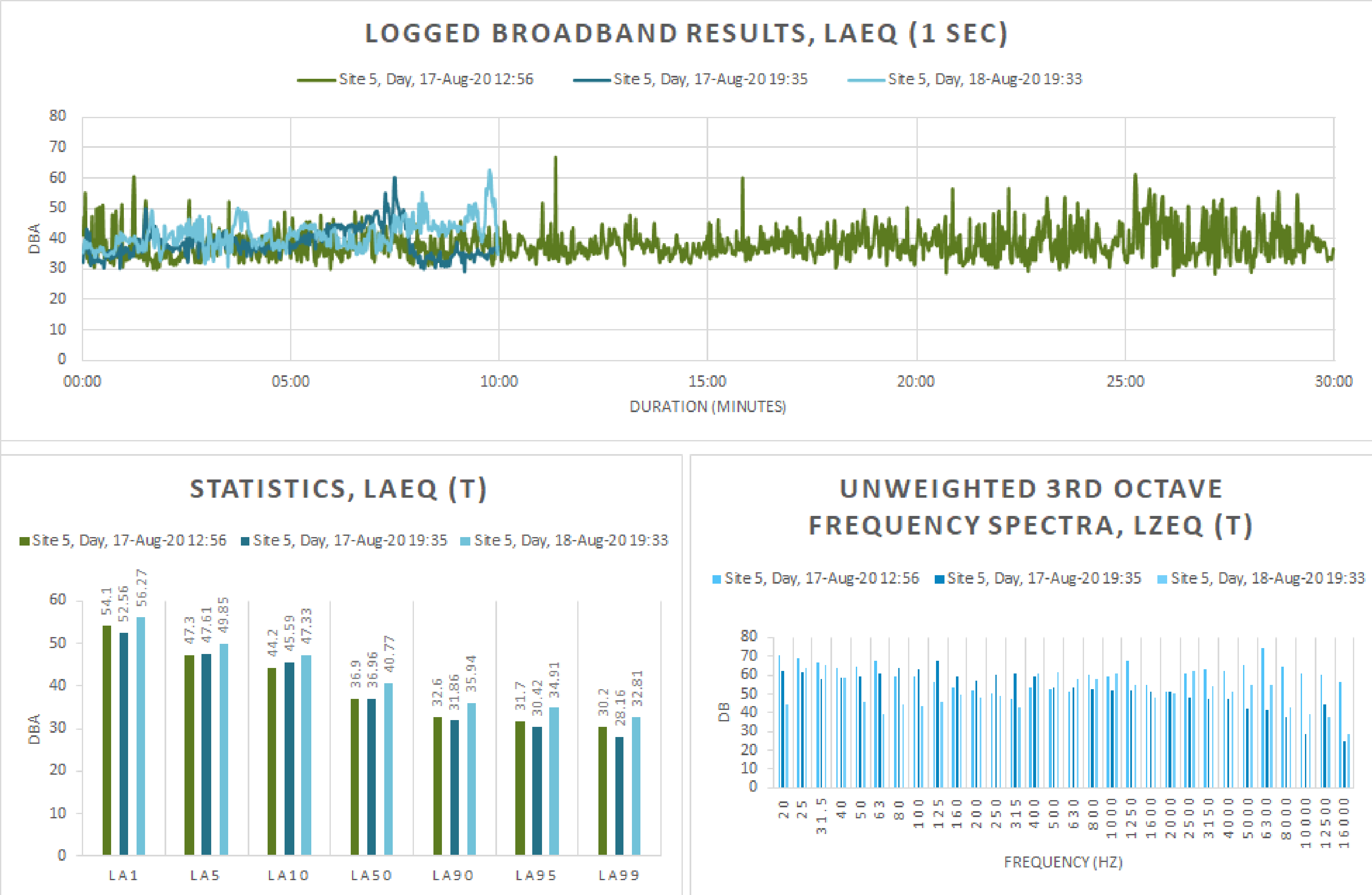

Figure 32: Detailed day-time survey results for Site 5

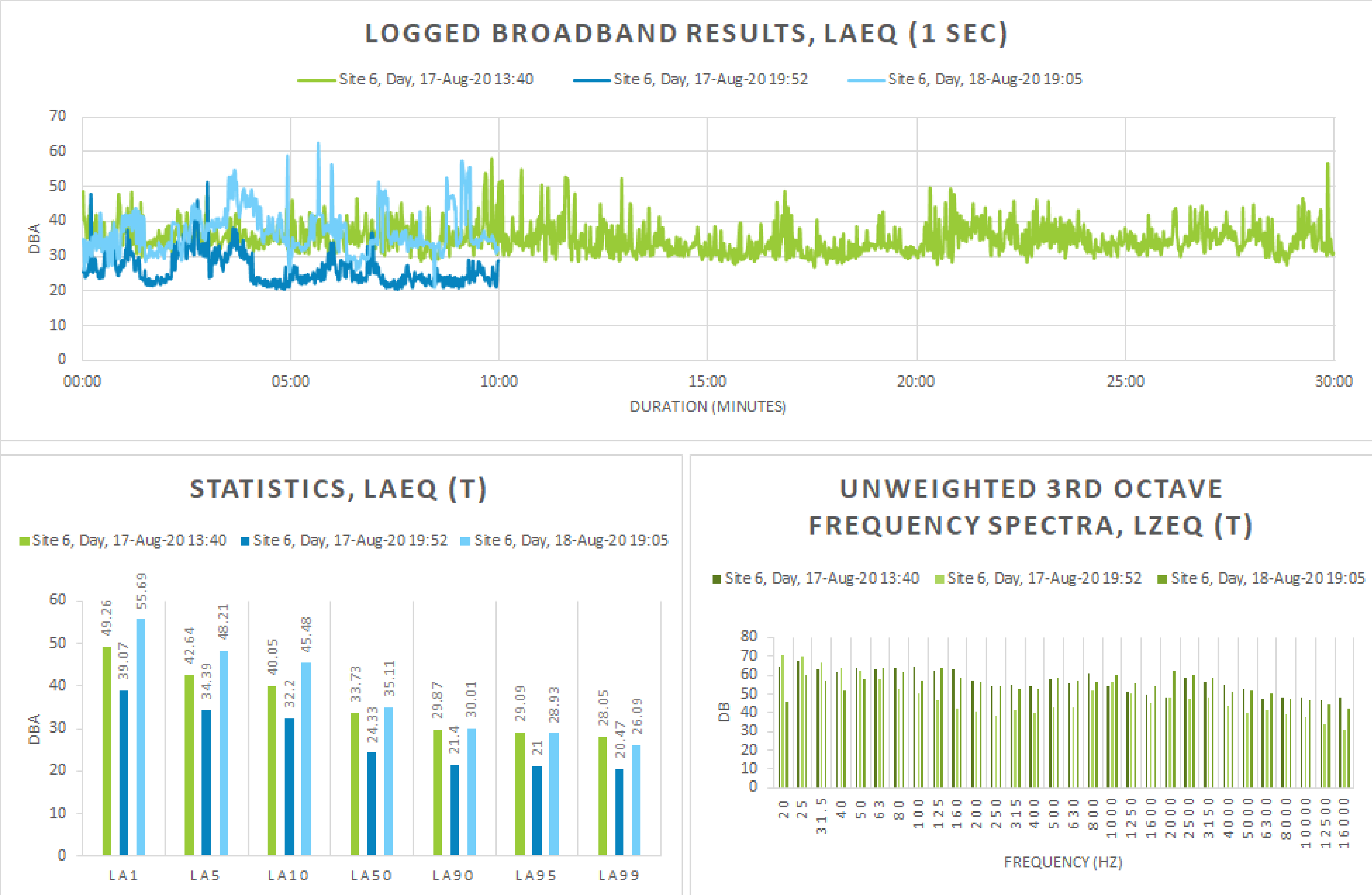

Figure 33: Detailed day-time survey results for Site 6

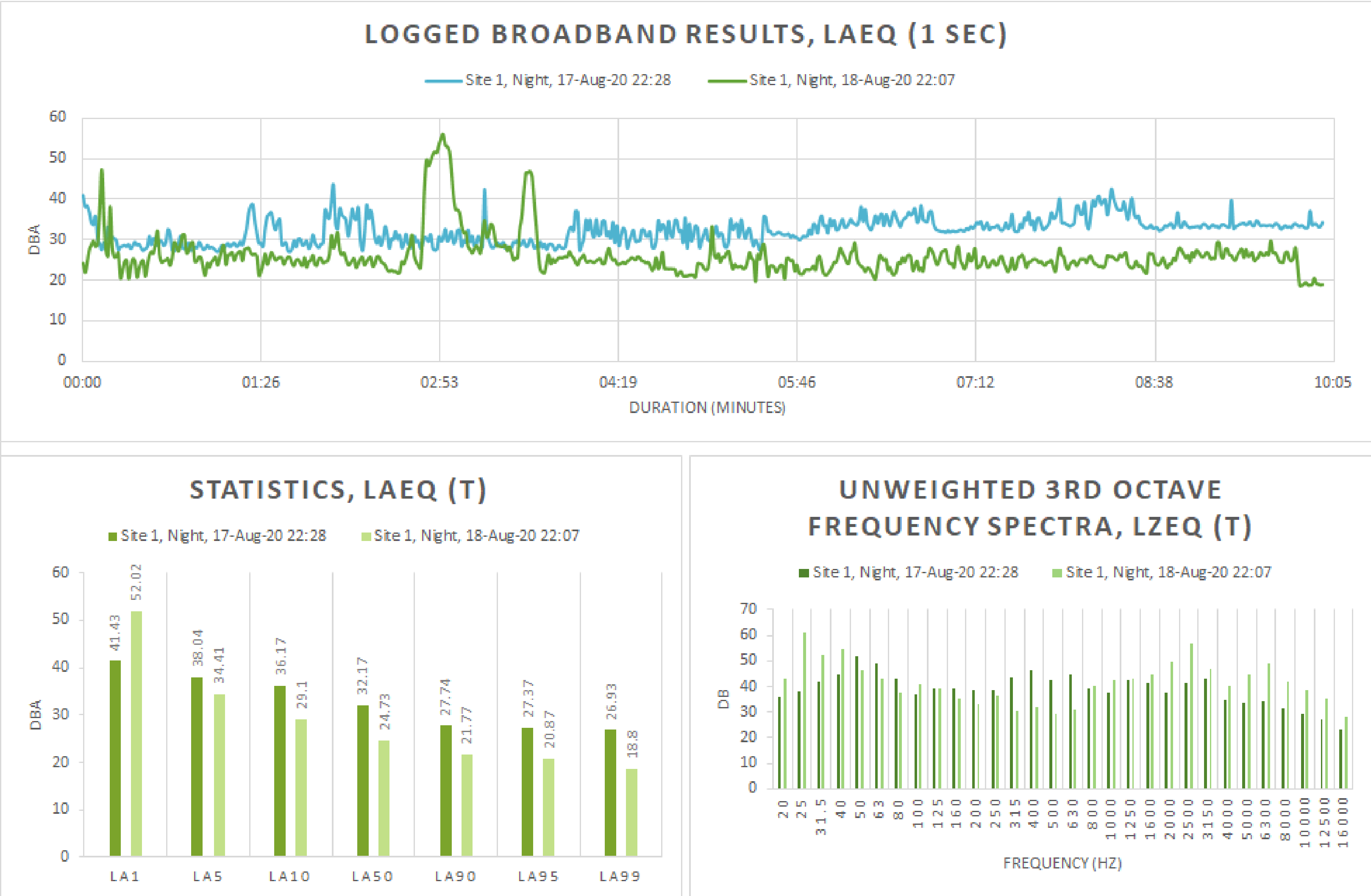

Figure 34: Detailed night-time survey results for Site 1

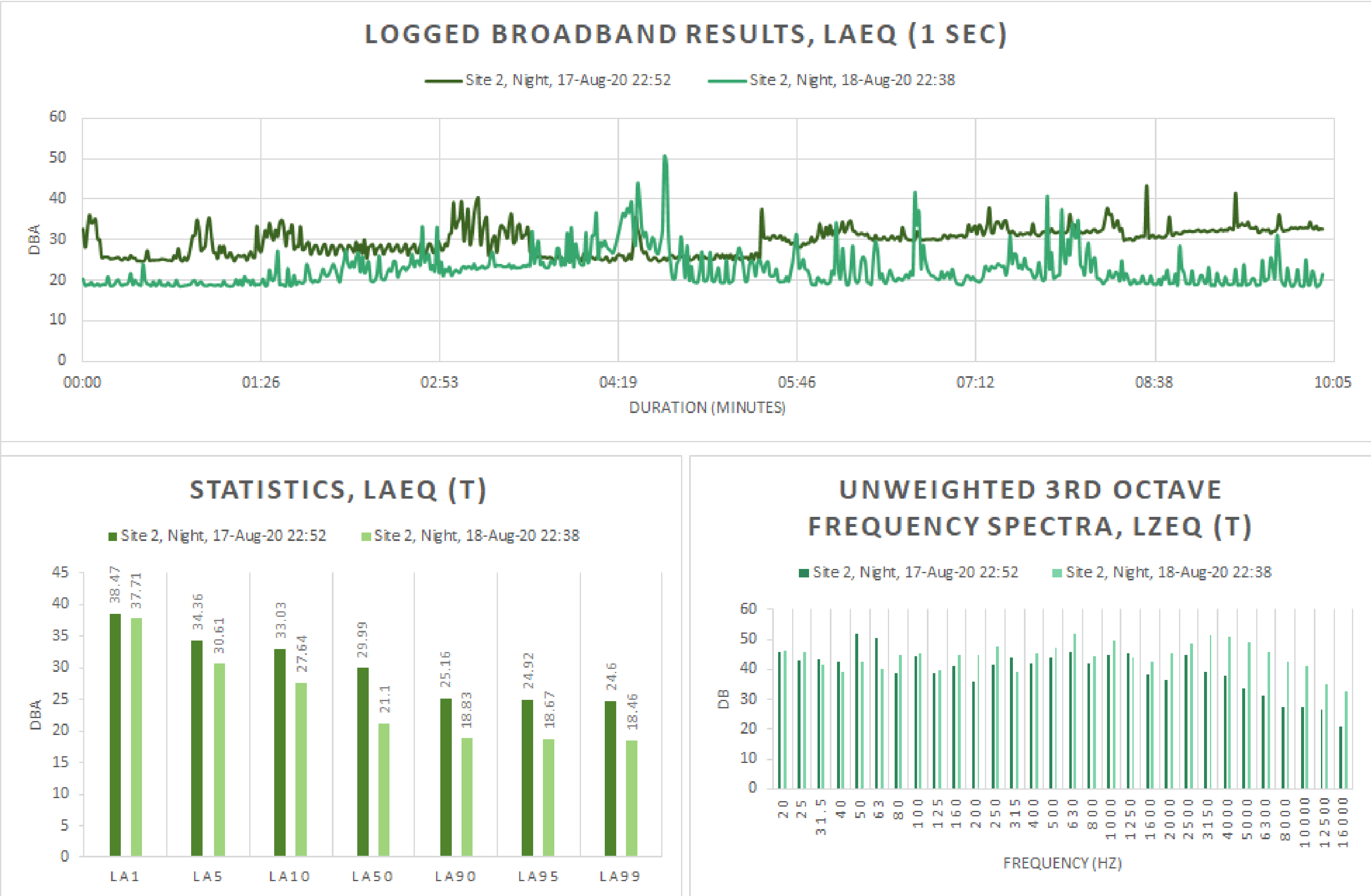

Figure 35: Detailed night -time survey results for Site 2

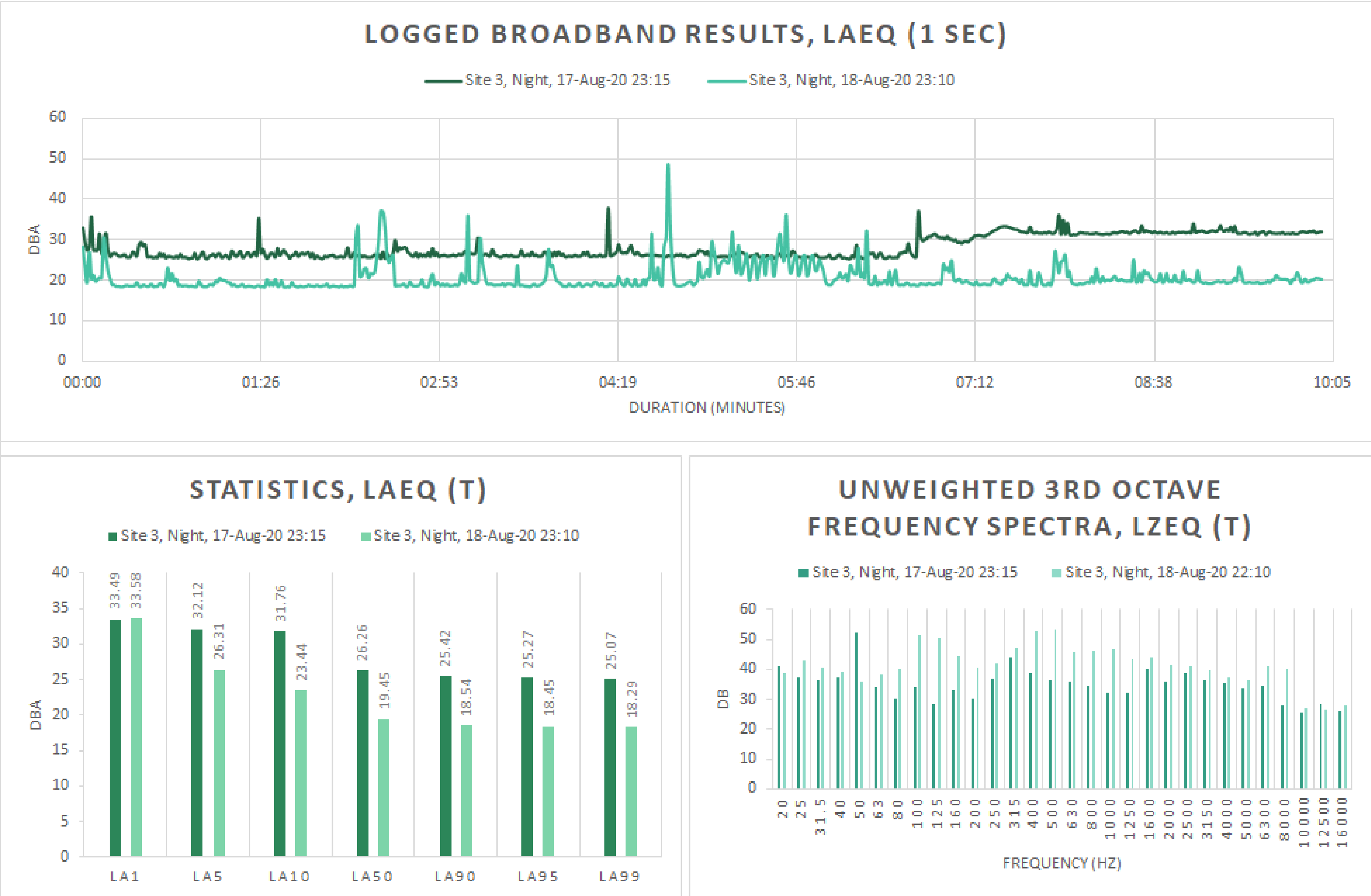

Figure 36: Detailed night -time survey results for Site 3

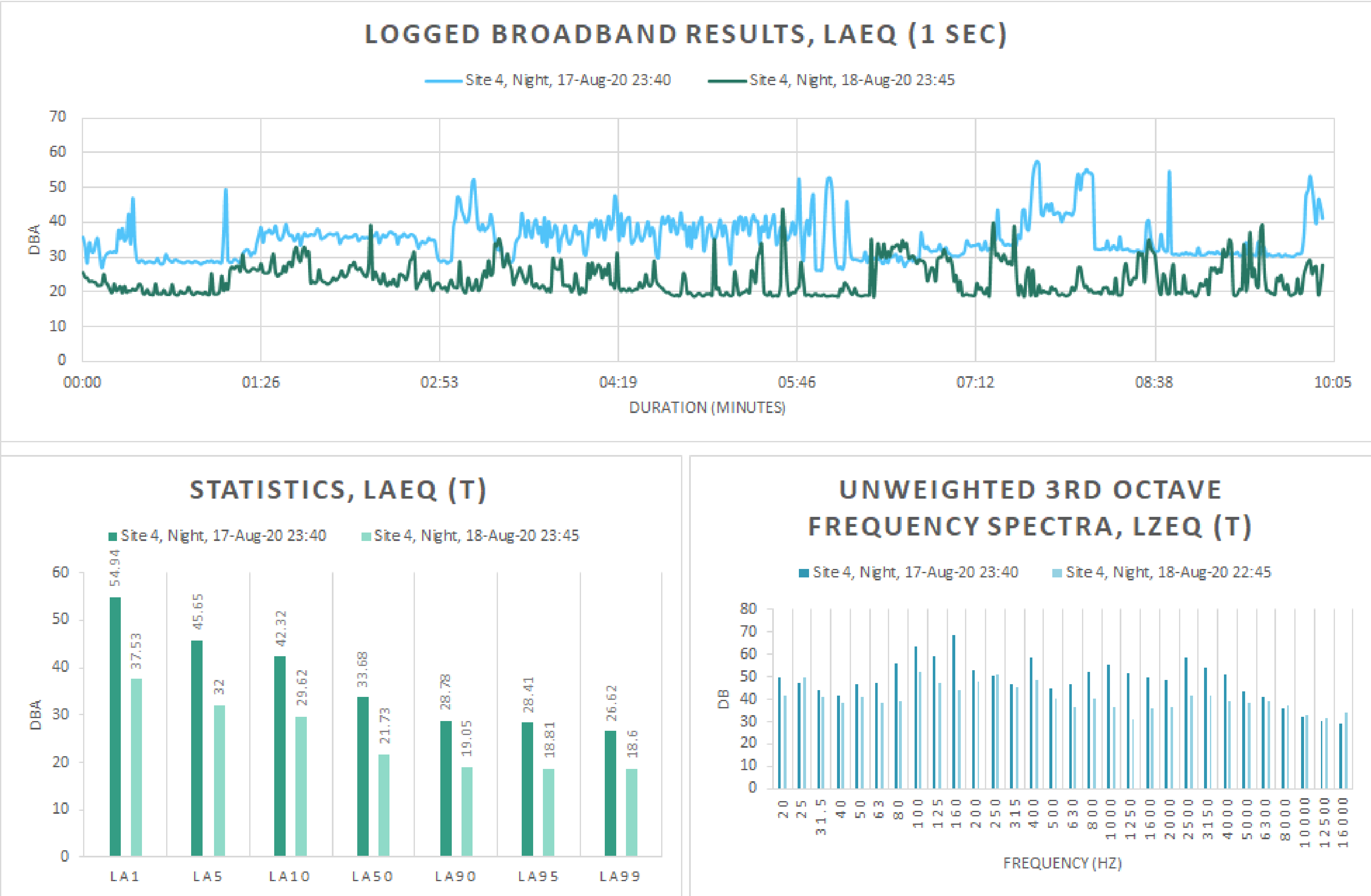

Figure 37: Detailed night -time survey results for Site 4

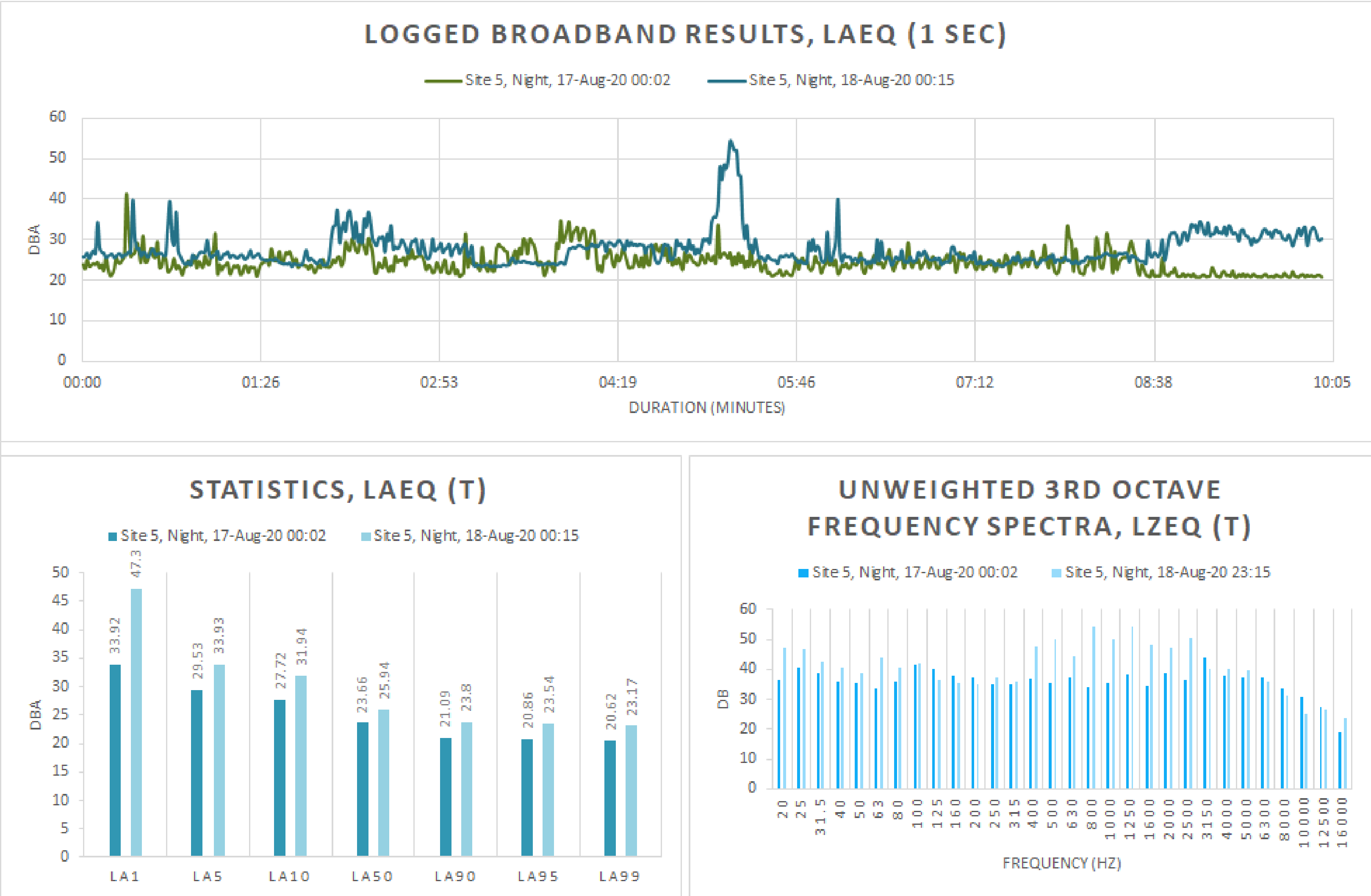

Figure 38: Detailed night -time survey results for Site 5

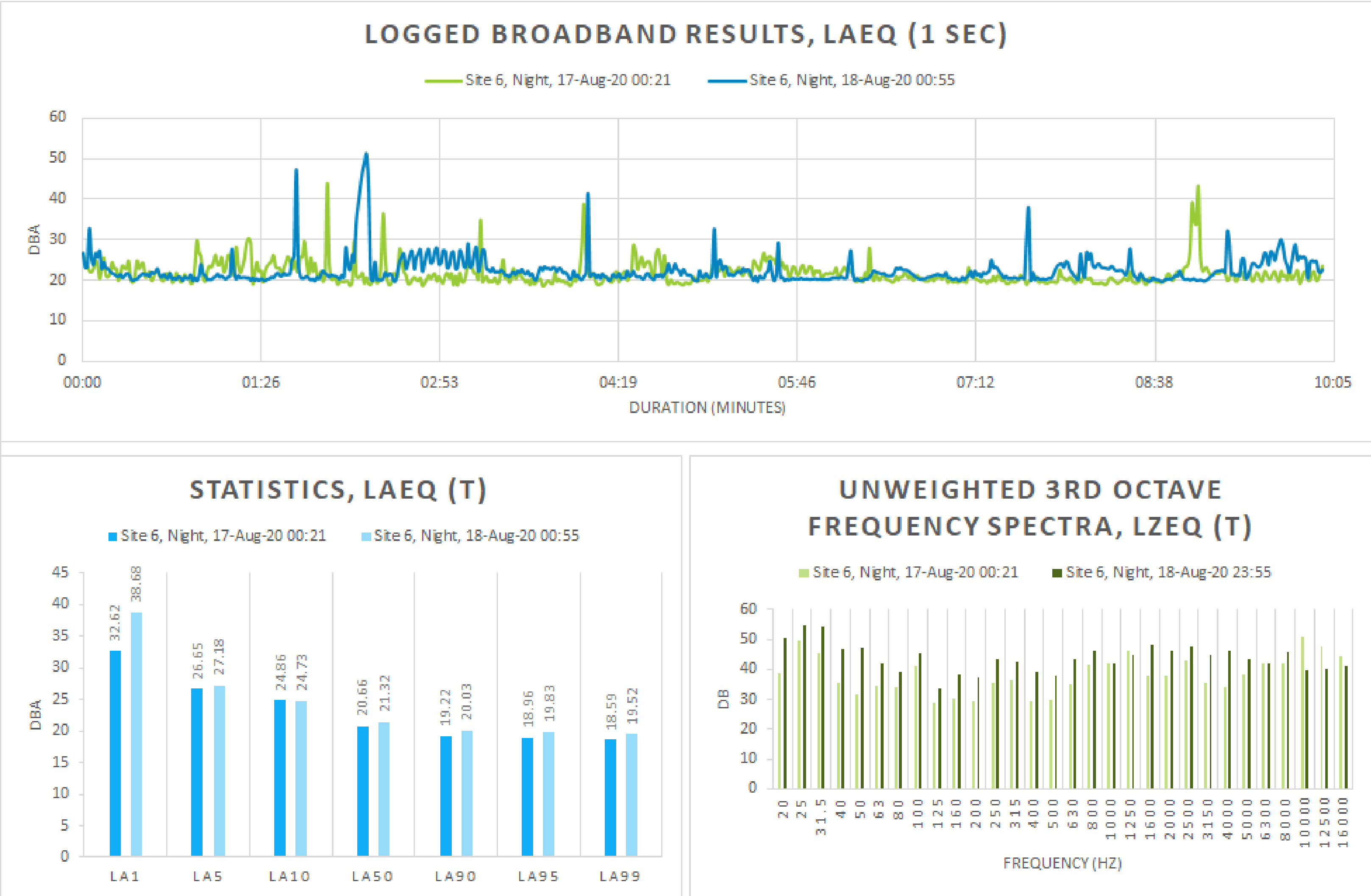

Figure 39: Detailed night -time survey results for Site 6

Appendix F – Impact Assessment Methodology

The methodology used for assessing the significance of the impact was obtained from the SLR.

PART A: DEFINITIONS AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	**L**	**M**	**H**	**VH**
INTENSITY = VL							
DURATION	Very long	**VH**	**Low**	**Low**	**Medium**	**Medium**	**High**
	Long term	**H**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Medium term	**M**	**Very Low**	**Low**	**Low**	**Low**	**Medium**
	Short term	**L**	**Very low**	**Very Low**	**Low**	**Low**	**Low**
	Very short	**VL**	**Very low**	**Very Low**	**Very Low**	**Low**	**Low**
INTENSITY = L							
DURATION	Very long	**VH**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Long term	**H**	**Low**	**Medium**	**Medium**	**Medium**	**High**
	Medium term	**M**	**Low**	**Low**	**Medium**	**Medium**	**Medium**
	Short term	**L**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Very short	**VL**	**Very low**	**Low**	**Low**	**Low**	**Medium**
INTENSITY = M							
DURATION	Very long	**VH**	**Medium**	**High**	**High**	**High**	**Very High**
	Long term	**H**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**	**Medium**	**High**
	Very short	**VL**	**Low**	**Low**	**Low**	**Medium**	**Medium**
INTENSITY = H							
DURATION	Very long	**VH**	**High**	**High**	**High**	**Very High**	**Very High**
	Long term	**H**	**Medium**	**High**	**High**	**High**	**Very High**
	Medium term	**M**	**Medium**	**Medium**	**High**	**High**	**High**
	Short term	**L**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Very short	**VL**	**Low**	**Medium**	**Medium**	**Medium**	**High**
INTENSITY = VH							
DURATION	Very long	**VH**	**High**	**High**	**Very High**	**Very High**	**Very High**
	Long term	**H**	**High**	**High**	**High**	**Very High**	**Very High**
	Medium term	**M**	**Medium**	**High**	**High**	**High**	**Very High**
	Short term	**L**	**Medium**	**Medium**	**High**	**High**	**High**
	Very short	**VL**	**Low**	**Medium**	**Medium**	**High**	**High**
			VL	**L**	**M**	**H**	**VH**
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**VH**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Probable	**H**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Possible/ frequent	**M**	**Very Low**	**Very Low**	**Low**	**Medium**	**High**
	Conceivable	**L**	**Insignificant**	**Very Low**	**Low**	**Medium**	**High**
	Unlikely/ improbable	**VL**	**Insignificant**	**Insignificant**	**Very Low**	**Low**	**Medium**
			VL	**L**	**M**	**H**	**VH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

***VH = very high, H = high, M= medium, L= low and VL= very low and + denotes a positive impact.**