# Environmental Noise Impact Assessment for the Tetra4 Cluster 2 Gas Production Project

Project done for **EIMS (Pty) Ltd**


**Report Compiled By:**
Reneé von Gruenewaldt

**Fieldwork Completed By:**
Jeffrey Moletsane



**Report No:** 21EIM08 | **Date:** June 2022



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

# Report Details

| | |
|---|---|
| **Report Title** | Environmental Noise Impact Assessment for the Tetra4 Cluster 2 Gas Production Project |
| **Client** | EIMS (Pty) Ltd |
| **Report Number** | 21EIM08 |
| **Report Version** | Rev 0.3 |
| **Date** | September 2022 |
| **Prepared by** | Reneé von Gruenewaldt (Pr. Sci. Nat), MSc (University of Pretoria) |
| **Reviewed by** | Nick Grobler, BEng (Chem), BEng (Hons) (Env) (University of Pretoria) |
| **Notice** | Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in (1) air quality impact assessments and (2) environmental noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003. |
| **Declaration** | 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. |
| **Copyright Warning** | Unless otherwise noted, the copyright in all text and other matter (including the manner of presentation) is the exclusive property of Airshed Planning Professionals (Pty) Ltd. It is a criminal offence to reproduce and/or use, without written consent, any matter, technical procedure and/or technique contained in this document. |

# Revision Record

| Version | Date | Comments |
|---|---|---|
| Rev 0 | April 2022 | For client's review |
| Rev 0.1 | April 2022 | Editorial changes |
| Rev 0.2 | June 2022 | Incorporation of client's comments |
| Rev 0.3 | September 2022 | Amendment of section 6 to include current mitigation measres |

# Glossary and Abbreviations

| | |
|---|---|
| **Airshed** | Airshed Planning Professionals (Pty) Ltd |
| **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. |
| **DMRE** | Department of Mineral Resources and Energy |
| **EA** | Environmental Authorisation |
| **EAR** | Enviro Acoustic Research |
| **EC** | European Commission |
| **EHS** | Environmental, Health, and Safety (IFC) |
| **EIA** | Environmental Impact Assessment |
| **EIMS** | EIMS (Pty) Ltd |
| **EMPr** | Environmental Management Programme |
| **GN** | Government Notice |
| **Hz** | Frequency in Hertz |
| **IEC** | International Electro Technical 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. |
| **$L_{A90}$** | 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 |
| **LNG** | Liquid Natural Gas |

| | |
|---|---|
| **$L_P$** | Sound pressure level (in dB) |
| **Ltd** | Limited |
| **$L_W$** | Sound Power Level (in dB) |
| **$m^2$** | Area in square metres |
| **m/s** | Speed in metres per second |
| **NA** | Not applicable |
| **NACA** | National Association for Clean Air |
| **NEMA** | National Environmental Management Act |
| **NEMAQA** | National Environmental Management Air Quality Act |
| **NEMWA** | National Environmental Management: Waste Act 59 of 2008 |
| **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 |
| **SAWS** | South African Weather Services |
| **SLM** | Sound Level Meter |
| **SoW** | Scope of Work |
| **STRM** | Shuttle Radar Topography Mission |
| **USGS** | United States Geological Survey |
| **WHO** | World Health Organisation |

# Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by EIMS (Pty) Ltd (EIMS) to undertake a specialist environmental noise impact study for Tetra4 Cluster 2 expansion (hereafter referred to as the project).

The main objective of the noise specialist study was to determine the significance of impacts on the acoustic environment and noise receptors (NSRs) given noise generated by activities proposed as part of the project.

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

1. A review of 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; and
    c. A short-term baseline noise survey.
4. An impact assessment, including:
    a. A source inventory for operations and activities proposed as part of the project.
    b. Noise propagation simulations to determine environmental noise levels over the selected study area and at NSRs as a result of the project.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable noise management measures and monitoring requirements.
6. Determining impact significance.
7. The preparation of a comprehensive specialist noise impact assessment report.

In the assessment of sampled and simulated noise levels, reference was made to the International Finance Corporation (IFC) noise level guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these are applicable to nearby NSRs. Annoyance was assessed according to the South African National Standard (SANS) 10103 (2008) scale.

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:

- NSRs:
    - Include places of residence and areas where members of the public may be affected by noise generated by proposed activities.
    - Potential noise sensitive receptors within the study area include individual homesteads and industrial and residential areas.
- Atmospheric conditions are more conducive to noise attenuation during the day.

- On average, noise impacts are expected to be slightly more notable to the southwest and southeast (day-time) and southwest (night-time) of the project activities.
- All the measurements indicated a site with a very complex sound character. Areas away from busy roads and mining activities are very quiet, with measurement locations closer to houses, busy roads and mining activities indicating higher sound levels. Vegetation growth closer to dwellings creates habitat, attracting birds and insects, which in turn make sounds that increases the ambient sound levels. The vegetation also increased wind-induced noises. The larger part of the study area, away from roads, dwellings and mining activities can be rated as **Rural** as per the SANS 10103:2008 criteria.

A source inventory was developed for the project. A detailed list of equipment, pumps and compressors was provided. Noise levels for the equipment were obtained from a combination of sources available in the BSI Standards: code of practice for noise and vibration control on construction and open sites (BSI, 2008), a noise source level database for similar operations (based on source measurements carried out in accordance with the procedures specified in SANS 10103) and calculations using the $L_W$ predictive equations for mobile equipment as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998).

The source inventory, local meteorological conditions and information on topography and local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 25.5 km east-west by 27 km north-south. The area was divided into a grid matrix with a 50-m resolution. The model was set to calculate $L_P$'s ($L_{Aeq}$) at each grid and discrete receptor point at a height of 1.5 m above ground level.

A summary of simulated noise levels due to project construction and operational activities area as follows:

- Construction activities:
  - Activities were specified to take place during day-time hours only
  - Exceedances of the day-time IFC noise guidelines for residential, educational, and institutional areas (55 dBA) were as follows:
    - **Wells:** Up to 400 m from activities.
    - **Pipeline:** Up to 90 m from activities.
    - **Blower Stations:** Up to 600 m from activities (this is a conservative estimate as topography was not taken into account for these predictions).
    - **Plant:** Up to 420 m from Plant area.
    - **Compressor Stations:** Up to 380 m from Compressor Station areas.
- Operational activities:
  - Activities were assumed to take place continuously (24 hours per day)
  - Exceedances of the night-time IFC noise guidelines for residential, educational, and institutional areas (45 dBA) were as follows:
    - **Blower Stations:** Up to 150 m from activities (this is a conservative estimate as topography was not taken into account for these predictions).
    - **Plant:** Up to 600 m from Plant area.
    - **Compressor Stations:** Up to 120 m from Compressor Station areas.

It is recommended that general good practice measures for managing noise as set out in this report, be adopted as part of the facility's Environmental Management Plan. In the event that noise related complaints are received short term (30-min to 24-hours in duration) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The significance of environmental noise impacts was assessed according to the methodology adopted by EIMS. The significance of project activities was found to be as follows:

- Construction activities:
  - Wells, Blower Stations and pipeline: Significance rating was **medium** without mitigation and **low** with mitigation.
  - Compressor Stations and plant: Significance rating was **low** without and with mitigation.
- Operational activities:
  - Blower Stations, Compressor Stations and plant: Significance was **low** without and with mitigation
- Decommissioning activities: Significance rating was **medium** without mitigation and **low** with mitigation.

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

# Table of Contents

# List of Tables

# List of Figures

# 1 Introduction

In 2012, a Production Right (Ref: 12/4/1/07/2/2) was granted which spans approximately 187 000 hectares for the development of natural gas (Helium and Methane) production operations around the town of Virginia in the Free State Province. Within the approval of the Production Right, the 2010 Environmental Management Programme (EMPr) was approved which is applicable to a large portion of the Production Right area (Figure 1-1).

The activities in the Production Right include:

- Continued exploration activities;
- Drilling and establishment of further production wells throughout the entire production area (260 production wells);
- Installation of intra-field pipelines throughout the entire production area (~500 km);
- Installation of boosters and main compressors; and
- Central gas processing plant (not approved in the original Environmental Impact Assessment (EIA) and approved EMPr).

On 21 September 2017, the Department of Mineral Resources and Energy (DMRE) issued an integrated environmental authorisation ("Cluster 1 EA") (reference: 12/04/07) to Tetra4 in terms of the National Environmental Management Act (NEMA). The Cluster 1 EA (as amended by Cluster 1 EA amendments dated 26 August 2019 and 1 September 2020) authorises the development of "Cluster 1" of the Project. In this EA approval, various new wells and pipelines, booster and compressor stations, a Helium and Liquid Natural Gas (LNG) Facility and associated infrastructure was approved which comprises the first gas field for development within the approved Production Right area. The Cluster 1 EA also authorises certain waste management activities as per the List of Waste Management Activities (Government Notice 921, as amended) published under the National Environmental Management: Waste Act 59 of 2008 (NEMWA).

Tetra4 now wishes to expand the natural gas operations, to be located within the approved production right area and around the Cluster 1 project (Figure 1-1). This planned expansion to the existing approved production activities will involve up to 300 new production wells, gas transmission pipelines and associated infrastructure, 3 compressor stations and an additional new combined LNG and Liquid Helium (LHe) plant ("LNG/LHe Plant") and associated infrastructure, as well as powerlines as part of the Cluster 2 expansion of the Project in order to meet the future production requirements. The Cluster 2 study area and infrastructure buffer zones are presented in Figure 1-2.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by EIMS (Pty) Ltd (EIMS) to undertake a specialist environmental noise impact study for Cluster 2 expansion (hereafter referred to as the project).

## 1.1 Study Objective

The main objective of the noise specialist study was to determine the significance of impacts on the acoustic environment and potential noise sensitive receptors (NSRs) given noise generated by activities proposed as part of the project.

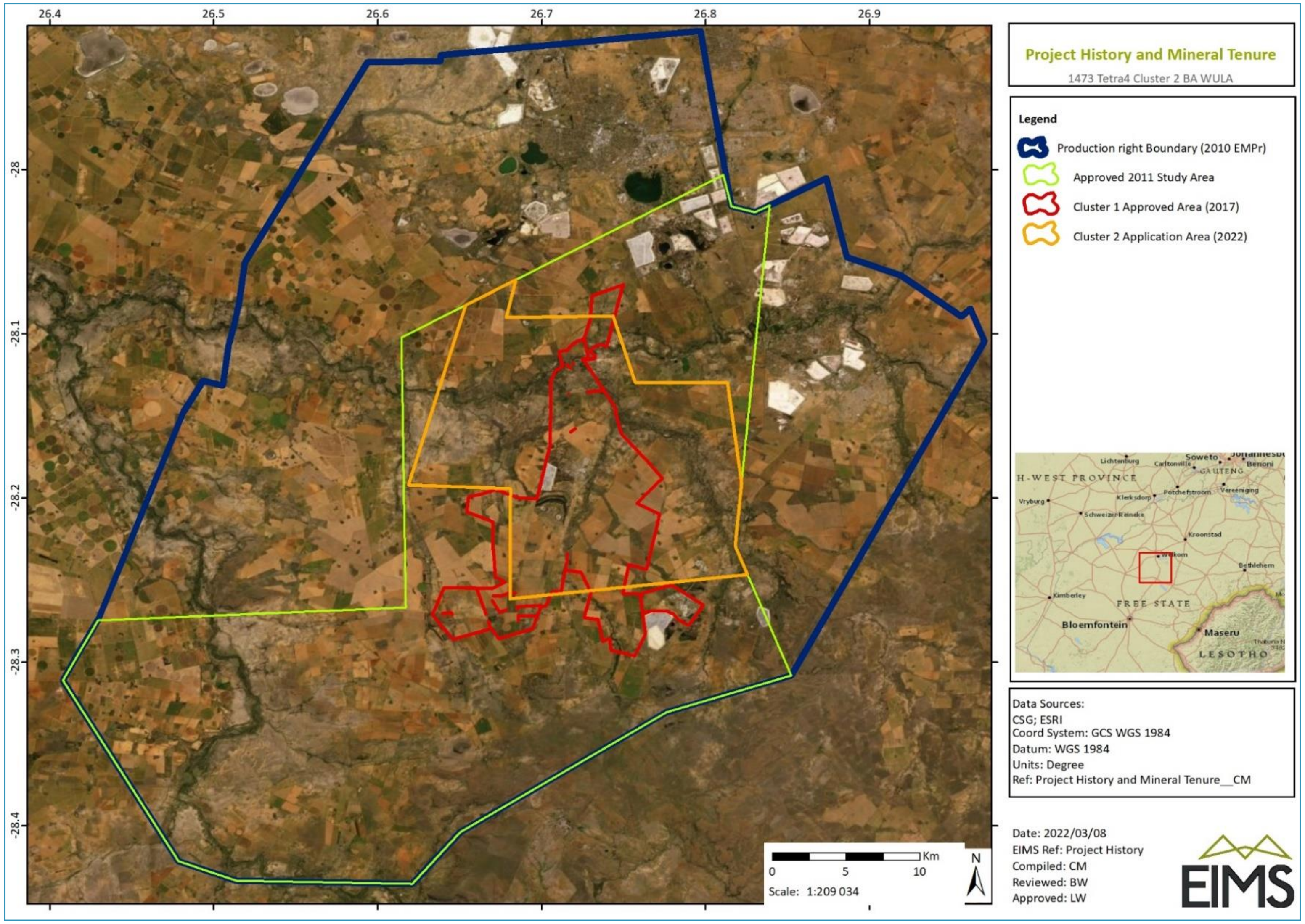



*Figure 1-1: Project history and mineral tenure*

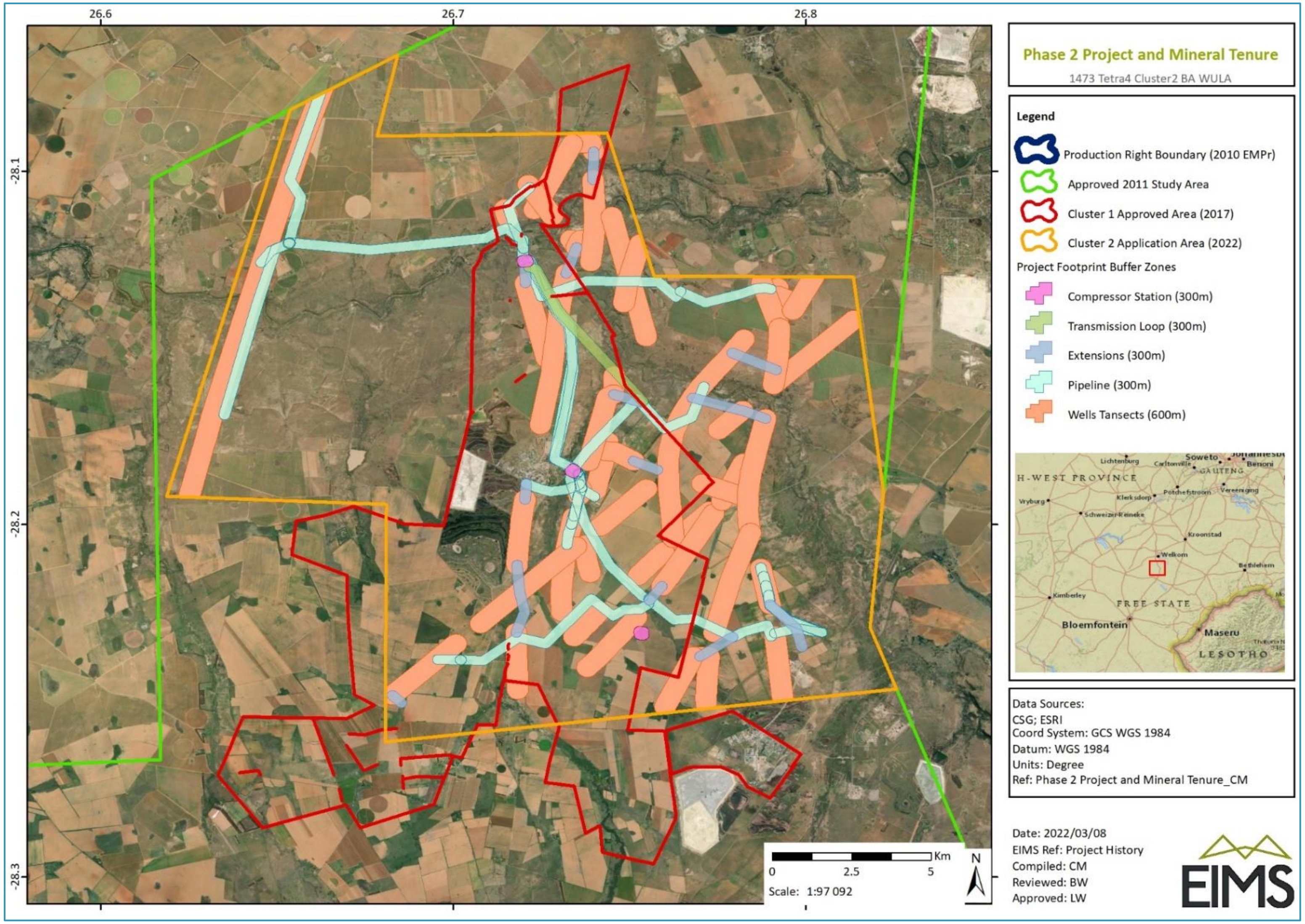



*Figure 1-2: Cluster 2 study area and proposed infrastructure footprint buffer zones*

## 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 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; and
    c. A short-term baseline noise survey.
4. An impact assessment, including:
    a. A source inventory for operations and activities proposed as part of the project.
    b. Noise propagation simulations to determine environmental noise levels over the selected study area and at NSRs as a result of the project.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable noise management measures and monitoring requirements.
6. Determining impact significance.
7. 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.

### 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.

The declaration of independence for Reneé von Gruenewaldt is provided in Appendix B.

## 1.4 Description of Activities from a Noise Perspective

### 1.4.1 Construction

Noise generating sources during construction include equipment used for activities such as land clearing, site preparation, excavation, drilling, clean-up, and landscaping.

Construction can be described or divided into distinct categories. These are earthmoving equipment, materials handling equipment, stationary equipment, impact equipment, and other types of equipment. The first three categories include machines that are powered by internal combustion engines. Machines in the latter two categories are powered pneumatically, hydraulically, or electrically. Additionally, exhaust noise tends to account for most of the noise emitted by machines in the first three categories (those that use internal combustion engines) whereas engine-related noise is usually secondary to the noise produced by the impact between impact equipment and the material on which it acts (Bugliarello, et al., 1976).

Construction and diesel mobile mining equipment generally produce noise in the lower end of the frequency spectrum. Reverse, or moving beeper alarms emit at higher frequency ranges and are often heard over long distances.

Noise generated during construction activities is highly variably since it is characterised by variations in the power expended by equipment. Besides having daily variations in activities, construction is accomplished in several different phases where each phase has a specific equipment mix depending on the work to accomplished during that phase.

### 1.4.2 Operation

Sound fields in an industrial setting, are usually complex due to the participation of many sources: propagation through air (air-borne noise), propagation through solids (structure-borne noise), diffraction at the machinery boundaries, reflection from the floor, wall, ceiling and machinery surface, absorption on the surfaces, etc. High noise levels can therefore be present in the vicinity of operating machinery. The project will include pumps, compressors, motors, cooling towers, trucks and generators. For a given machine, the sound pressure levels depend on the part of the total mechanical or electrical energy that is transformed into acoustical energy.

Piping noise associated with the movement of the LNG from blower stations and compressors to the plant are usually very localised and not considered significant.

### 1.4.3 Operational Hours

The construction activities were provided to take place during day-time hours (07:00 to 18:00). Project activities have been assumed to take place 24 hours per day.

## 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. And, 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 1-3. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-pascals (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).*

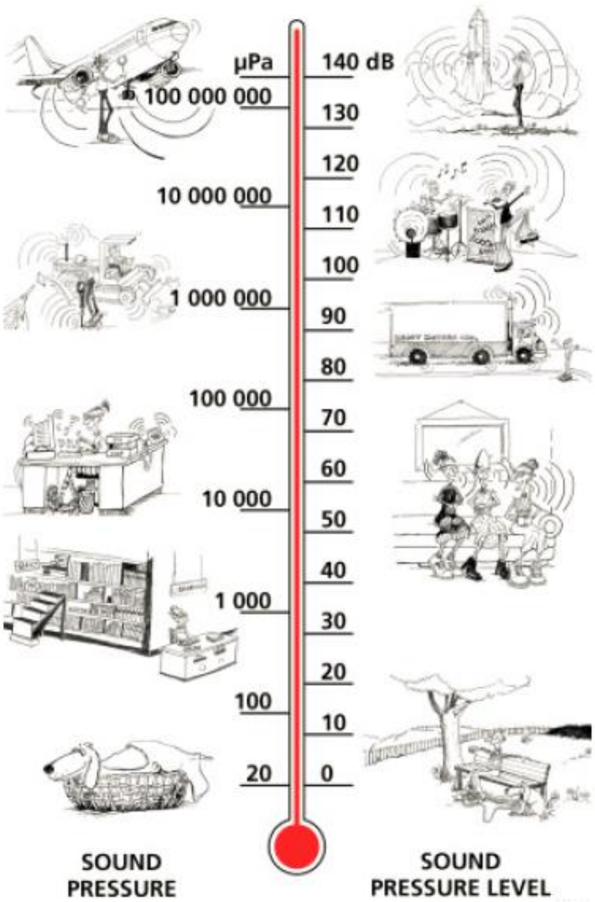



*Figure 1-3: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)*

### 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 1-4). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

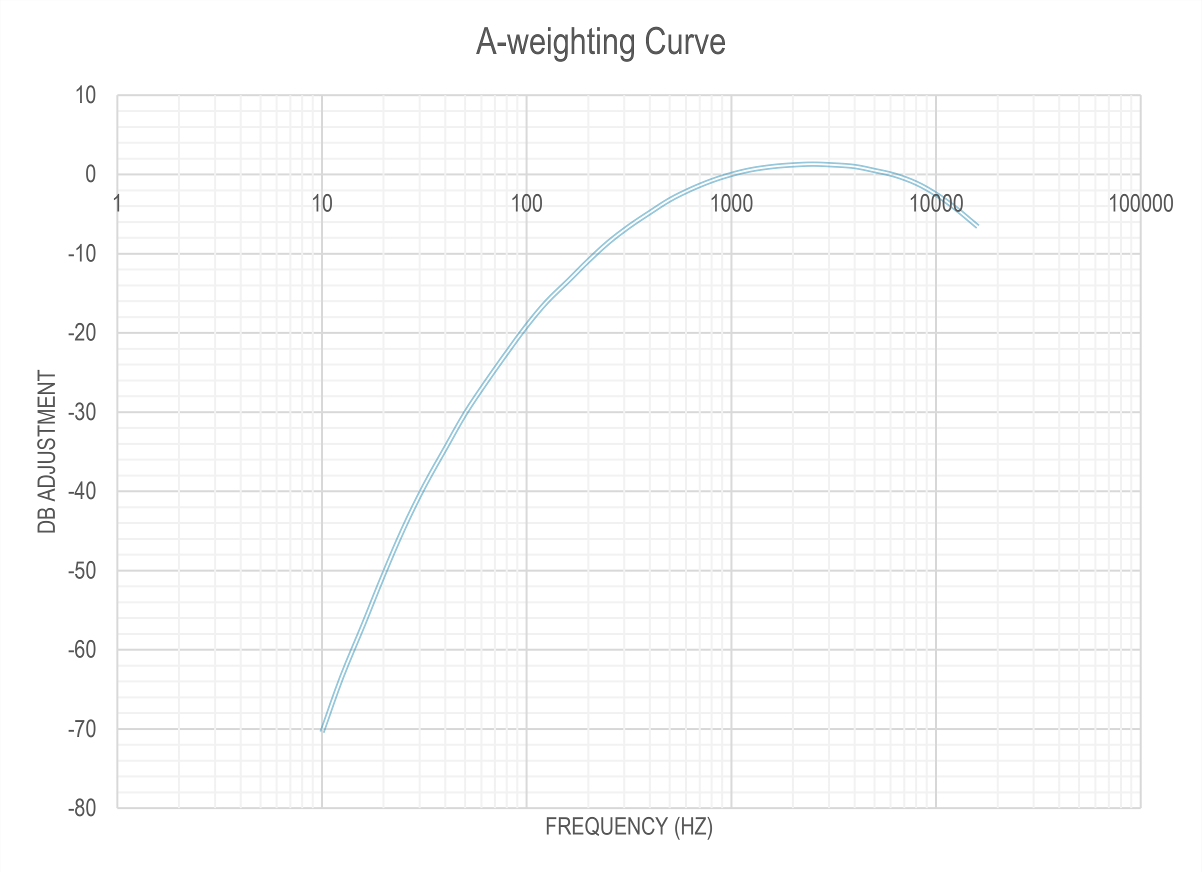



*Figure 1-4: A-weighting curve*

### 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 just simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

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

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

### 1.5.4 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:

- **$L_{Aeq}$ (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **$L_{AIeq}$ (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 the South African Bureau of Standards' (SABS) South African National Standard (SANS) 10103 of 2008 for *'The measurement and rating of environmental noise with respect to annoyance and to speech communication'* prescribes the sampling of $L_{AIeq}$ (T).
- **$L_{Req,d}$** – 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.
- **$L_{A90}$** – The A-weighted 90% statistical noise level, i.e., the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the $L_{Aeq}$ could have been in the absence of noisy single events and is considered representative of background noise levels.
- **$L_{AFmax}$** – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.
- **$L_{AFmin}$** – The minimum A-weighted noise level measured with the fast time weighting. It's the lowest level of noise that occurred during a sampling period.

## 1.6 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 $L_W$'s (noise 'emissions') and $L_P$'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

The following information was supplied for inclusion in the study:

- Layout maps;
- Process description;
- List of equipment and related power ratings;
- Throughputs;
- Energy balance; and,
- Flare parameters.

### 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, together with those published by the IFC in their *General Environmental Health and Safety (EHS) Guidelines* (IFC 2007) and World Health Organisation (WHO) *Guidelines for Community Noise* (WHO 1999), were considered in the assessment.

### 1.6.3 Noise Propagation Simulations

The propagation of noise from project 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 outdoors in order 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, such as commonly occurs at night.

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

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

Where;

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

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

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

If the dimensions of a noise source are small compared with the distance to the listener, it is called a point source. All sources of noise 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 25.5 km east-west by 27 km north-south. The area was divided into a grid matrix with a 50-m resolution. The model was set to calculate $L_P$'s ($L_{Aeq}$) at each grid and discrete receptor point at a height of 1.5 m above ground level.

### 1.6.4 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. Homesteads and residential areas included in the assessment as NSRs were identified from available maps and satellite imagery.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use, and terrain data. Atmospheric attenuation potential was described based on measured meteorological data obtained from the Welkom South African Weather Services (SAWS) station. Data for the period January 2015 to January 2022 was considered.

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/) in January 2022. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

### 1.6.5 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 by Enviro Acoustic Research (2016) and Airshed (2022) was used.

The survey methodology that Airshed applied, 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 1-1.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session.
- Samples 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).
- $L_{AIeq}$ (T), $L_{Aeq}$ (T); $L_{AFmax}$; $L_{AFmin}$; $L_{Zeq}$ (T), $L_{90}$ 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.

*Table 1-1: Sound level meter details*

| Equipment | Serial Number | Purpose | Last Calibration Date |
|---|---|---|---|
| Svantek 977 sound level meter | S/N 36183 | Noise sampling. | 1,2 March 2021 |
| Svantek 7052E ½" microphone | S/N 78692 | | |
| Svantek SV 12L ½" pre-amplifier | S/N 40659 | | |
| SVANTEK SV33 Class 1 Acoustic Calibrator | S/N 43170 | Testing of the acoustic sensitivity before and after each daily sampling session. | 2 March 2021 |

| Equipment | Serial Number | Purpose | Last Calibration Date |
|---|---|---|---|
| Kestrel 4000 Pocket Weather Tracker | S/N 559432 | Determining wind speed, temperature and humidity during sampling. | Not Applicable |

SANS 10103 (2008) prescribes the method for the calculation of the equivalent continuous rating level ($L_{Req,T}$) from measurement data. $L_{Req,T}$ is the equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during a specified time interval, plus specified adjustments for tonal character, impulsiveness of the sound and the time of day; and derived from the applicable equation:

$$L_{Req,T} = L_{Aeq,T} + C_i + C_t + K_n$$

Where

- $L_{Req,T}$ is the equivalent continuous rating level;
- $L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level, in decibels;
- $C_i$ is the impulse correction;
- $C_t$ is the correction for tonal character; and
- $K_n$ is the adjustment for the time of day (or night), 0 dB for daytime and +10 dB for night-time.

### 1.6.6 Source Inventory

To determine the change in noise impacts associated with the project, a source inventory had to be developed. A detailed list of equipment was provided and used to compile the source inventory. $L_W$'s for construction equipment were obtained from BSI Standards Publication for construction equipment (BSI, 2008). The $L_W$'s for operational equipment were calculated using predictive equations for industrial machinery as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998).

Decommissioning activities are expected to result in noise impacts similar to impacts associated with the construction phase. A source inventory was therefore only developed for the construction and operational phase of the project.

### 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 EIMS. Refer to Appendix F of this report for the methodology.

## 1.7 Management of Uncertainties

The following limitations and assumptions should be noted:

- The quantification of sources of noise was limited to the construction and operational phase of the project. Impacts due to closure phase activities are expected to be similar to construction activities and its impacts only assessed qualitatively. Noise impacts will cease post-closure.
- The source power levels were calculated based on information provided by EIMS. The assumption is that this information is correct and reflects the routine construction and operational phase of the project.
- Structural obstacles were not included in the propagation modelling of the project noise sources. This is a conservative approach as the simulated noise impacts would not be attenuated by structural obstacles.
- 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.
- The environmental noise assessment focuses on the evaluation of impacts for humans.
- The scope of work did not include a vibration assessment.

# 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.

The Noise Control Regulations were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations. The Free State Province did promulgate provincial regulations in 1998.

## 2.2 Free State Provincial Noise Control Regulations (PN 24 of 1998)

The control of noise in the Free State Province is legislated in the form of Noise Control Regulations promulgated in terms of Section 25 of the Environment Conservation Act (Act no. 73 of 1989).

These regulations provide the following definitions:

1. **"ambient sound level" -** the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation;

2. **"disturbing noise" -** a noise level that exceeds the ambient sound level measured continuously at the same measuring point by 5 dBA or more.

3. **"noise level" -** the reading on an integrating impulse sound level meter taken at a measuring point in the presence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation, and, if the alleged disturbing noise has a discernible pitch, for example, a whistle, buzz, drone or music, to which 5 dBA has been added;

In addition, the regulations also provide the following stipulations:

1. **In terms of Regulation 2 (d):**
   “A local authority may –
   before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests be conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings and that reports or certificates relating to the noise impact to the satisfaction of that local authority be submitted by the owner, developer, tenant or occupant to the local authority”;

2. **In terms of Regulation 3 (c):**

"No person shall –

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

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

## 2.3 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 2-1 are typical rating levels for different districts specified.

*Table 2-1: 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:

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

## 2.4 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 2-2**, or result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. $\Delta$ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

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

*Table 2-2: 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 |

## 2.5 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.

## 2.6 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 (Government Notice [GN] R982 as amended by GN 326 of 7 April 2017; GN 706 of 13 July 2018 and GN 320 of 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 2-3: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (Government Notice [GN] R982 as amended by GN 326 of 7 April 2017; GN 706 of 13 July 2018 and GN 320 of 20 March 2020).*

| A specialist report prepared in terms of the Environmental Impact Regulations 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<br>Appendix A |
| A declaration that the person is independent in a form as may be specified by the competent authority | Section 1.3.1<br>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<br>Section 3.3 |
| A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change | Section 3.3<br>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<br>Section 4 |
| 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<br>Section 4 |
| A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers; | Section 4 |
| 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 |
| 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 |
| 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<br>Section 6<br>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 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 |

## 2.7 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 2-4: 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 |
| • 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 with 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 |
| • 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 |
| • desired noise levels for the area. | Section 4 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 1.6.3, Section 1.6.4 and Section 4 |
| • a map showing the proposed development footprint (including supporting infrastructure) with a 50m buffered development envelope; | Figure 1-2 |
| • 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; | Section 3.3 |
| • 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. |
| • 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

NSRs generally include places of residence and areas where members of the public may be affected by noise generated by proposed activities.

Potential noise sensitive receptors within the study area (Figure 3-1) include individual homesteads and industrial and residential areas (i.e., Virginia).

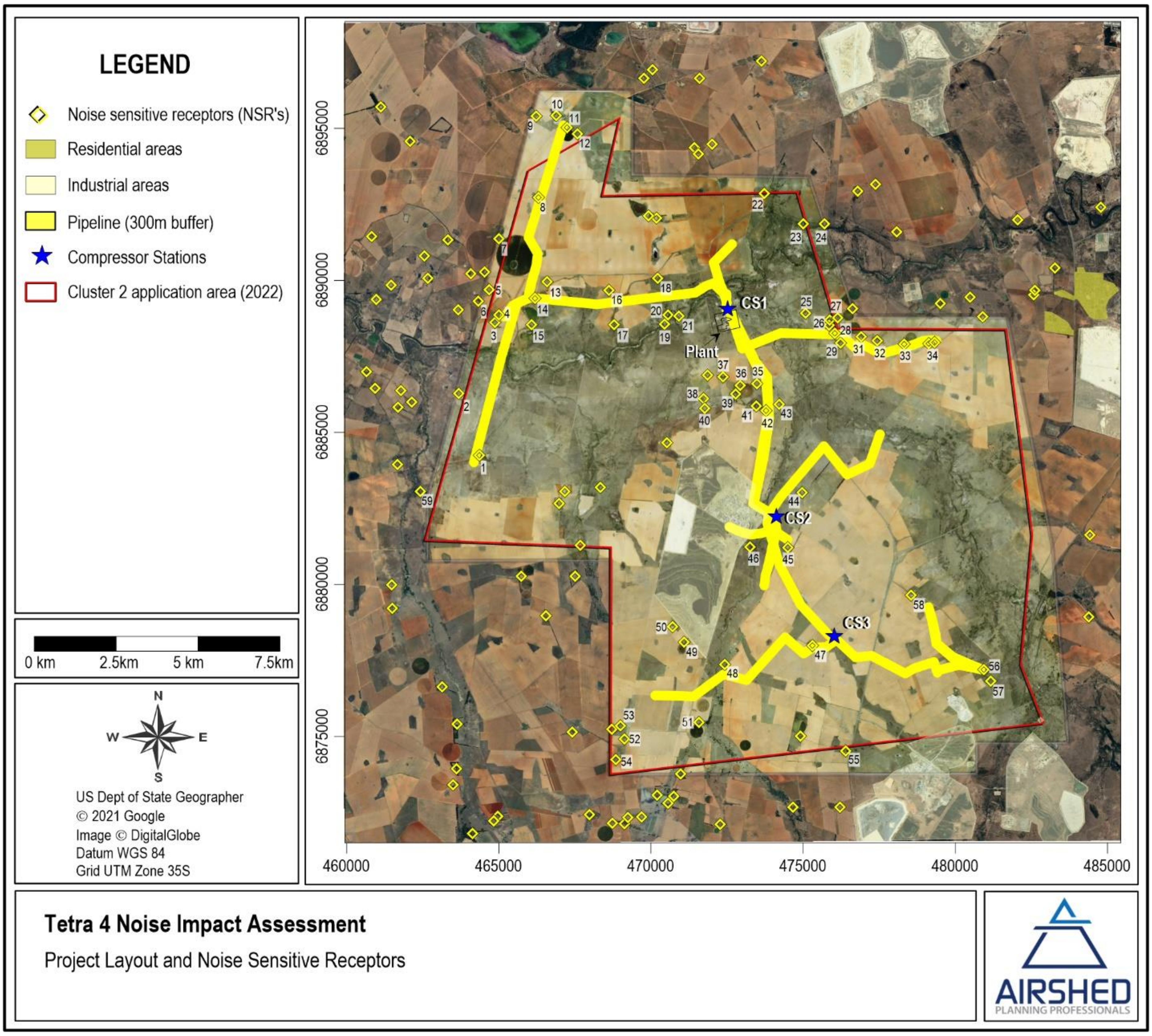



*Figure 3-1: Sensitive receptors within the study area*

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

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

Reference was made to meteorological data from the South African Weather Services (SAWS) operated station located in Welkom, for the period January 2015 to January 2022. The measured data set indicates wind flow primarily from the northeastern sector (Figure 3-2 (a)) during the day with winds also frequent from the northwestern and southwestern sectors. At night, the wind field is mostly from a northeastern sector (Figure 3-2 (b)). Calm conditions occur 2.96% of time during the day and 3.11% during the night. On average, noise impacts are expected to be slightly more notable to the southeast and southwest of the project activities during the day and to the southwest of the project activities during the night.

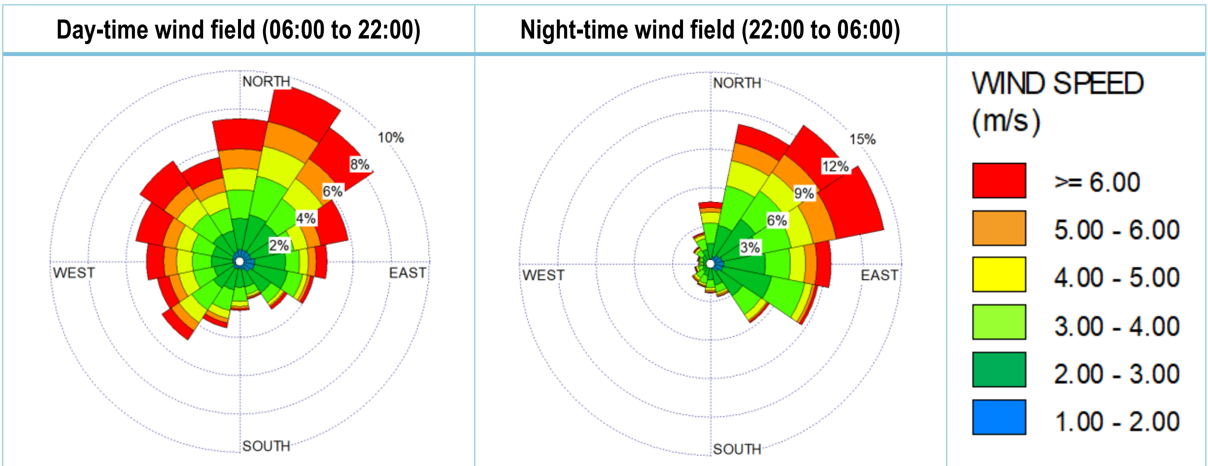



*Figure 3-2: Wind rose for SAWS data, January 2015 to January 2022*

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night (Figure 3-3). CadnaA requires the definition of both temperature and humidity. An average temperature of 18°C and a humidity of 70% were applied in simulations.

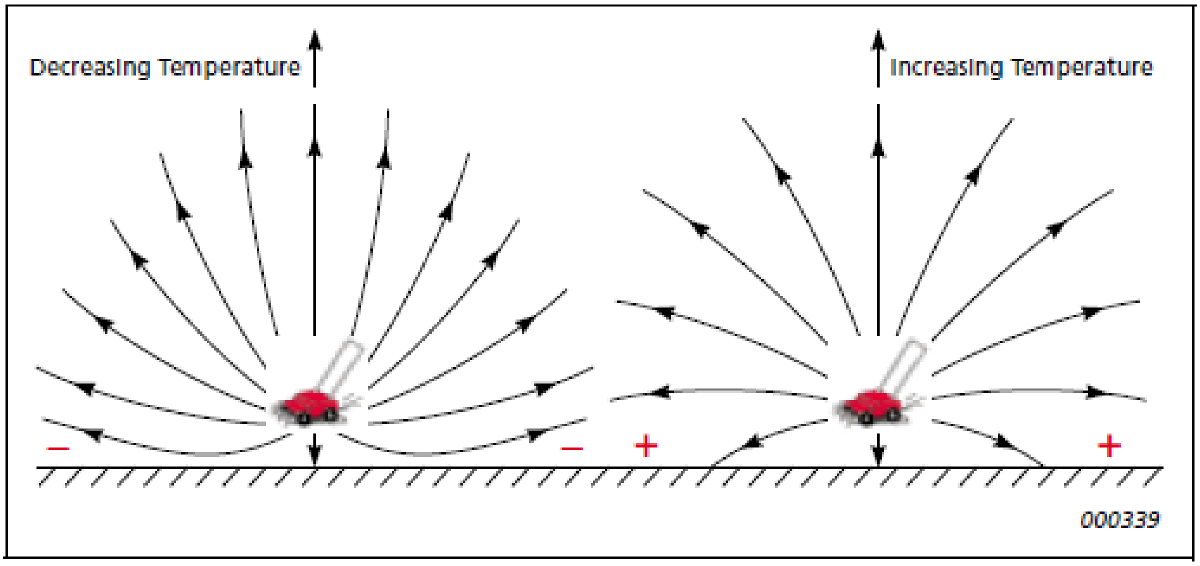



*Figure 3-3: Bending the path of sound during typical day time conditions (image provided on the left) and night-time conditions (image provided on the right)*

### 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[1] for the study area is provided in Figure 3-4.

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, ground cover was found to be acoustically mixed.

[1] SRTM1 from the United States Geological Survey at https://earthexplorer.usgs.gov

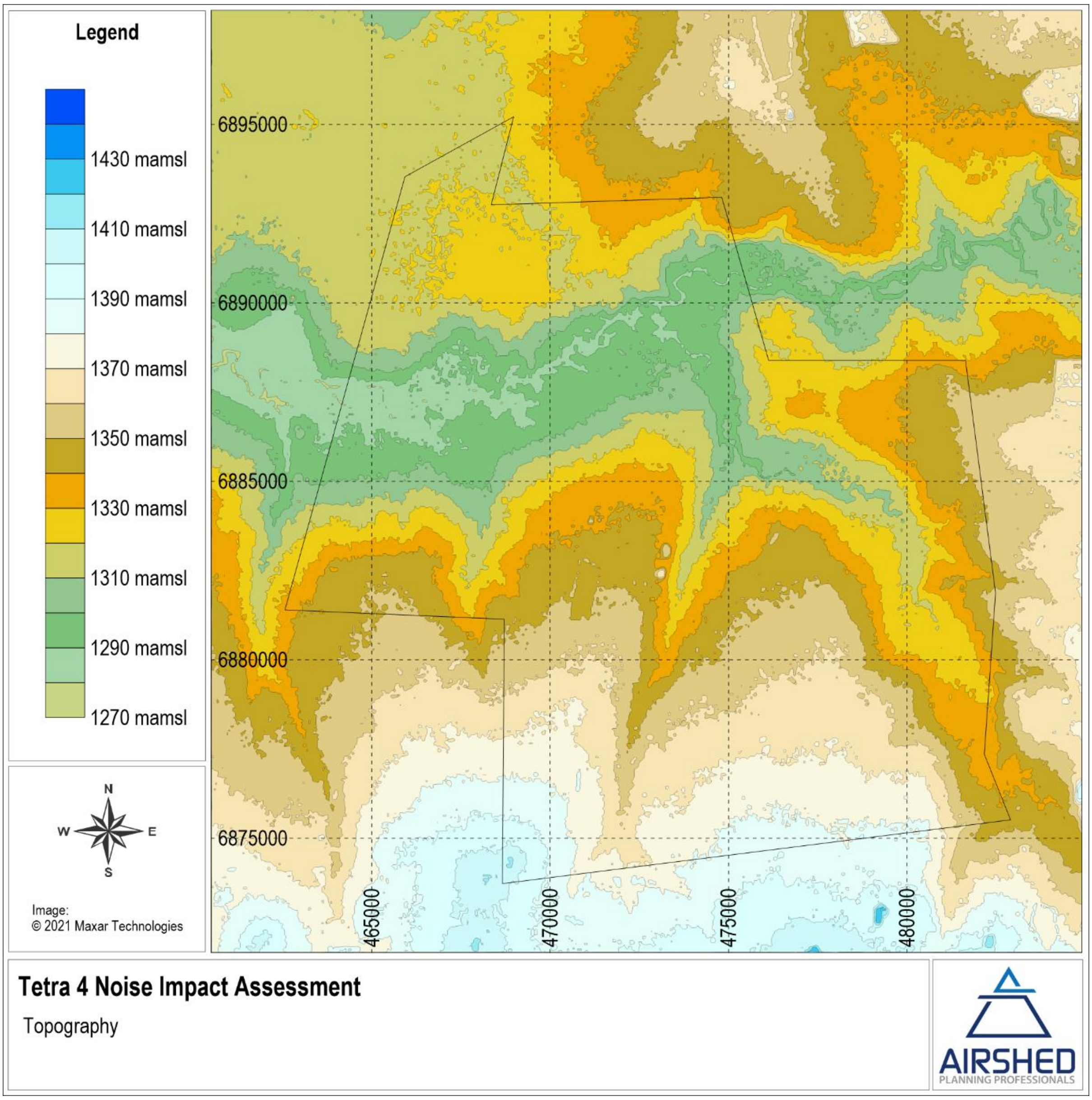



*Figure 3-4: Topography for the study area*

## 3.3 Noise Survey and Results

Sampling points for the noise survey conducted by Airshed in 2022 were selected based on proposed project activities, position of sensitive receptors and noise survey locations selected for the baseline campaign conducted in 2016 (Figure 3-5).

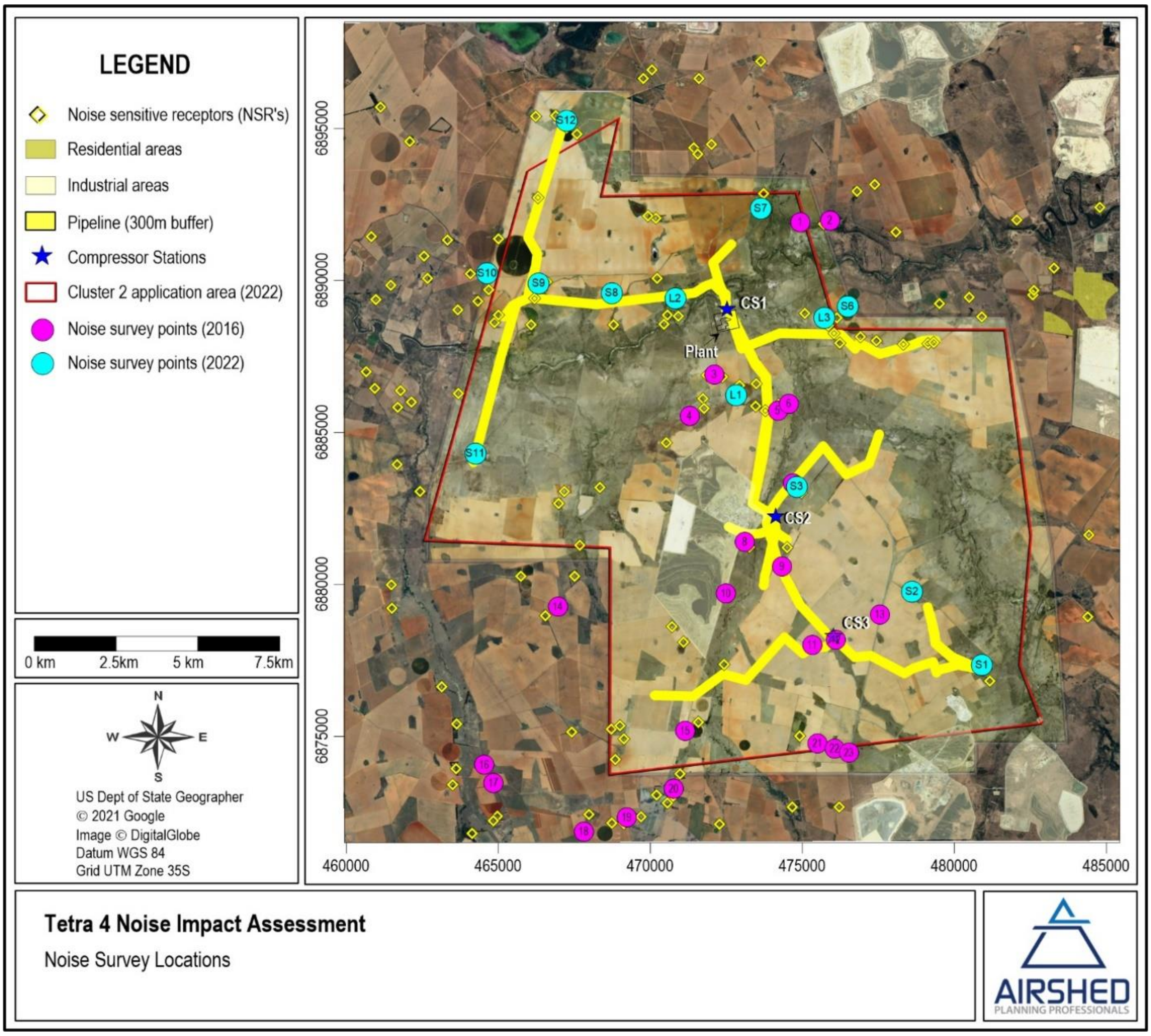



*Figure 3-5: Baseline noise survey sites*

### 3.3.1 Baseline Noise Survey Undertaken in 2016

A summary of the baseline noise levels within the study area, as measured by Enviro Acoustic Research (EAR) during March 2016 (with the exception of Site 11 which was sampled in June 2016) (De Jager, 2016), is provided in Table 3-1.

*Table 3-1: Summary of noise measurements conducted in 2016 by EAR*

| Measurement Location | Day-time | Night-time | Comment |
|---|---|---|---|
| | $L_{Aeq}$ (dBA) | $L_{Aeq}$ (dBA) | |
| 1 | 22 | | Birds and insects. Some birds fly over second measurement. Naturally quiet. |
| | 23 | | |
| | 23 | | |
| 2 | 47 | | |

| Measurement Location | Day-time LAeq (dBA) | Night-time LAeq (dBA) | Comment |
|---|---|---|---|
| | 22 | | Naturally quiet location. Birds and insects. First measurement LDV and voices. |
| 3 | 27 | | Birds and insects dominant sound. Fans or low rumble barely audible. |
| | 25 | | |
| 4 | 24 | | Typical bushveld appearance. Bird calls at times. Quite quiet. Fans audible in background. Insects audible. Impulsive sounds just audible. |
| | 23 | | |
| 5 | 56 | | Next to corrugated gravel road. Traffic on tar road clearly audible but passing cars dominating sound levels (during passing). Birds dominating during quiet periods. Wind noises with a banging noise audible in distance. Measurement 1: 6 cars (5 slow, 1 very fast). Cars generally driving slow due to condition of road, Measurement 2: 1 car racing. |
| | 54 | | |
| 6 | 69 | | Insects and birds with traffic dominating. Some wind noises. Measurement 1: 36 cars and a bus, Measurement 2: 34 cars and 3 trucks. |
| | 70 | | |
| 7 | 61 | | Fans from Beatrix shaft constant background noise. Road noises dominate with passing though few cars. Bird sounds dominant in quiet periods. Measurement 1: 16 cars in 10 min. Measurement 2: 14 cars and 1 bus. |
| | 65 | | |
| 8 | 44 | | Next to road, close to process plant. Plant fans and pumps dominant. Sounds of vehicles audible at times. Birds audible. |
| | 44 | | |
| 9 | 54 | | Next to gas borehole. Dominating sound of beeping alarm with constant sound similar to leaking gas. |
| | 54 | | |
| | 54 | | |
| 10 | 31 | | Large stand of bluegums. Birds dominate but low rumbling coming from mining area. |
| 11 | 48 | 46 | A number of 10 minute measurements were collected over a period of 2 nights from the evening of 9 to 11 June 2016.Bird and water sprayers dominated the soundscape, likely masking noise from traffic on the R30. |
| 12 | 36 | | Light wind. Birds and insects dominating. Vehicular noise from R30 constant and quite dominating. Sound of wind though maize barely audible. |
| | 37 | | |
| 13 | 78 | | Road noises dominate. Measurement 1: 110 cars and 9 trucks, Measurement 2: 134 cars and 8 trucks. |
| | 79 | | |
| 14 | 29 | | Bird sounds dominate. TLB working in distance but inaudible. Cricket or similar insect. |
| 15 | 24 | | Quiet with little activities in area. Bird sounds audible in area at times. Insects and possibly wind noises. Sound of tractor working on farmland just audible about 1000 m away. Cattle mooing in far distance. |
| | 26 | | |
| 16 | 30 | | Very quiet location close to road. Area quiet due to insufficient habitat for animals. Light wind. Bird sounds in distance. Insects. Possible wind induced noises later in measurement. Ldv passing at speed 3 min in measurement. Cows in area calling/mooing. Cow mooing max |
| | 33 | | |

| Measurement Location | Day-time $L_{Aeq}$ (dBA) | Night-time $L_{Aeq}$ (dBA) | Comment |
|---|---|---|---|
| | | | sound second measurement. Sound levels 20 - 25 dBA in quiet periods. |
| 17 | 27 | | Directly under powerline. Constant corona discharge audible. Insects and bird sounds. Light wind with gust at times. |
| | 27 | | |
| | 26 | | |
| | 27 | | |
| 18 | 27 | | Bird sounds dominate. Insects. Farming equipment in area just audible. |
| | 26 | | |
| 19 | 26 | | Birds. Some wind induced noises. Insects. Farming equipment just audible at times for undefined area. |
| | 24 | | |
| 20 | 34 | | Birds dominating but sound of farming equipment audible at times. Dove very dominant at times. |
| | 35 | | |
| 21 | 30 | | Open field around 1000 m from road. Birds dominating. Insects clearly audible. Vehicles audible during passing. Typical quiet rural area. Trucks clearly audible and distinguishable during passing. |
| | 33 | | |
| 22 | 37 | | Location around 500 m from road. No trees close. Birds' constant background sound. Vehicle sounds clearly audible and distinguishable during passing. Maximum sounds relate to bird sounds. Insect sounds at times. |
| | 36 | | |
| 23 | 73 | | 10 m from road. 2 measurements. Windless. Lots of bird sounds a constant background. A large number of massive blue gums in vicinity (20 to 30 m). Measurement 1: 45 cars and 7 trucks. Measurement 2: 46 cars and 3 trucks. |
| | 72 | | |

### 3.3.2 Baseline Noise Survey Undertaken in 2022

Survey results for the campaign undertaken on the 15 to 17 February 2022 are summarised in Table 3-2.

The study area, given the baseline measurements, can generally be rated as rural as per the SANS 10103:2008 criteria. The baseline noise measurements for the area near L3 and S6 is generally higher than the quieter surrounding farm areas where farm activities such as tractors and mining were audible. The measured day-time baseline at L3 and S6 were more typical of urban and suburban districts respectively (as per the SANS 10103:2008 criteria). Higher night-time noise measurements were observed at sites L1, L2 and L3 on 15 February where night-time patrols were more prevalent. Night-time noise measurements undertaken at these three sites on 16 February were lower and more in line with rural districts (as per the SANS 10103:2008 criteria).

For detailed time-series, frequency spectra and statistical results, the reader is referred to Appendix E.

*Table 3-2: Summary of noise measurements conducted in 2022*

| Sampling point | Visual and acoustic observations | General weather conditions | Time of day | Start date and time | Duration | LAFmax (dBA) | LAFmin (dBA) | LAeq (dBA) | LAIeq (dBA) | LA90 (dBA) |
|---|---|---|---|---|---|---|---|---|---|---|
| Site L1 | Noise sources include birds, insects, dogs and vehicle traffic. | Winds of 0.6 m/s from the NW<br>25°C<br>69% humidity<br>70% cloud cover | Day | 2022/02/15 19:01 | 00:15:01 | 54.0 | 34.1 | 40.1 | 45.1 | 37.9 |
| | | Winds of 1.4 m/s from the NW<br>24°C<br>69% humidity<br>60% cloud cover | Day | 2022/02/16 18:35 | 00:15:02 | 61.4 | 27.6 | 39.4 | 44.4 | 30.4 |
| | | Winds of 0.8 m/s from the N<br>21°C<br>70% humidity<br>60% cloud cover | Night | 2022/02/15 23:15 | 00:15:01 | 53.2 | 46.2 | 51.2 | 51.2 | 48.1 |
| | | Winds of 0.9 m/s from the NW<br>20°C<br>72% humidity<br>60% cloud cover | Night | 2022/02/16 23:35 | 00:15:01 | 55.0 | 24.0 | 37.9 | 42.9 | 29.5 |
| Site L2 | Noise sources include birds, insects, farm animals and activities and vehicle traffic. | Winds of 0.7 m/s from the NW<br>25°C<br>68% humidity<br>70% cloud cover | Day | 2022/02/15 18:29 | 00:15:02 | 53.3 | 35.0 | 41.1 | 46.1 | 37.9 |

| Sampling point | Visual and acoustic observations | General weather conditions | Time of day | Start date and time | Duration | LAFmax (dBA) | LAFmin (dBA) | LAeq (dBA) | LAleq (dBA) | LA90 (dBA) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Winds of 1.7 m/s from the NW<br>25°C<br>69% humidity<br>60% cloud cover | Day | 2022/02/16 18:06 | 00:15:03 | 63.8 | 27.6 | 47.4 | 52.4 | 36.5 |
| | | 21°C<br>70% humidity<br>70% cloud cover | Night | 2022/02/15 22:40 | 00:15:02 | 67.5 | 58.3 | 64.9 | 68.3 | 61.1 |
| | | Winds of 1.1 m/s from the NW<br>22°C<br>70% humidity<br>60% cloud cover | Night | 2022/02/16 22:03 | 00:15:02 | 59.5 | 23.0 | 43.5 | 56.5 | 29.6 |
| Site L3 | Noise sources include birds, insects, dogs and tractor activities. | Winds of 0.3 m/s from the N24°C68% humidity80% cloud cover | Day | 2022/02/15 19:37 | 00:15:01 | 59.5 | 52.3 | 57.0 | 57.0 | 55.5 |
| | | Winds of 1.2 m/s from the NW<br>23°C<br>70% humidity<br>60% cloud cover | Day | 2022/02/16 19:32 | 00:15:01 | 74.5 | 32.6 | 51.9 | 51.9 | 36.4 |
| | | 23°C<br>69% humidity<br>70% cloud cover | Night | 2022/02/15 22:03 | 00:15:01 | 60.5 | 55.6 | 58.3 | 58.3 | 56.5 |
| | | Winds of 1 m/s from the NW<br>20°C<br>72% humidity<br>60% cloud cover | Night | 2022/02/16 22:57 | 00:15:01 | 64.7 | 23.9 | 42.4 | 47.4 | 29.5 |

| Sampling point | Visual and acoustic observations | General weather conditions | Time of day | Start date and time | Duration | LAFmax (dBA) | LAFmin (dBA) | LAeq (dBA) | LAIeq (dBA) | LA90 (dBA) |
|---|---|---|---|---|---|---|---|---|---|---|
| Site S1 | Noise sources include birds, insects, farm animals and activities and vehicle traffic. | Winds of 3.4 m/s from the NW<br>26°C<br>50% humidity<br>40% cloud cover | Day | 2022/02/16 09:44 | 00:10:02 | 62.4 | 32.4 | 40.2 | 45.2 | 35.7 |
| Site S2 | Noise sources include birds and insects. | Winds of 2.4 m/s from the NW<br>24°C<br>50% humidity<br>20% cloud cover | Day | 2022/02/16 10:16 | 00:10:01 | 55.4 | 33.9 | 41.5 | 46.5 | 37.6 |
| Site S3 | Noise sources include birds, insects, vehicle traffic and mining activities. | Winds of 3.1 m/s from the NW<br>25°C<br>57% humidity<br>40% cloud cover | Day | 2022/02/16 11:01 | 00:10:01 | 67.3 | 32.2 | 43.5 | 48.5 | 34.5 |
| Site S6 | Noise sources include birds and vehicle traffic. | Winds of 3.5 m/s from the NW<br>30°C<br>58% humidity<br>60% cloud cover | Day | 2022/02/16 11:55 | 00:10:01 | 71 | 38.9 | 47.9 | 47.9 | 41.4 |
| Site S7 | Noise sources include birds, insects and farm animals. | Winds of 3.7 m/s from the NW<br>30°C<br>58% humidity<br>70% cloud cover | Day | 2022/02/16 12:28 | 00:10:01 | 56.9 | 33.8 | 41.3 | 46.3 | 36 |
| Site S8 | Noise sources include birds. | Winds of 2.8 m/s from the NW<br>31°C<br>68% humidity<br>70% cloud cover | Day | 2022/02/16 12:58 | 00:10:03 | 66.3 | 29.3 | 39 | 44 | 33.3 |

| Sampling point | Visual and acoustic observations | General weather conditions | Time of day | Start date and time | Duration | LAFmax (dBA) | LAFmin (dBA) | LAeq (dBA) | LAIeq (dBA) | LA90 (dBA) |
|---|---|---|---|---|---|---|---|---|---|---|
| Site S9 | Noise sources include birds and children. | Winds of 3.7 m/s from the NW<br>27°C<br>60% humidity<br>70% cloud cover | Day | 2022/02/16 13:27 | 00:10:01 | 69.9 | 27.1 | 42.2 | 47.2 | 30.7 |
| Site S10 | Noise sources include birds, vehicle traffic and people talking. | Winds of 1.4 m/s from the NE<br>24°C<br>58% humidity | Day | 2022/02/17 07:37 | 00:10:05 | 61.9 | 32.5 | 46 | 51 | 38.8 |
| Site S11 | Noise sources include birds, insects, farm animals and vehicle traffic. | Winds of 1.8 m/s from the NE<br>25°C<br>59% humidity<br>10% cloud cover | Day | 2022/02/17 08:10 | 00:10:27 | 63.3 | 28.8 | 40.7 | 45.7 | 31.1 |
| Site S12 | Noise sources include birds, farm animals and farm activities. | Winds of 1.2 m/s from the NE<br>29°C<br>54% humidity | Day | 2022/02/17 08:59 | 00:10:02 | 67.3 | 33.1 | 45.3 | 50.3 | 36 |

### 3.3.3 General Noise Survey Conclusions

All the measurements indicated a site with a very complex sound character. Areas away from busy roads and mining activities are very quiet, with measurement locations closer to houses, busy roads and mining activities indicating higher sound levels. Vegetation growth closer to dwellings creates habitat, attracting birds and insects, which in turn make sounds that increases the ambient sound levels. The vegetation also increased wind-induced noises. The larger study area, away from roads, dwellings and mining activities can be rated as **Rural** as per the SANS 10103:2008 criteria.

# 4 Impact Assessment

The noise source inventory, noise propagation modelling and results for the construction and operational phase of the project are discussed in the following section.

## 4.1 Construction Phase

Construction activities will take place during day-time hours only (07:00 to 18:00) with a one-hour lunch break.

### 4.1.1 Noise Sources and Sound Power Levels

The list of construction equipment was provided for the current assessment (Table 4-1). Source noise levels for construction equipment were obtained from a combination of sources available in the BSI Standards: code of practice for noise and vibration control on construction and open sites (BSI, 2008), a noise source level database for similar operations (based on source measurements carried out in accordance with the procedures specified in SANS 10103) and calculations using the $L_W$ predictive equations for mobile equipment (Bruce & Moritz, 1998).

The source noise levels obtained from the BSI standards (at a distance of 10 m) are provided in Table 4-2 with the equivalent noise source levels at source provided in Table 4-3.

*Table 4-1: List of noise sources for the project construction activities*

| Area | Description | No. of units |
|---|---|---|
| **Construction of Wells** | Dozer | 1 |
| | Tracked excavator | 1 |
| | Grader | 1 |
| | Water bowser discharging | 1 |
| | Tractor towing water bowser | 1 |
| | Truck with trailer | 1 |
| | Cable percussion drilling rig | 1 |
| **Construction of Pipeline** | Back-actor | 1 |
| | Truck mounted crane (high-up) | 1 |
| | Compactor | 1 |
| | Tracked excavator | 1 |
| | Grader | 1 |
| | Ditcher/Digging wheel | 1 |
| | Backhoe (TLB) | 2 |
| **Construction of Plant** | Dozer | 2 |
| | Tracked excavator | 4 |
| | Grader | 2 |
| | Water bowser discharging | 2 |
| | Tractor towing water bowser | 1 |

| Area | Description | No. of units |
|---|---|---|
| | Hauling: Dump truck | 2 |
| | Backhoe (TLB) | 4 |
| | Truck mounted crane (high-up) | 1 |
| | Rough terrain / telescope crane | 1 |
| | Compactor | 1 |
| | Forklift | 2 |
| | Low-bed/flat-bed truck | 2 |
| | Pre-cast concrete piling – hydraulic hammer | 1 |
| | Concrete mixer truck | 4 |
| **Construction of Compressor/ Blower Stations** | Dozer | 1 |
| | Tracked excavator | 1 |
| | Grader | 1 |
| | Water bowser discharging | 1 |
| | Tractor towing water bowser | 1 |
| | Hauling: Dump truck | 1 |
| | Backhoe (TLB) | 1 |
| | Truck mounted crane (high-up) | 1 |
| | Rough terrain / telescope crane | 1 |
| | Compactor | 1 |
| | Forklift | 1 |
| | Low-bed/flat-bed truck | 1 |
| | Pre-cast concrete piling – hydraulic hammer | 1 |
| | Concrete mixer truck | 1 |

*Table 4-2: Sound level data for the construction equipment as obtained from the BSI standard (BSI, 2014)*

| Area | Description | Octave band sound pressure levels at 10m, Hz | | | | | | | | A-weighted sound pressure level, $L_{Aeq,T}$, dB at 10m |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| **Construction of Wells** | Dozer | 89 | 90 | 81 | 73 | 74 | 70 | 68 | 64 | 80 |
| | Tracked excavator | 75 | 84 | 78 | 74 | 70 | 68 | 64 | 61 | 77 |
| | Grader | 88 | 87 | 83 | 79 | 84 | 78 | 74 | 65 | 86 |
| | Water bowser discharging | 80 | 81 | 75 | 79 | 73 | 74 | 70 | 65 | 81 |
| | Tractor towing water bowser | 78 | 86 | 84 | 78 | 78 | 77 | 70 | 69 | 83* |
| | Truck with trailer | 88 | 90 | 80 | 79 | 76 | 71 | 65 | 61 | 81 |
| | Cable percussion drilling rig | 77 | 77 | 67 | 66 | 70 | 68 | 62 | 56 | 74 |
| **Construction of Pipeline** | Truck mounted crane (high-up) | 87 | 86 | 77 | 73 | 75 | 72 | 67 | 59 | 79 |
| | Compactor | 81 | 76 | 72 | 73 | 72 | 72 | 68 | 63 | 78 |
| | Tracked excavator | 75 | 84 | 78 | 74 | 70 | 68 | 64 | 61 | 77 |
| | Grader | 88 | 87 | 83 | 79 | 84 | 78 | 74 | 65 | 86 |
| | Backhoe (TLB) | 68 | 67 | 63 | 62 | 62 | 61 | 54 | 47 | 67 |
| **Construction of Plant** | Dozer | 89 | 90 | 81 | 73 | 74 | 70 | 68 | 64 | 80 |
| | Tracked excavator | 75 | 84 | 78 | 74 | 70 | 68 | 64 | 61 | 77 |
| | Grader | 88 | 87 | 83 | 79 | 84 | 78 | 74 | 65 | 86 |
| | Water bowser discharging | 80 | 81 | 75 | 79 | 73 | 74 | 70 | 65 | 81 |
| | Tractor towing water bowser | 78 | 86 | 84 | 78 | 78 | 77 | 70 | 69 | 83 |
| | Hauling: Dump truck | 86 | 79 | 79 | 79 | 79 | 84 | 69 | 60 | 87 |
| | Backhoe (TLB) | 68 | 67 | 63 | 62 | 62 | 61 | 54 | 47 | 67 |
| | Truck mounted crane (high-up) | 87 | 86 | 77 | 73 | 75 | 72 | 67 | 59 | 79 |
| | Rough terrain / telescope crane | 78 | 69 | 67 | 64 | 62 | 57 | 49 | 40 | 67 |
| | Compactor | 81 | 76 | 72 | 73 | 72 | 72 | 68 | 63 | 78 |
| | Pre-cast concrete piling – hydraulic hammer | 82 | 82 | 82 | 89 | 83 | 78 | 75 | 70 | 89 |
| | Concrete mixer truck | 83 | 74 | 66 | 69 | 70 | 78 | 60 | 55 | 80 |
| **Construction of Compressor/ Blower Stations** | Dozer | 89 | 90 | 81 | 73 | 74 | 70 | 68 | 64 | 80 |
| | Tracked excavator | 75 | 84 | 78 | 74 | 70 | 68 | 64 | 61 | 77 |
| | Grader | 88 | 87 | 83 | 79 | 84 | 78 | 74 | 65 | 86 |
| | Water bowser discharging | 80 | 81 | 75 | 79 | 73 | 74 | 70 | 65 | 81 |

| Area | Description | Octave band sound pressure levels at 10m, Hz | | | | | | | | A-weighted sound pressure level, $L_{Aeq, T}$, dB at 10m |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| | Tractor towing water bowser | 78 | 86 | 84 | 78 | 78 | 77 | 70 | 69 | 83 |
| | Hauling: Dump truck | 86 | 79 | 79 | 79 | 79 | 84 | 69 | 60 | 87 |
| | Backhoe (TLB) | 68 | 67 | 63 | 62 | 62 | 61 | 54 | 47 | 67 |
| | Truck mounted crane (high-up) | 87 | 86 | 77 | 73 | 75 | 72 | 67 | 59 | 79 |
| | Rough terrain / telescope crane | 78 | 69 | 67 | 64 | 62 | 57 | 49 | 40 | 67 |
| | Compactor | 81 | 76 | 72 | 73 | 72 | 72 | 68 | 63 | 78 |
| | Pre-cast concrete piling – hydraulic hammer | 82 | 82 | 82 | 89 | 83 | 78 | 75 | 70 | 89 |
| | Concrete mixer truck | 83 | 74 | 66 | 69 | 70 | 78 | 60 | 55 | 80 |

*Table 4-3: Sound power level ($L_w$) estimates at source for the construction phase*

| Area | Description | Type | Octave band sound pressure levels, Hz | | | | | | | | A-weighted sound pressure level, $L_{Aeq, T}$, dB at source | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | | |
| **Construction of Wells** | Dozer | Lw | 120 | 121 | 112 | 104 | 105 | 101 | 99 | 95 | 111.1 | Calculated based on BSI (2014) at 10m |
| | Tracked excavator | Lw | 106 | 115 | 109 | 105 | 101 | 99 | 95 | 92 | 107.9 | Calculated based on BSI (2014) at 10m |
| | Grader | Lw | 119 | 118 | 114 | 110 | 115 | 109 | 105 | 96 | 117.5 | Calculated based on BSI (2014) at 10m |
| | Water bowser discharging | Lw | 110 | 112 | 106 | 110 | 104 | 105 | 101 | 96 | 111.6 | Calculated based on BSI (2014) at 10m |
| | Tractor towing water bowser | Lw | 109 | 117 | 115 | 109 | 109 | 108 | 101 | 100 | 114.5 | Calculated based on BSI (2014) at 10m |
| | Truck with trailer | Lw | 119 | 121 | 111 | 110 | 107 | 102 | 96 | 92 | 112.4 | Calculated based on BSI (2014) at 10m |
| | Cable percussion drilling rig | Lw | 108 | 108 | 98 | 97 | 101 | 99 | 93 | 87 | 104.9 | Calculated based on BSI (2014) at 10m |
| **Construction of Pipeline** | Back-actor | Lw | 113 | 111.2 | 103.6 | 101.3 | 97.6 | 93.8 | 89 | | 103.7 | Measurement Database |
| | Truck mounted crane (high-up) | Lw | 118 | 117 | 108 | 104 | 106 | 103 | 98 | 90 | 110.4 | Calculated based on BSI (2014) at 10m |

| Area | Description | Type | Octave band sound pressure levels, Hz | | | | | | | | A-weighted sound pressure level, $L_{Aeq,T}$, dB at source | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | | |
| | Compactor | $L_W$ | 112 | 107 | 103 | 104 | 103 | 103 | 99 | 94 | 108.7 | Calculated based on BSI (2014) at 10m |
| | Tracked excavator | $L_W$ | 106 | 115 | 109 | 105 | 101 | 99 | 95 | 92 | 107.9 | Calculated based on BSI (2014) at 10m |
| | Grader | $L_W$ | 119 | 118 | 114 | 110 | 115 | 109 | 105 | 96 | 117.5 | Calculated based on BSI (2014) at 10m |
| | Ditcher/Digging wheel | $L_W$ | 115.5 | 120.5 | 123.5 | 118.5 | 116.5 | 113.5 | 107.5 | 101.5 | 121.8 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Backhoe (TLB) | $L_W$ | 99 | 98 | 94 | 93 | 93 | 92 | 85 | 78 | 97.8 | Calculated based on BSI (2014) at 10m |
| **Construction of Plant** | Dozer | $L_W$ | 120 | 121 | 112 | 104 | 105 | 101 | 99 | 95 | 111.1 | Calculated based on BSI (2014) at 10m |
| | Tracked excavator | $L_W$ | 106 | 115 | 109 | 105 | 101 | 99 | 95 | 92 | 107.9 | Calculated based on BSI (2014) at 10m |
| | Grader | $L_W$ | 119 | 118 | 114 | 110 | 115 | 109 | 105 | 96 | 117.5 | Calculated based on BSI (2014) at 10m |
| | Water bowser discharging | $L_W$ | 110 | 112 | 106 | 110 | 104 | 105 | 101 | 96 | 111.6 | Calculated based on BSI (2014) at 10m |
| | Tractor towing water bowser | $L_W$ | 109 | 117 | 115 | 109 | 109 | 108 | 101 | 100 | 114.5 | Calculated based on BSI (2014) at 10m |
| | Hauling: Dump truck | $L_W$ | 117 | 110 | 110 | 110 | 110 | 115 | 100 | 91 | 117.7 | Calculated based on BSI (2014) at 10m |
| | Backhoe (TLB) | $L_W$ | 99 | 98 | 94 | 93 | 93 | 92 | 85 | 78 | 97.8 | Calculated based on BSI (2014) at 10m |
| | Truck mounted crane (high-up) | $L_W$ | 118 | 117 | 108 | 104 | 106 | 103 | 98 | 90 | 110.4 | Calculated based on BSI (2014) at 10m |
| | Rough terrain / telescope crane | $L_W$ | 111.8 | 116.8 | 119.8 | 114.8 | 112.8 | 109.8 | 103.8 | 97.8 | 118.1 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Compactor | $L_W$ | 112 | 107 | 103 | 104 | 103 | 103 | 99 | 94 | 108.7 | Calculated based on BSI (2014) at 10m |
| | Forklift | $L_W$ | 105.6 | 110.6 | 113.6 | 108.6 | 106.6 | 103.6 | 97.6 | 91.6 | 111.8 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Low-bed/flat-bed truck | $L_W$ | 113.1 | 118.1 | 121.1 | 116.1 | 114.1 | 111.1 | 105.1 | 99.1 | 119.4 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Pre-cast concrete piling – hydraulic hammer | $L_W$ | 113 | 113 | 113 | 120 | 114 | 109 | 106 | 101 | 119.7 | Calculated based on BSI (2014) at 10m |
| | Concrete mixer truck | $L_W$ | 114 | 105 | 97 | 100 | 101 | 109 | 91 | 86 | 111 | Calculated based on BSI (2014) at 10m |
| **Construction of Compressor/ Blower Stations** | Dozer | $L_W$ | 120 | 121 | 112 | 104 | 105 | 101 | 99 | 95 | 111.1 | Calculated based on BSI (2014) at 10m |
| | Tracked excavator | $L_W$ | 106 | 115 | 109 | 105 | 101 | 99 | 95 | 92 | 107.9 | Calculated based on BSI (2014) at 10m |
| | Grader | $L_W$ | 119 | 118 | 114 | 110 | 115 | 109 | 105 | 96 | 117.5 | Calculated based on BSI (2014) at 10m |
| | Water bowser discharging | $L_W$ | 110 | 112 | 106 | 110 | 104 | 105 | 101 | 96 | 111.6 | Calculated based on BSI (2014) at 10m |
| | Tractor towing water bowser | $L_W$ | 109 | 117 | 115 | 109 | 109 | 108 | 101 | 100 | 114.5 | Calculated based on BSI (2014) at 10m |
| | Hauling: Dump truck | $L_W$ | 117 | 110 | 110 | 110 | 110 | 115 | 100 | 91 | 117.7 | Calculated based on BSI (2014) at 10m |

| Area | Description | Type | Octave band sound pressure levels, Hz | | | | | | | | A-weighted sound pressure level, $L_{Aeq, T}$, dB at source | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | | |
| | Backhoe (TLB) | $L_W$ | 99 | 98 | 94 | 93 | 93 | 92 | 85 | 78 | 97.8 | Calculated based on BSI (2014) at 10m |
| | Truck mounted crane (high-up) | $L_W$ | 118 | 117 | 108 | 104 | 106 | 103 | 98 | 90 | 110.4 | Calculated based on BSI (2014) at 10m |
| | Rough terrain / telescope crane | $L_W$ | 111.8 | 116.8 | 119.8 | 114.8 | 112.8 | 109.8 | 103.8 | 97.8 | 118.1 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Compactor | $L_W$ | 112 | 107 | 103 | 104 | 103 | 103 | 99 | 94 | 108.7 | Calculated based on BSI (2014) at 10m |
| | Forklift | $L_W$ | 105.6 | 110.6 | 113.6 | 108.6 | 106.6 | 103.6 | 97.6 | 91.6 | 111.8 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Low-bed/flat-bed truck | $L_W$ | 113.1 | 118.1 | 121.1 | 116.1 | 114.1 | 111.1 | 105.1 | 99.1 | 119.4 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Pre-cast concrete piling – hydraulic hammer | $L_W$ | 113 | 113 | 113 | 120 | 114 | 109 | 106 | 101 | 119.7 | Calculated based on BSI (2014) at 10m |
| | Concrete mixer truck | $L_W$ | 114 | 105 | 97 | 100 | 101 | 109 | 91 | 86 | 111 | Calculated based on BSI (2014) at 10m |

### 4.1.2 Noise Propagation and Simulated Noise Levels

The propagation of noise was calculated with CadnaA in accordance with ISO 9613. Meteorological and site-specific acoustic parameters as discussed in Section 3.2, along with source data discussed in Section 4.1.1, were applied in the model. Results are presented in tabular form at NSRs within the study area, as isopleths and as profile graphs were applicable.

#### *4.1.2.1 Proposed Wells*

The exact location of the wells will only be determined during the exploration phase as more data becomes available to guide the positioning of further wells. The construction site for the wells was assumed to be 30m x 30m for equipment movement and setup. The final size applied for now, after the noise impact assessment was completed, is 50m x 50m. The impact distance from construction site, however, will remain the same for both areas.

Simulated day-time noise levels due to well construction activities as a function of distance are shown in Figure 4-1. IFC day-time noise guidelines for residential areas (55 dBA) are exceeded up to 400 m from the well construction sites. As construction will only take place during day-time hours and will be of limited duration, NSRs within 400m radius of all well construction sites should be notified of the activities and potential disturbance durations prior to construction taking place.

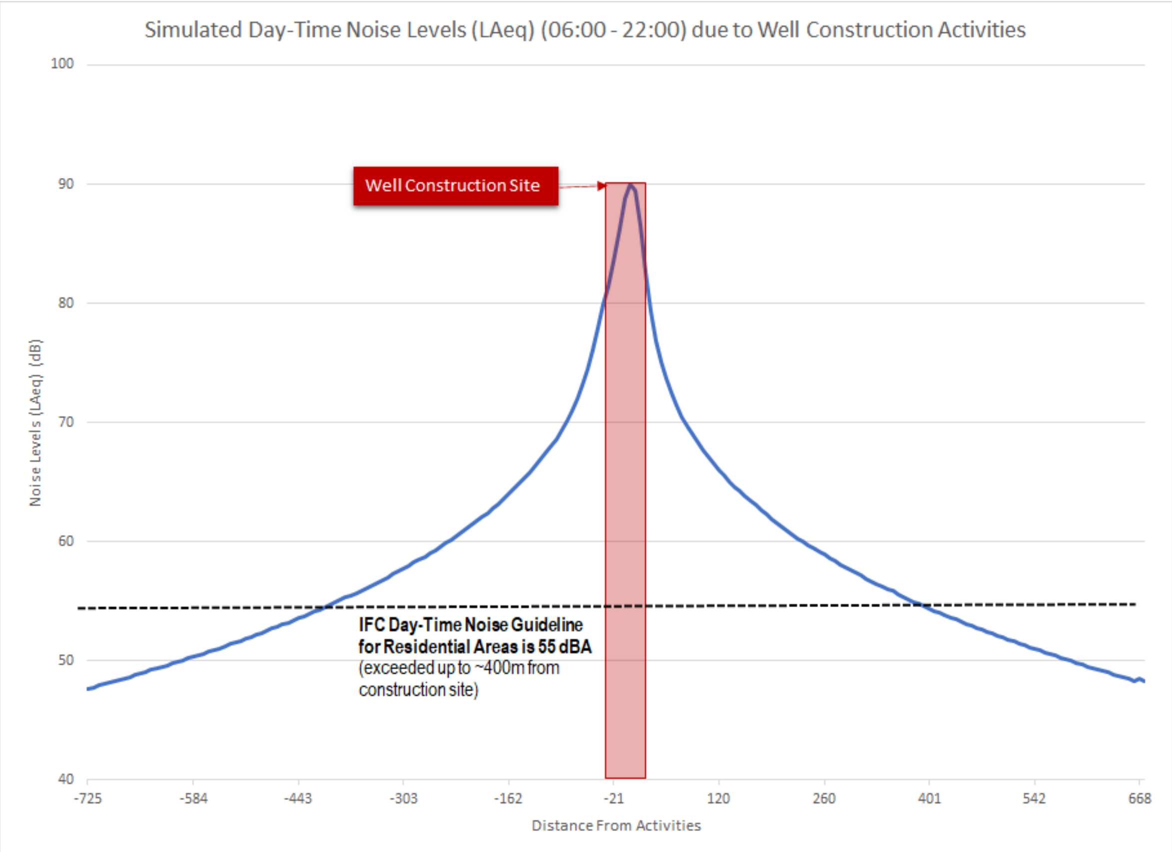



*Figure 4-1: Profile for the simulated day-time noise levels (LAeq) due to well construction activities*

#### 4.1.2.2 Pipeline

Figure 4-2 provides an indication of the potential noise levels due to pipeline construction activities assuming the centreline of the 300 m buffer provided for this activity. The pipeline may however be located anywhere within the 300 m buffer.

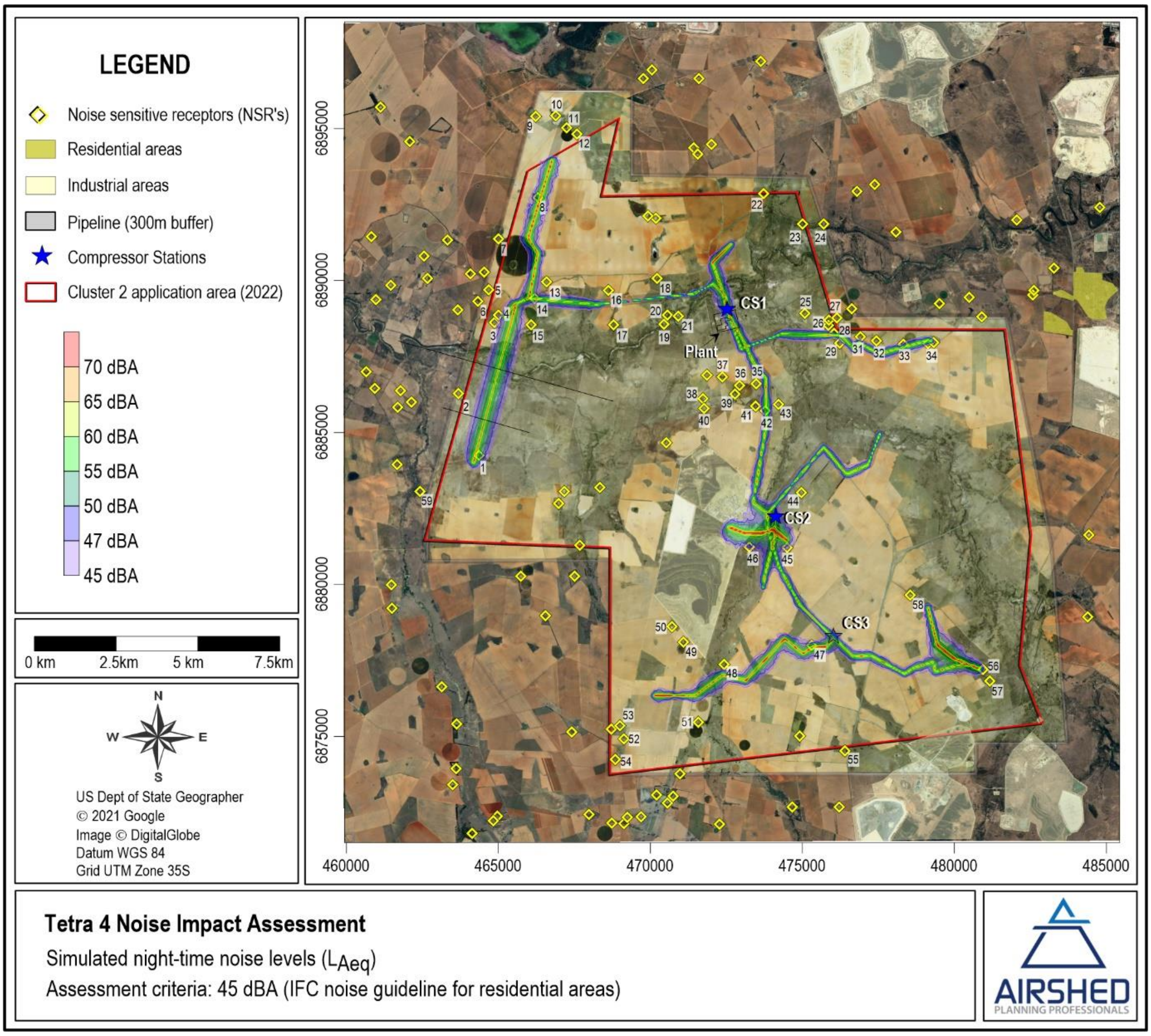



*Figure 4-2: Isopleths indicating the simulated day-time noise levels (LAeq) due to pipeline construction activities*

A profile of the simulated noise levels due to pipeline construction activities is provided in Figure 4-3. IFC day-time noise guidelines for residential areas (55 dBA) are exceeded up to 90 m from the pipeline construction site. Note, the dips in the profile are due to topography that was included in simulations for the pipeline.

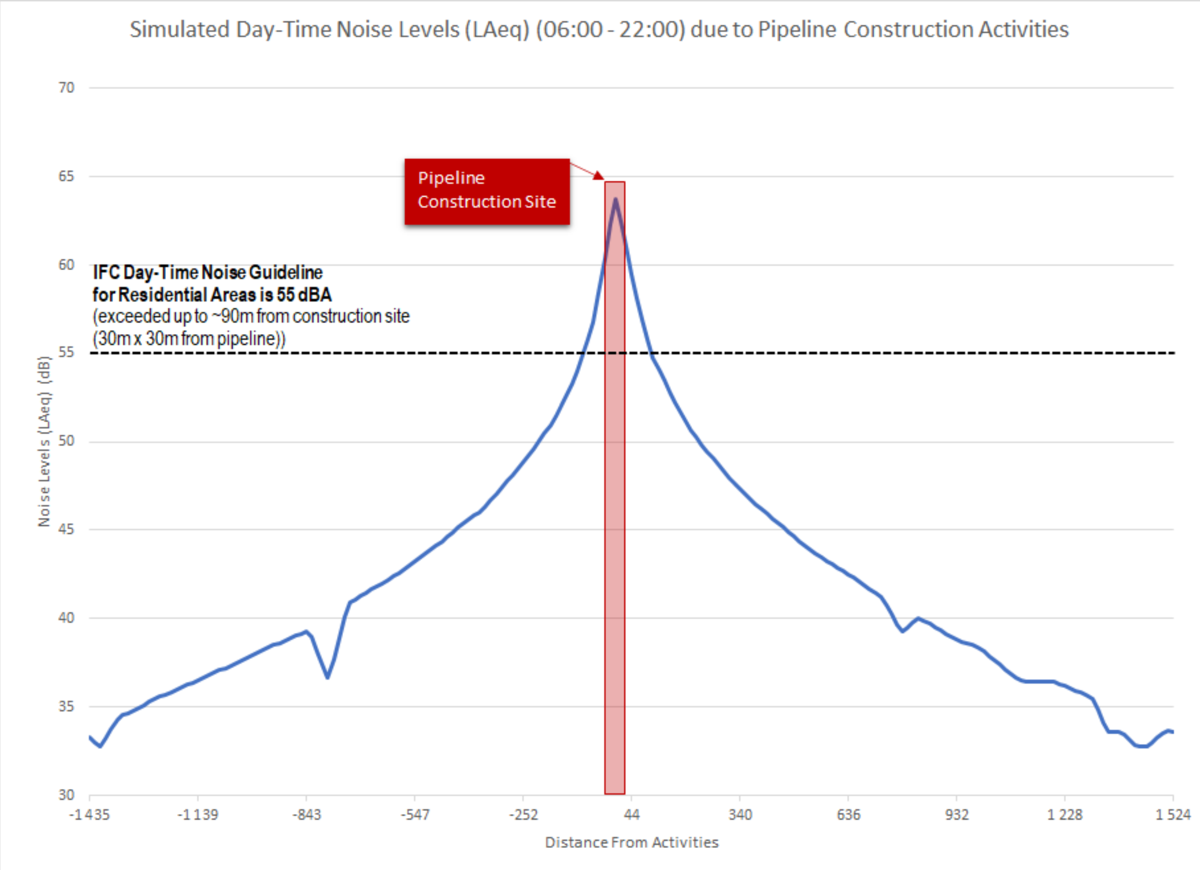



*Figure 4-3: Profile for the simulated day-time noise levels (LAeq) due to pipeline construction activities*

The maximum simulated day-time noise levels, due to pipeline construction, at potential NSRs within the study site is summarised in Table 4-4. This summary takes into account the potential shift in the pipeline alignment within the provided 300m buffer and is therefore conservative. For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. The increase in noise levels above the baseline due to the construction of the pipeline (depending on its location within the 300 m buffer) may result in 'little' community reaction at NSR31, NSR34 and NSR56, 'medium' reaction at NSR8, NSR42, NSR45, and NSR47 and 'strong' community reaction at NSR14. With the exception of NSR56, the predicted increase in noise levels due to pipeline construction activities at all of the above listed NSRs are above 7 dBA (1992 Noise Control Regulations definition for "disturbing noise").

*Table 4-4: Summary of simulated day-time noise levels (provided as dBA) due to the pipeline construction activities and baseline noise measurements at NSRs within the vicinity of the project*

| Noise Sensitive Receptor | Comments | Project operations [a] | Baseline | Increase Above Baseline [b] |
|---|---|---|---|---|
| NSR1 | Baseline noise levels typical of rural districts | 64.7 | 45.0 | 19.7 |
| NSR2 | Baseline noise levels typical of rural districts | 38.8 | 45.0 | 0.9 |
| NSR3 | Baseline noise levels typical of rural districts | 46.3 | 45.0 | 3.7 |
| NSR4 | Baseline noise levels typical of rural districts | 45.8 | 45.0 | 3.4 |
| NSR5 | Baseline noise levels typical of rural districts | 35.7 | 45.0 | 0.5 |
| NSR6 | Baseline noise levels typical of rural districts | 36.0 | 45.0 | 0.5 |
| NSR7 | Baseline noise levels typical of rural districts | 37.8 | 45.0 | 0.8 |
| NSR8 | Baseline noise levels typical of rural districts | 57.3 | 45.0 | 12.5 |
| NSR9 | Baseline noise levels typical of rural districts | 25.2 | 45.0 | 0.0 |
| NSR10 | Baseline noise levels typical of rural districts | 25.1 | 45.0 | 0.0 |
| NSR11 | Baseline noise levels typical of rural districts | 26.8 | 45.0 | 0.1 |
| NSR12 | Baseline noise levels typical of rural districts | 27.4 | 45.0 | 0.1 |
| NSR13 | Baseline noise levels typical of rural districts | 43.4 | 45.0 | 2.3 |
| NSR14 | Baseline noise levels typical of rural districts | 62.1 | 45.0 | 17.2 |
| NSR15 | Baseline noise levels typical of rural districts | 43.9 | 45.0 | 2.5 |
| NSR16 | Baseline noise levels typical of rural districts | 34.8 | 45.0 | 0.4 |
| NSR17 | Baseline noise levels typical of rural districts | 28.7 | 45.0 | 0.1 |
| NSR18 | Baseline noise levels typical of rural districts | 28.8 | 45.0 | 0.1 |
| NSR19 | Baseline noise levels typical of rural districts | 30.0 | 45.0 | 0.1 |
| NSR20 | Baseline noise levels typical of rural districts | 38.4 | 45.0 | 0.9 |
| NSR21 | Baseline noise levels typical of rural districts | 35.2 | 45.0 | 0.4 |
| NSR22 | Baseline noise levels typical of rural districts | 16.1 | 45.0 | 0.0 |
| NSR23 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR24 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR25 | Baseline noise levels typical of urban districts (<550 m from road) | 37.4 | 55.0 | 0.1 |
| NSR26 | Baseline noise levels assumed to be typical of rural districts | 39.5 | 45.0 | 1.1 |
| NSR27 | Baseline noise levels typical of suburban districts (<1000 m from road) | 33.4 | 50.0 | 0.1 |
| NSR28 | Baseline noise levels assumed to be typical of rural districts | 43.5 | 45.0 | 2.3 |
| NSR29 | Baseline noise levels assumed to be typical of rural districts | 44.4 | 45.0 | 2.7 |
| NSR30 | Baseline noise levels assumed to be typical of rural districts | 29.9 | 45.0 | 0.1 |
| NSR31 | Baseline noise levels assumed to be typical of rural districts | 53.6 | 45.0 | 9.2 |
| NSR32 | Baseline noise levels assumed to be typical of rural districts | 44.5 | 45.0 | 2.8 |
| NSR33 | Baseline noise levels assumed to be typical of rural districts | 47.1 | 45.0 | 4.2 |
| NSR34 | Baseline noise levels assumed to be typical of rural districts | 52.0 | 45.0 | 7.8 |
| NSR35 | Baseline noise levels typical of urban districts (<500m from R30 road) | 43.3 | 55.0 | 0.3 |
| NSR36 | Baseline noise levels typical of suburban districts (<1000m from R30) | 36.7 | 50.0 | 0.2 |
| NSR37 | Baseline noise levels typical of rural districts | 34.3 | 45.0 | 0.4 |
| NSR38 | Baseline noise levels typical of rural districts | 25.3 | 45.0 | 0.0 |
| NSR39 | Baseline noise levels typical of rural districts | 34.2 | 45.0 | 0.3 |
| NSR40 | Baseline noise levels typical of rural districts | 19.6 | 45.0 | 0.0 |
| NSR41 | Baseline noise levels typical of suburban districts (<1000 m from R30) | 44.8 | 50.0 | 1.1 |
| NSR42 | Baseline noise levels typical of suburban districts (<1000 m from R30) | 64.0 | 50.0 | 14.2 |
| NSR43 | Baseline noise levels typical of urban districts (<500 m from R30 road) | 40.4 | 55.0 | 0.1 |
| NSR44 | Baseline noise levels typical of rural districts | 38.1 | 45.0 | 0.8 |
| NSR45 | Baseline noise levels typical of rural districts | 56.3 | 45.0 | 11.6 |
| NSR46 | Baseline noise levels typical of rural districts | 47.8 | 45.0 | 4.6 |
| NSR47 | Baseline noise levels typical of rural districts | 59.1 | 45.0 | 14.3 |
| NSR48 | Baseline noise levels typical of rural districts | 42.0 | 45.0 | 1.8 |
| NSR49 | Baseline noise levels typical of rural districts | 28.8 | 45.0 | 0.1 |
| NSR50 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR51 | Baseline noise levels typical of rural districts | 34.9 | 45.0 | 0.4 |
| NSR52 | Baseline noise levels typical of rural districts | 23.9 | 45.0 | 0.0 |

| Noise Sensitive Receptor | Comments | Project operations (a) | Baseline | Increase Above Baseline (b) |
|---|---|---|---|---|
| NSR53 | Baseline noise levels typical of rural districts | 21.6 | 45.0 | 0.0 |
| NSR54 | Baseline noise levels typical of rural districts | 22.9 | 45.0 | 0.0 |
| NSR55 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR56 | Baseline noise levels typical of rural districts | 49.5 | 45.0 | 5.8 |
| NSR57 | Baseline noise levels typical of rural districts | 36.9 | 45.0 | 0.6 |
| NSR58 | Baseline noise levels typical of rural districts | 34.7 | 45.0 | 0.4 |
| NSR59 | Baseline noise levels typical of rural districts | 24.2 | 45.0 | 0.0 |

**Notes:**

(a) Exceedances of IFC guideline (55 dBA for day-time at residential areas) are provided in bold.

(b) Likely community response in accordance with the SANS 10103:

| <3 dBA | <5 dBA | <10 dBA | <15 dBA | <20 dBA |
|---|---|---|---|---|
| *Change imperceptible* | *No reaction* | *'Little' reaction with sporadic complaints* | *'Medium' reaction with widespread complaints* | *'Strong' to 'very strong' reaction with threats of community action or vigorous community action.* |

### 4.1.2.3 Blower Station

The exact location of the Blower Stations will be dependent on the well locations. It is proposed that a Blower Station for every 10 wells will be constructed.

Simulated day-time noise levels due to Blower Station construction activities as a function of perpendicular distance are shown in Figure 4-4.

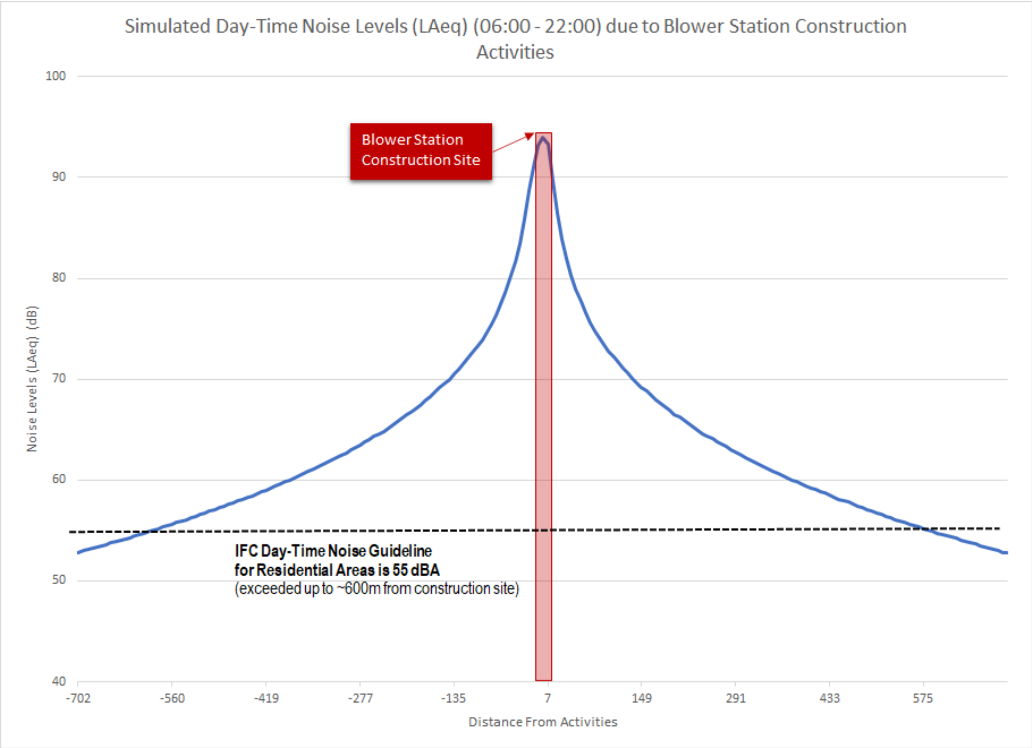



*Figure 4-4: Profile for the simulated day-time noise levels (LAeq) due to Blower Station construction activities*

IFC day-time noise guidelines for residential areas (55 dBA) are exceeded up to 600 m from the Blower Station sites. As construction will only take place during day-time hours and will be of limited duration, NSRs within 600 m radius of all Blower Station construction sites should be notified of the activities and potential disturbance durations prior to construction taking place. Care should be taken to minimise heavy machinery activity (where possible) in these areas and to switch off equipment when not in use.

#### *4.1.2.4 Plant and Compressor Stations*

Three compressor stations are proposed: Compressor Station 1 (CS1), Compressor Station 2 (CS2) and Compressor Station 3 (CS3). There are two potential sites for CS3: the preferred site ~500 m south of CS2 and an alternative site ~4500 m south of CS2. Potential noise levels due to construction activities were assessed at all site locations.

Figure 4-5 to Figure 4-9 provides an indication of the potential noise levels due to plant and Compressor Station construction activities. The IFC day-time noise guidelines for residential areas (55 dBA) are not exceeded at any of the identified NSRs within the study area due to Plant and Compressor Station construction activities.

The simulated day-time noise levels, due to Plant and Compressor Station construction at potential NSRs within the study site is summarised in Table 4-5 and Table 4-6. The increase in noise levels above the baseline due to the construction of the plant and Compressor stations are unlikely to be disturbing[2] at NSRs and should not result in community reaction.

[2] 1992 Noise Control Regulations define "disturbing noise" as increase noise levels above baseline of 7 dBA

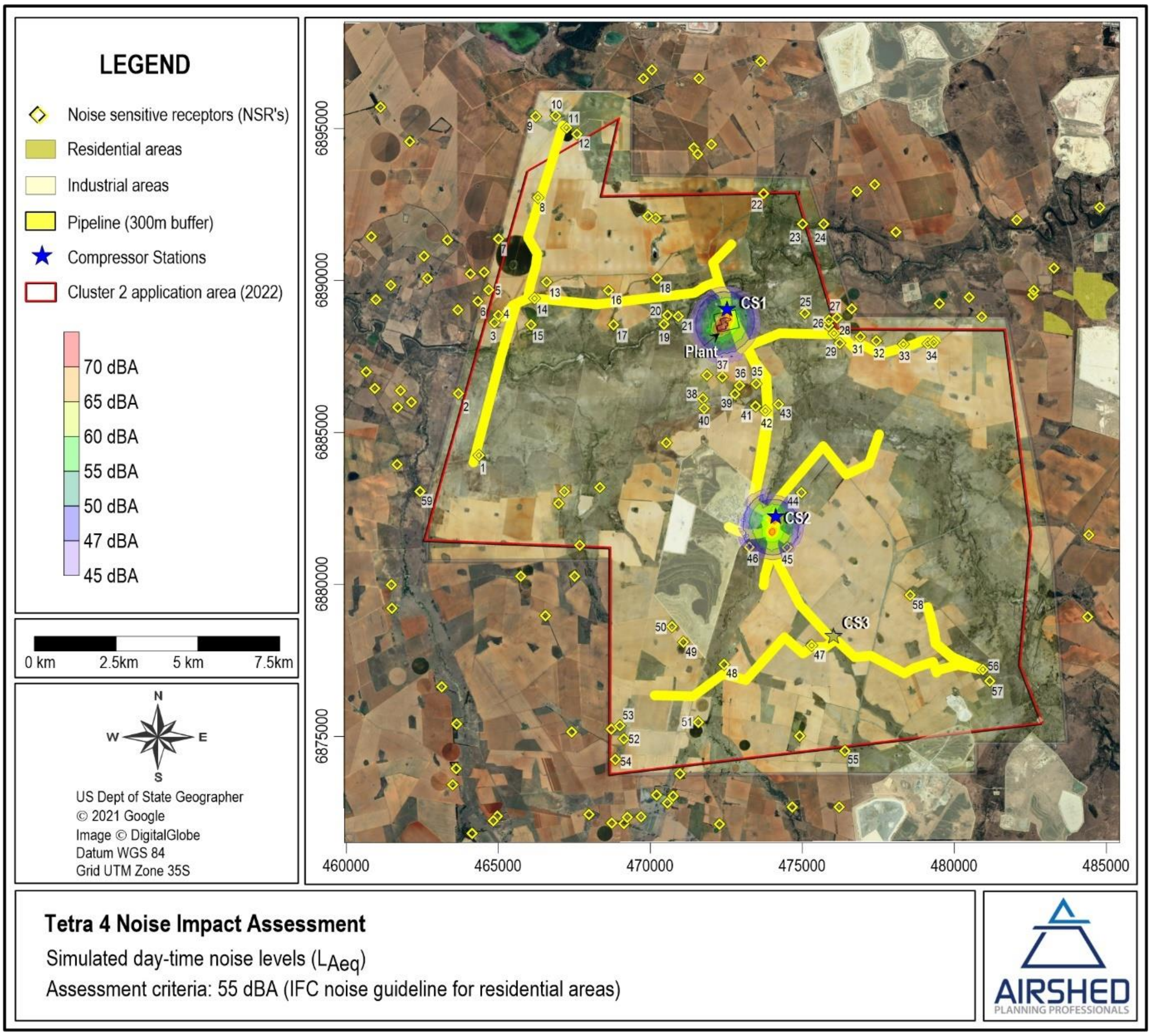



*Figure 4-5: Isopleths indicating the simulated day-time noise levels (LAeq) due to Plant and Compressor Station construction activities (assuming the preferred CS3 location)*

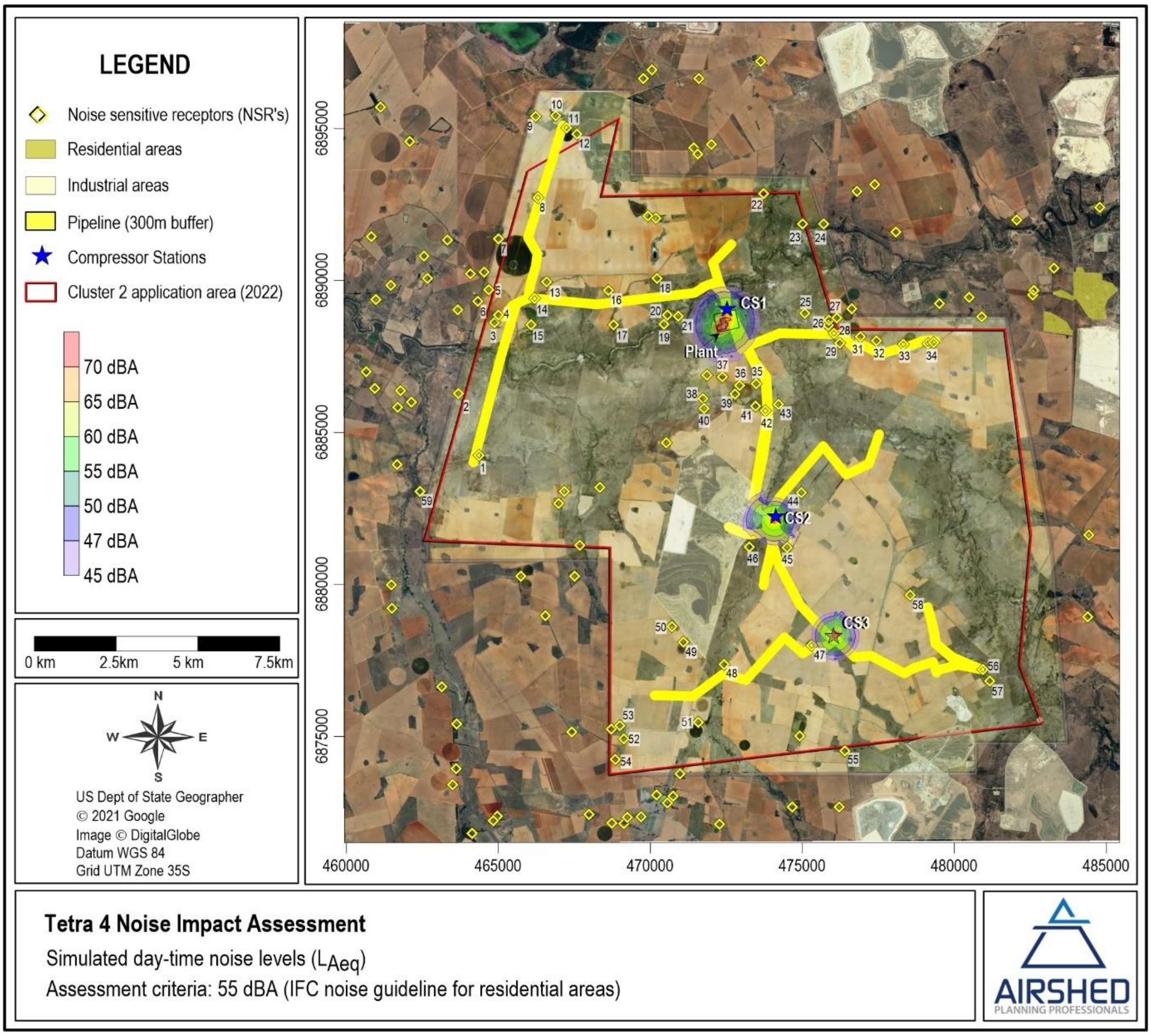



*Figure 4-6: Isopleths indicating the simulated day-time noise levels (LAeq) due to Plant and Compressor Station construction activities (assuming the alternative CS3 location)*

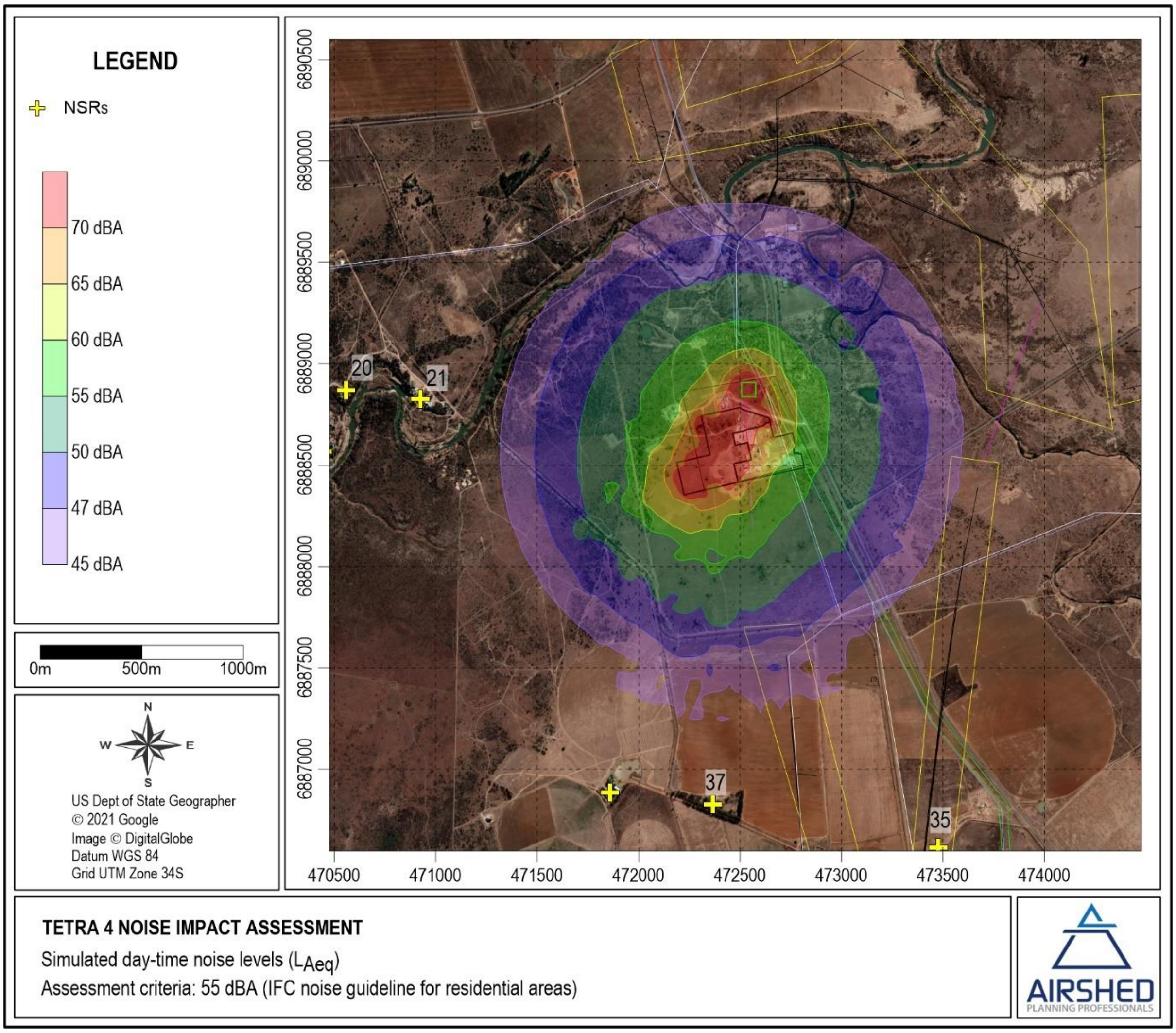



*Figure 4-7: Isopleths indicating the simulated day-time noise levels (LAeq) due to Plant and Compressor Station construction activities at the Plant site*

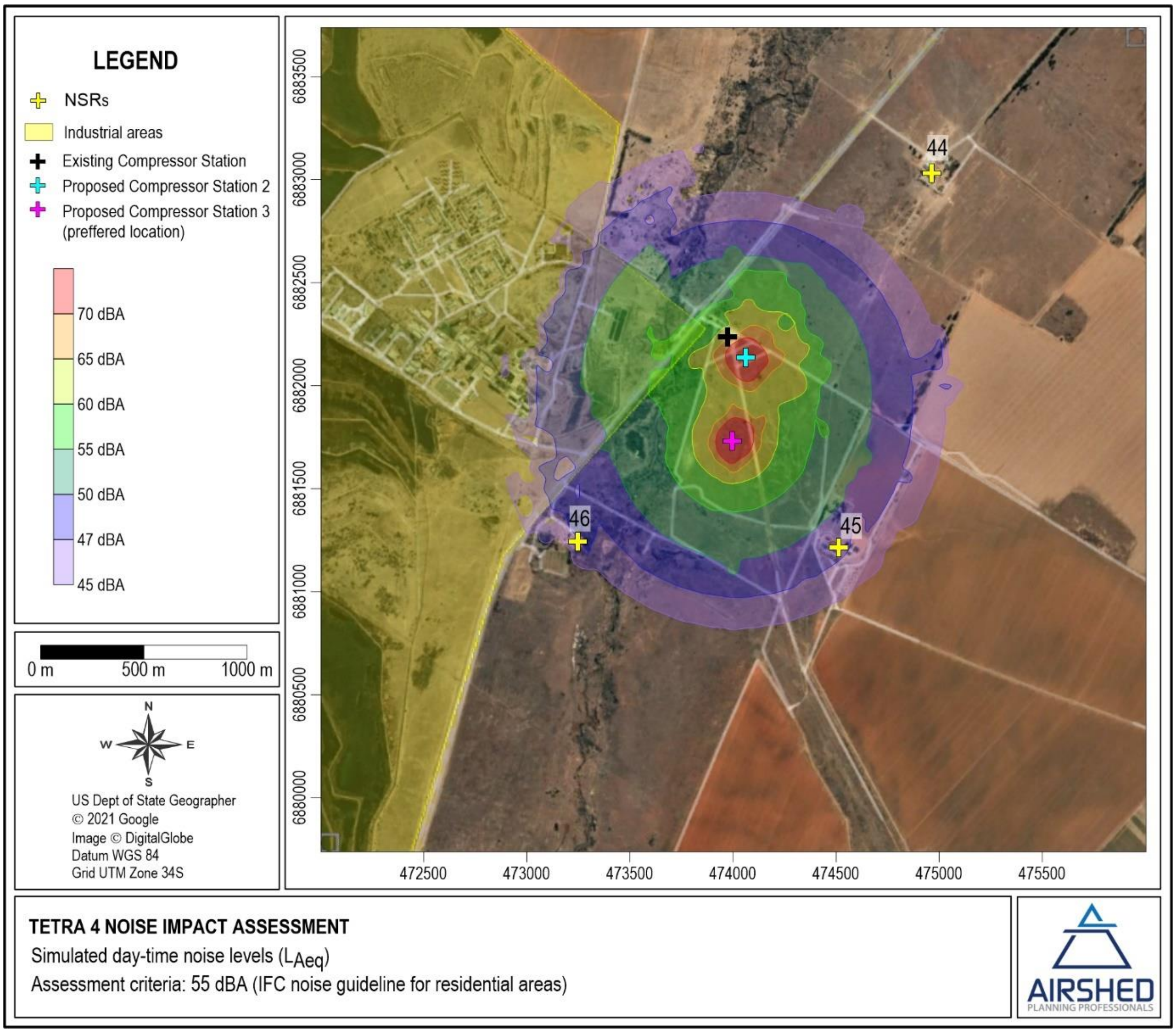



*Figure 4-8: Isopleths indicating the simulated day-time noise levels (LAeq) due to Compressor Station construction activities at the CS2 site (assuming the preferred CS3 location)*

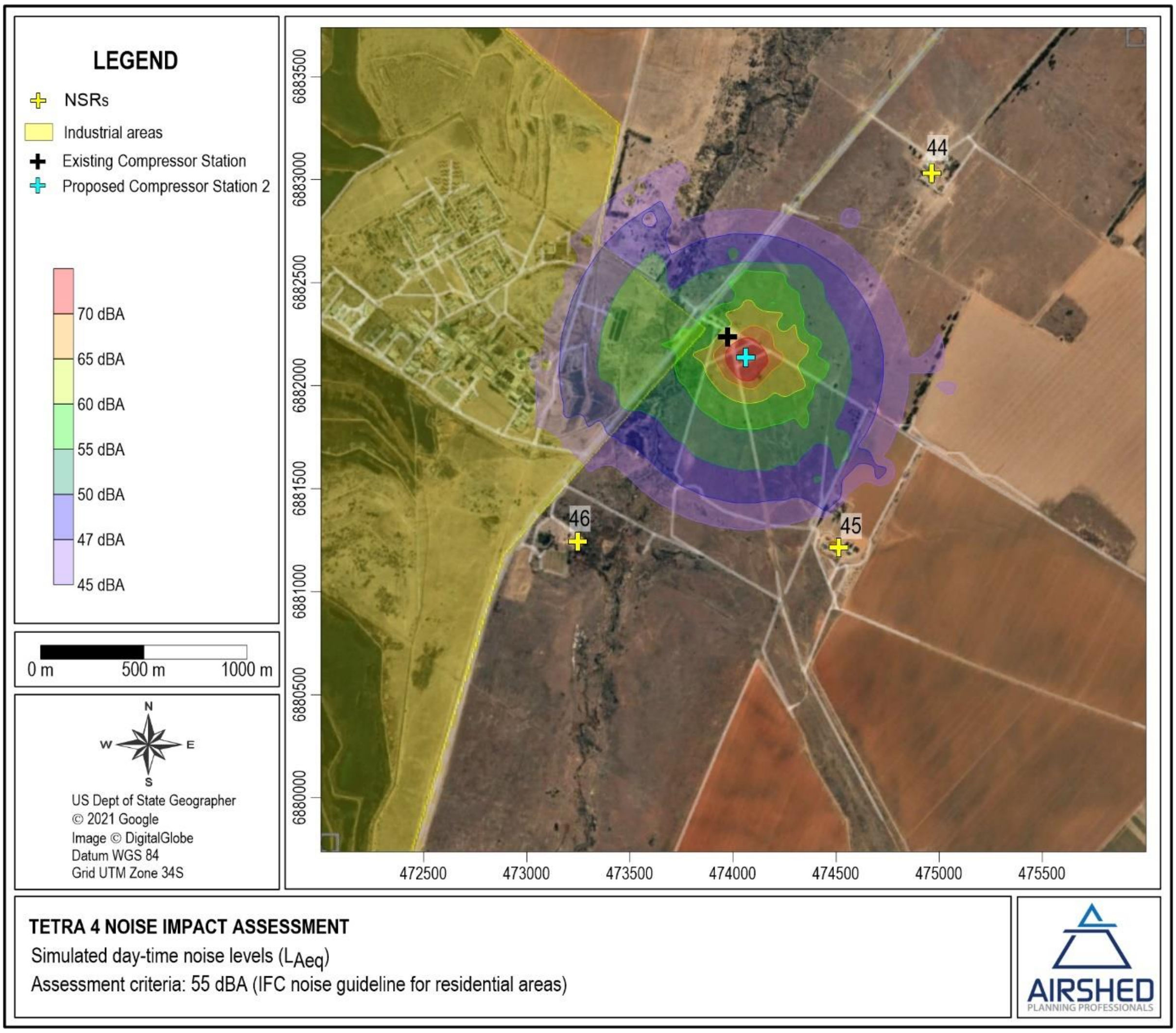



*Figure 4-9: Isopleths indicating the simulated day-time noise levels (LAeq) due to Compressor Station construction activities at the CS2 site (assuming the alternative CS3 location)*

*Table 4-5: Summary of simulated day-time noise levels (provided as dBA) due to the Plant and Compressor Station construction activities (assuming preferred location for CS3) and baseline noise measurements at NSRs within the vicinity of the project*

| Noise Sensitive Receptor | Comment | Project operations [a] | Baseline | Increase Above Baseline [b] |
|---|---|---|---|---|
| NSR1 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR2 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR3 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR4 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR5 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR6 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR7 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR8 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR9 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR10 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR11 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR12 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |

| Noise Sensitive Receptor | Comment | Project operations (a) | Baseline | Increase Above Baseline (b) |
|---|---|---|---|---|
| NSR13 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR14 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR15 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR16 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR17 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR18 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR19 | Baseline noise levels typical of rural districts | 35.6 | 45.0 | 0.5 |
| NSR20 | Baseline noise levels typical of rural districts | 38.2 | 45.0 | 0.8 |
| NSR21 | Baseline noise levels typical of rural districts | 40.8 | 45.0 | 1.4 |
| NSR22 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR23 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR24 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR25 | Baseline noise levels typical of urban districts (<550m from road) | 0.0 | 55.0 | 0.0 |
| NSR26 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR27 | Baseline noise levels typical of suburban districts (<1000m from road) | 0.0 | 50.0 | 0.0 |
| NSR28 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR29 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR30 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR31 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR32 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR33 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR34 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR35 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 55.0 | 0.0 |
| NSR36 | Baseline noise levels typical of suburban districts (<1000m from R30) | 36.0 | 50.0 | 0.2 |
| NSR37 | Baseline noise levels typical of rural districts | 42.1 | 45.0 | 1.8 |
| NSR38 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR39 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR40 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR41 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 50.0 | 0.0 |
| NSR42 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 50.0 | 0.0 |
| NSR43 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 55.0 | 0.0 |
| NSR44 | Baseline noise levels typical of rural districts | 40.1 | 45.0 | 1.2 |
| NSR45 | Baseline noise levels typical of rural districts | 47.5 | 45.0 | 4.4 |
| NSR46 | Baseline noise levels typical of rural districts | 45.1 | 45.0 | 3.1 |
| NSR47 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR48 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR49 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR50 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR51 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR52 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR53 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR54 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR55 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |

| Noise Sensitive Receptor | Comment | Project operations [(a)] | Baseline | Increase Above Baseline [(b)] |
|---|---|---|---|---|
| NSR56 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR57 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR58 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR59 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |

**Notes:**

(a) Exceedances of IFC guideline (55 dBA for day-time at residential areas) are provided in bold.

(b) Likely community response in accordance with the SANS 10103:

| <3 dBA | <5 dBA | <10 dBA | <15 dBA | <20 dBA |
|---|---|---|---|---|
| *Change imperceptible* | *No reaction* | *'Little' reaction with sporadic complaints* | *'Medium' reaction with widespread complaints* | *'Strong' to 'very strong' reaction with threats of community action or vigorous community action.* |

*Table 4-6: Summary of simulated day-time noise levels (provided as dBA) due to the Plant and Compressor Station construction activities (assuming alternative location for CS3) and baseline noise measurements at NSRs within the vicinity of the project*

| Noise Sensitive Receptor | Comments | Project operations [(a)] | Baseline | Increase Above Baseline [(b)] |
|---|---|---|---|---|
| NSR1 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR2 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR3 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR4 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR5 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR6 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR7 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR8 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR9 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR10 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR11 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR12 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR13 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR14 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR15 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR16 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR17 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR18 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR19 | Baseline noise levels typical of rural districts | 35.6 | 45.0 | 0.5 |
| NSR20 | Baseline noise levels typical of rural districts | 38.2 | 45.0 | 0.8 |
| NSR21 | Baseline noise levels typical of rural districts | 40.8 | 45.0 | 1.4 |
| NSR22 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR23 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR24 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR25 | Baseline noise levels typical of urban districts (<550m from road) | 0.0 | 55.0 | 0.0 |
| NSR26 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR27 | Baseline noise levels typical of suburban districts (<1000m from road) | 0.0 | 50.0 | 0.0 |
| NSR28 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR29 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |

| Noise Sensitive Receptor | Comments | Project operations [a] | Baseline | Increase Above Baseline [b] |
|---|---|---|---|---|
| NSR30 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR31 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR32 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR33 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR34 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR35 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 55.0 | 0.0 |
| NSR36 | Baseline noise levels typical of suburban districts (<1000m from R30) | 36.0 | 50.0 | 0.2 |
| NSR37 | Baseline noise levels typical of rural districts | 42.1 | 45.0 | 1.8 |
| NSR38 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR39 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR40 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR41 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 50.0 | 0.0 |
| NSR42 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 50.0 | 0.0 |
| NSR43 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 55.0 | 0.0 |
| NSR44 | Baseline noise levels typical of rural districts | 38.4 | 45.0 | 0.9 |
| NSR45 | Baseline noise levels typical of rural districts | 42.8 | 45.0 | 2.0 |
| NSR46 | Baseline noise levels typical of rural districts | 39.9 | 45.0 | 1.2 |
| NSR47 | Baseline noise levels typical of rural districts | 44.2 | 45.0 | 2.6 |
| NSR48 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR49 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR50 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR51 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR52 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR53 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR54 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR55 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR56 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR57 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR58 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |
| NSR59 | Baseline noise levels typical of rural districts | 0.0 | 45.0 | 0.0 |

**Notes:**

(a) Exceedances of IFC guideline (55 dBA for day-time at residential areas) are provided in bold.

(b) Likely community response in accordance with the SANS 10103:

| <3 dBA | <5 dBA | <10 dBA | <15 dBA | <20 dBA |
|---|---|---|---|---|
| *Change imperceptible* | *No reaction* | *'Little' reaction with sporadic complaints* | *'Medium' reaction with widespread complaints* | *'Strong' to 'very strong' reaction with threats of community action or vigorous community action.* |

## 4.2 Operation Phase

Operational activities were assumed to take place 24 hour per day, 7 days per week.

### 4.2.1 Noise Sources and Sound Power Levels

The list of equipment was provided for the current assessment and source noise levels were using the $L_W$ predictive equations (Bruce & Moritz, 1998). A summary of the calculated noise source levels is provided in Table 4-7.

The truck trips to transport materials to, and product from, the plant, were provided (Table 4-8). The tankers were assumed to travel at 40 km/hr onsite.

The sound power level for the elevated flare was calculated based on the German recognised Standard – VDI 3272 standard noise levels of flares:

$$Lwac = 112(\pm 6) + 17logQ$$

Where:

Lwac = A-weighted sound power level of the flare (dBA)

Q = flare gas mass flow (t/h)

Given that 32 kg/hr of flare header blanket gas and 4.4 kg/hr pilot gas is used, the sound power level was conservatively calculated to be 93.5 dBA at the flare tip. The height of the flare was provided as ranging between 9 m and 16 m. As the simulated noise levels using the upper and lower range of flare height had very little notable difference, only simulated results for the 9 m flare stack are provided. An exit velocity and exit temperature of 20 m/s and 1400°C respectively was assumed.

*Table 4-7: Sound power level ($L_w$) estimates for the project operational phase*

| Area | Description | Type | $L_W$ octave band frequency spectra (dB) | | | | | | | | | $L_W$ (dB) | $L_{WA}$ (dBA) | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | | | |
| **Compressor Station** | Cooling Tower Motors | $L_W$ | 70.9 | 70.9 | 73.9 | 75.9 | 78.9 | 78.9 | 77.9 | 72.9 | 64.9 | 85.2 | 83.6 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Compressor Motors | $L_W$ | 88.0 | 90.0 | 92.0 | 93.0 | 93.0 | 93.0 | 98.0 | 88.0 | 81.0 | 102.1 | 101.0 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| **Blower Station** | Blower | $L_W$ | 88.6 | 90.6 | 92.6 | 91.6 | 90.6 | 95.6 | 86.6 | 82.6 | 75.6 | 100.2 | 97.2 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Cooling Tower | $L_W$ | 89.0 | 92.0 | 92.0 | 88.0 | 88.0 | 87.0 | 87.0 | 84.0 | 78.0 | 98.2 | 92.9 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Centrifugal Pumps | $L_W$ | 72.1 | 73.1 | 74.1 | 76.1 | 76.1 | 79.1 | 76.1 | 72.1 | 66.1 | 84.6 | 82.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Generators | $L_W$ | 84.5 | 87.5 | 88.5 | 88.5 | 88.5 | 86.5 | 84.5 | 81.5 | 76.5 | 95.8 | 91.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| **Plant** | Pumps | $L_W$ | 84.6 | 85.6 | 86.6 | 88.6 | 88.6 | 91.6 | 88.6 | 84.6 | 78.6 | 97.1 | 95.2 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Compressors | $L_W$ | 111.7 | 108.1 | 110.0 | 109.1 | 107.9 | 110.7 | 114.7 | 112.2 | 110.1 | 120.6 | 119.2 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Motors | $L_W$ | 70.3 | 70.3 | 73.3 | 75.3 | 78.3 | 78.3 | 77.3 | 72.3 | 64.3 | 84.5 | 83.0 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| | Tankers | $L_W$ | | 113.4 | 118.4 | 121.4 | 116.4 | 114.4 | 111.4 | 105.4 | 99.4 | 125.0 | 119.6 | $L_W$ Predictions (Bruce & Moritz, 1998) |

*Table 4-8: Product and raw material transported via tankers to and from the plant and the total calculated truck trips*

| Detail | Quantity | Unit |
|---|---|---|
| LNG produced | 465.3 | tpd |
| $N_2$ brought in | 25.2 | tpd |
| Capacity of truck (LNG) | 24 | t |
| Capacity of truck ($N_2$) | 46 | t |
| Truck trips per day | 19.9 | |

## 4.2.2 Noise Propagation and Simulated Noise Levels

The propagation of noise was calculated with CadnaA in accordance with ISO 9613. Meteorological and site-specific acoustic parameters as discussed in Section 3.2, along with source data discussed in 4.2.1, were applied in the model. Results are presented in tabular form at NSRs within the study area, as isopleths and as profile graphs were applicable.

### *4.2.2.1 Blower Station*

The sound power levels for the Blower Station were conservatively calculated based on the equipment list provided. It has been stipulated that noise levels should not exceed 85 dBA at 1 m from the site. This will reduce the noise source levels from those calculated for the current assessment. Simulated noise levels due to Blower Station operational activities as a function of perpendicular distance are shown in Figure 4-10.

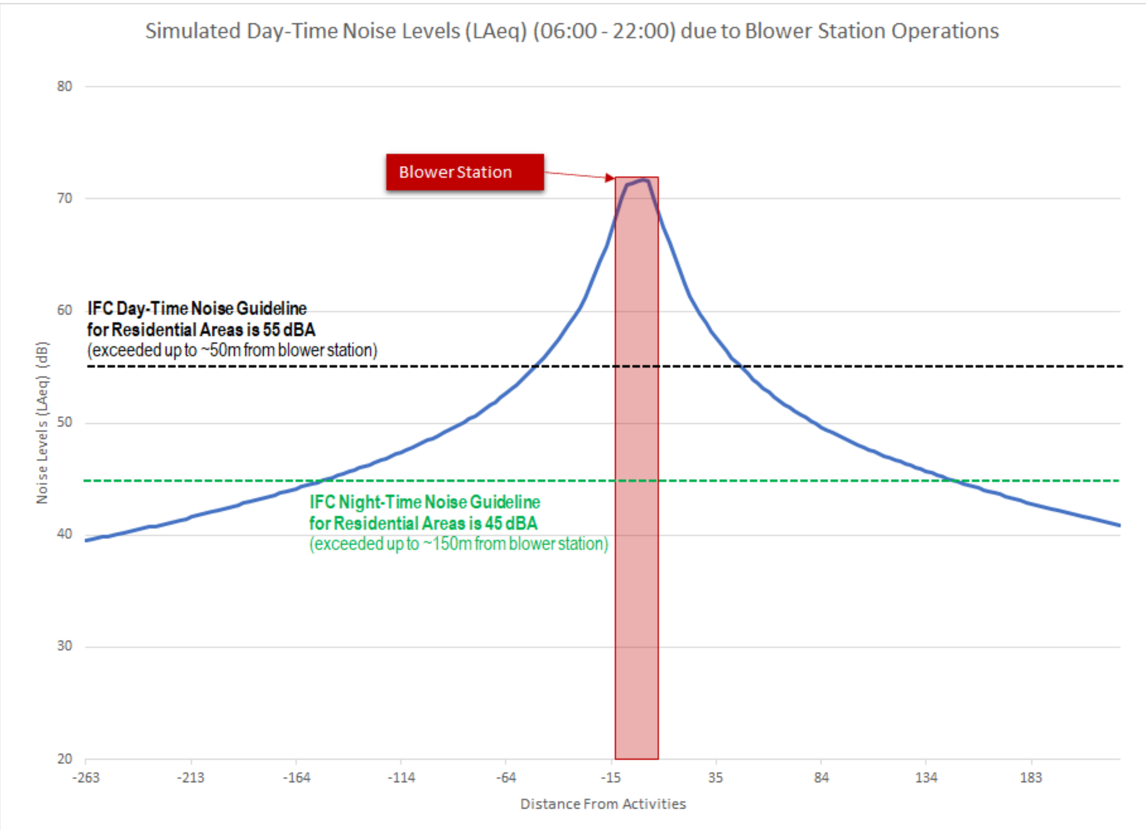



*Figure 4-10: Profile for the simulated day-time noise levels (LAeq) due to Blower Station operational activities*

IFC day-time (55 dBA) and night-time (45 dBA) noise guidelines for residential areas are exceeded up to 50 m and 150 m from the Blower Station sites respectively. Care should thus be taken to try to construct the Blower Stations at least 150 m from potential NSRs. If noise source levels can be reduced to 85 dBA at 1 m from the Station, IFC night-time noise guidelines (45 dBA) will only be exceeds up to 100 m from the Blower Station.

#### *4.2.2.2 Plant and Compressor Stations*

Figure 4-11 to Figure 4-22 provides an indication of the potential noise levels due to Plant and Compressor Station operational activities. The IFC day- (55 dBA) and night-time (45 dBA) noise guidelines for residential areas are not exceeded at any of the identified NSRs within the study area due to Plant and Compressor Station operational activities. It should be noted that the sound power levels were conservatively calculated based on equipment list provided. Using this information, the simulated noise levels due to Compressor Station operations exceeds the IFC night-time noise guidelines (45 dBA) up to 120 m from the operations. If noise source levels can be reduced to 85 dBA at 1 m from the Compressor Station, IFC night-time noise guidelines (45 dBA) will only be exceeded up to 100 m from the Compressor Stations.

The simulated day-time noise levels, due to Plant and Compressor Station operations, at potential NSRs within the study site is summarised in Table 4-9 to Table 4-11. The increase in noise levels above the baseline due to the operation of the Plant and Compressor Stations are unlikely to be disturbing[3] at NSRs and should not result in community reaction.

[3] 1992 Noise Control Regulations define “disturbing noise” as increase noise levels above baseline of 7 dBA

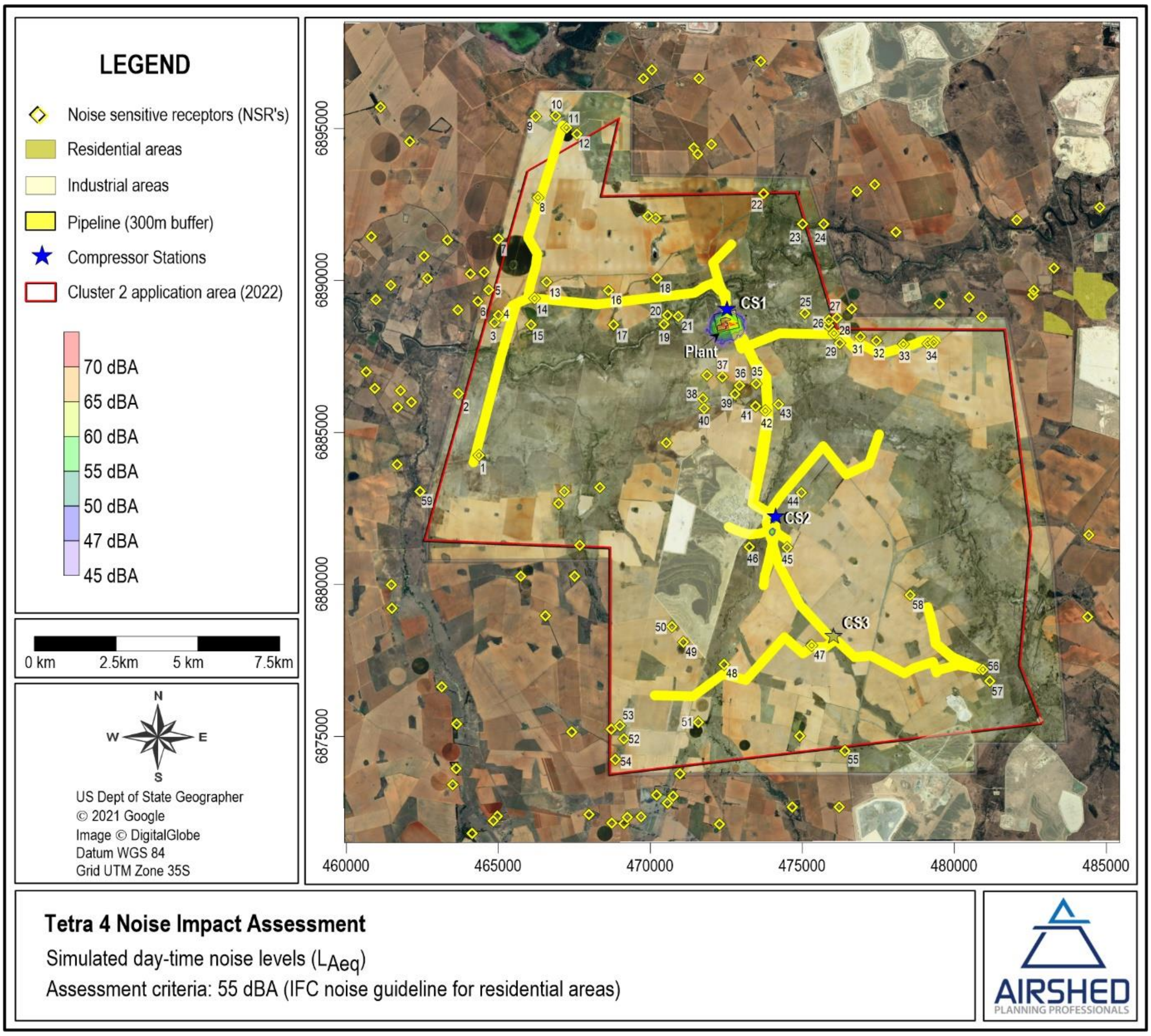



*Figure 4-11: Isopleths indicating the simulated day-time noise levels (LAeq) due to Plant and Compressor Station operational activities (assuming the preferred CS3 location)*

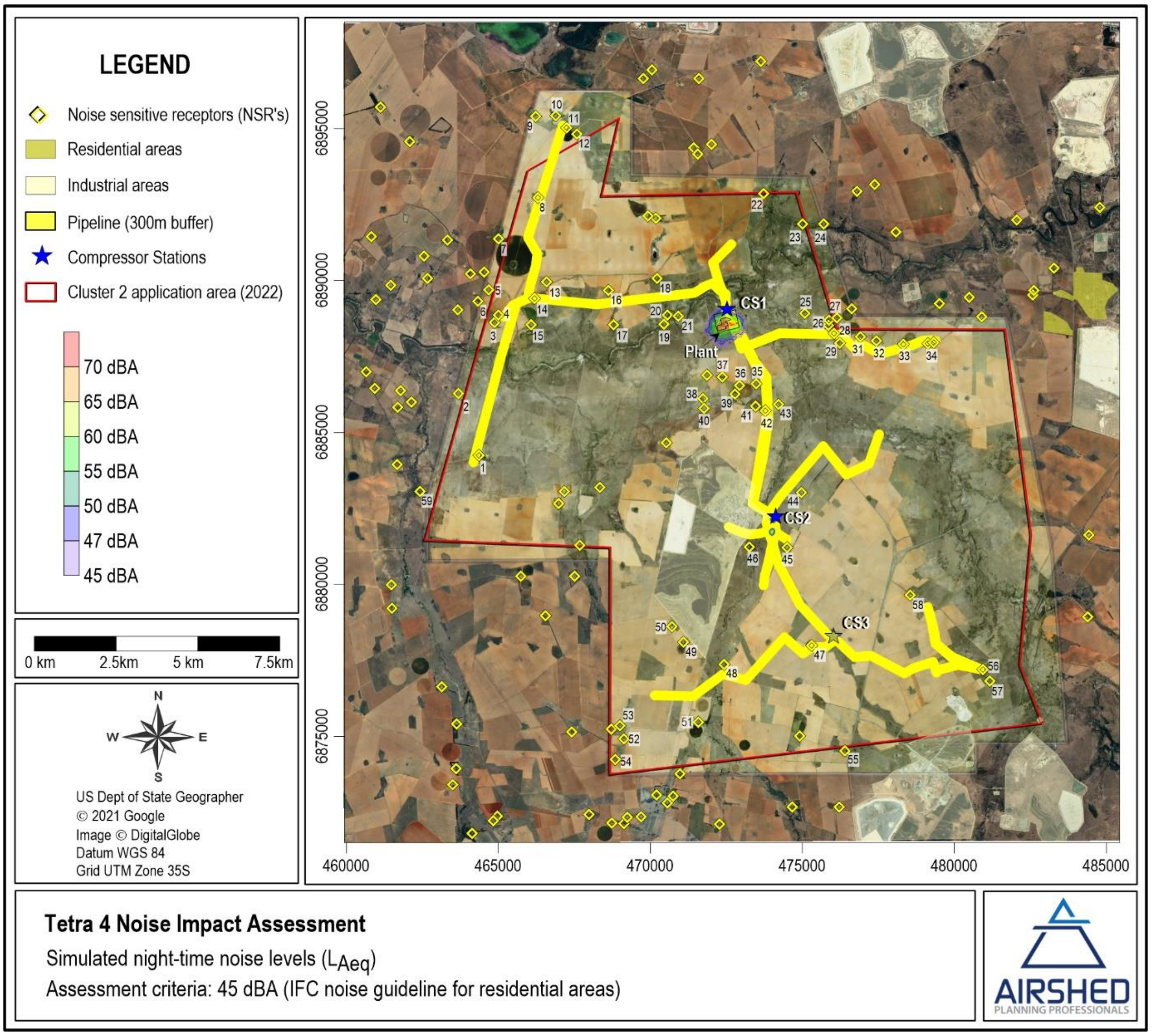



*Figure 4-12: Isopleths indicating the simulated night-time noise levels (LAeq) due to Plant and Compressor Station operational activities (assuming the preferred CS3 location)*

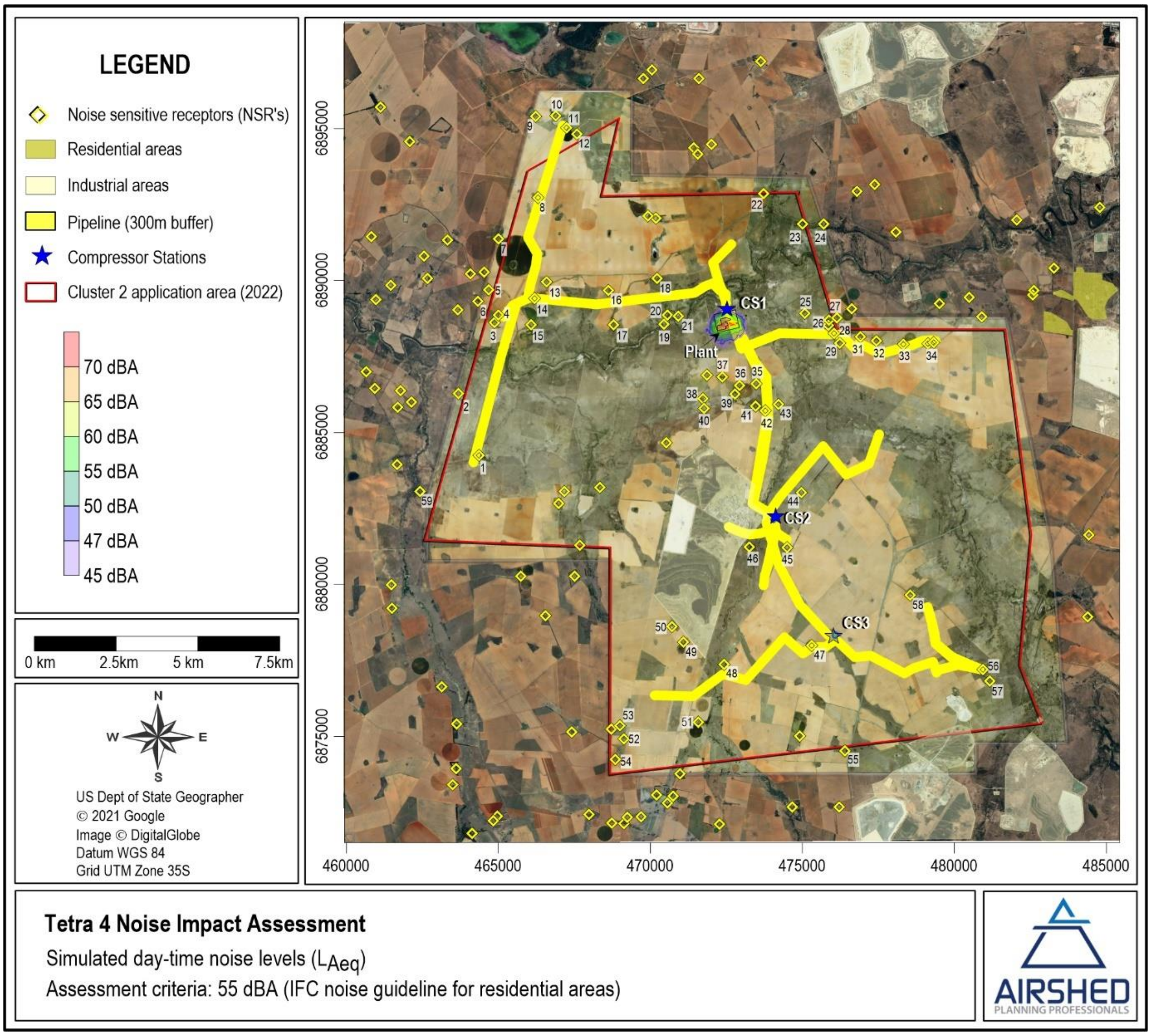



*Figure 4-13: Isopleths indicating the simulated day-time noise levels (LAeq) due to Plant and Compressor Station operational activities (assuming the alternative CS3 location)*

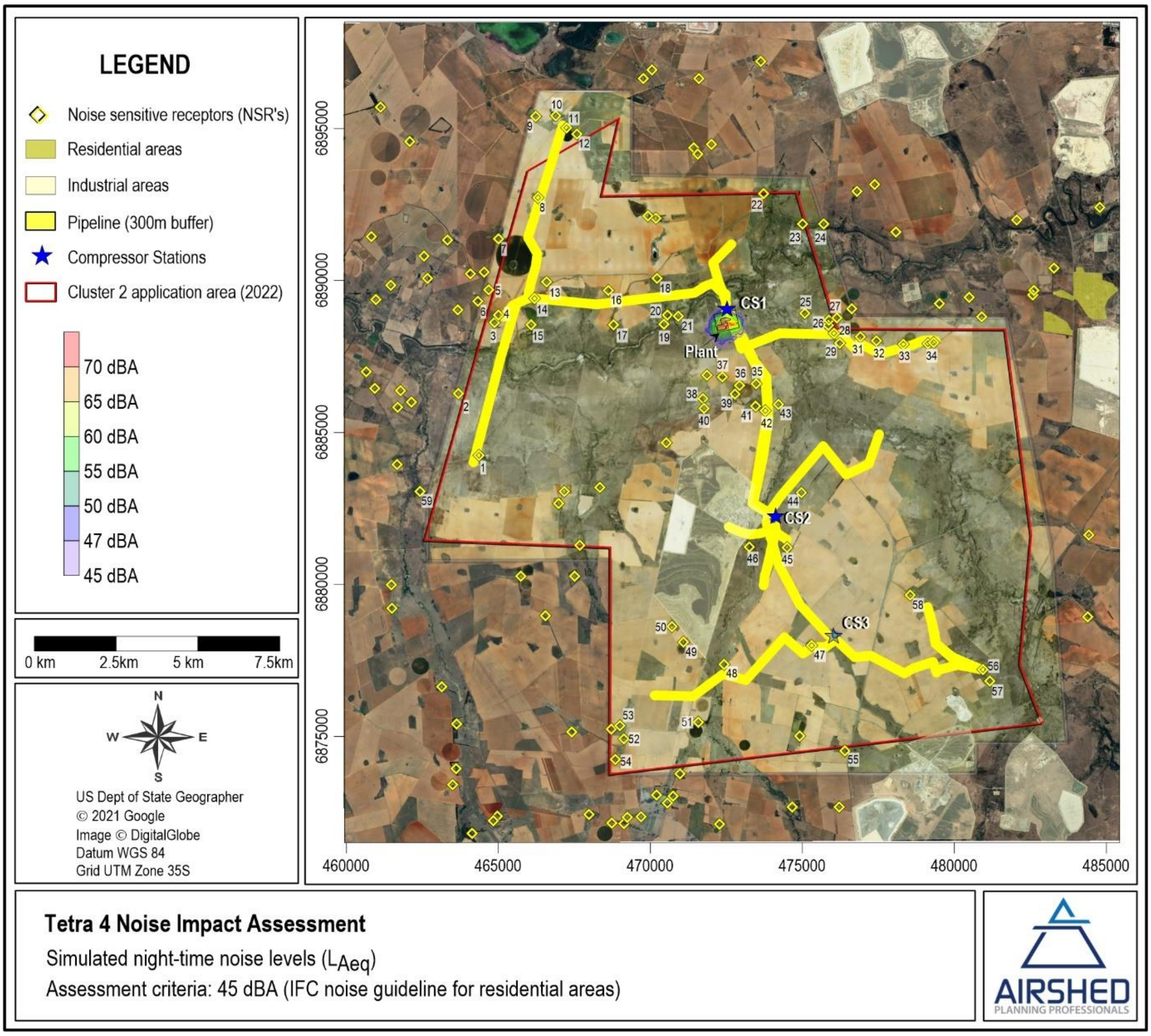



*Figure 4-14: Isopleths indicating the simulated night-time noise levels (LAeq) due to Plant and Compressor Station operational activities (assuming the alternative CS3 location)*

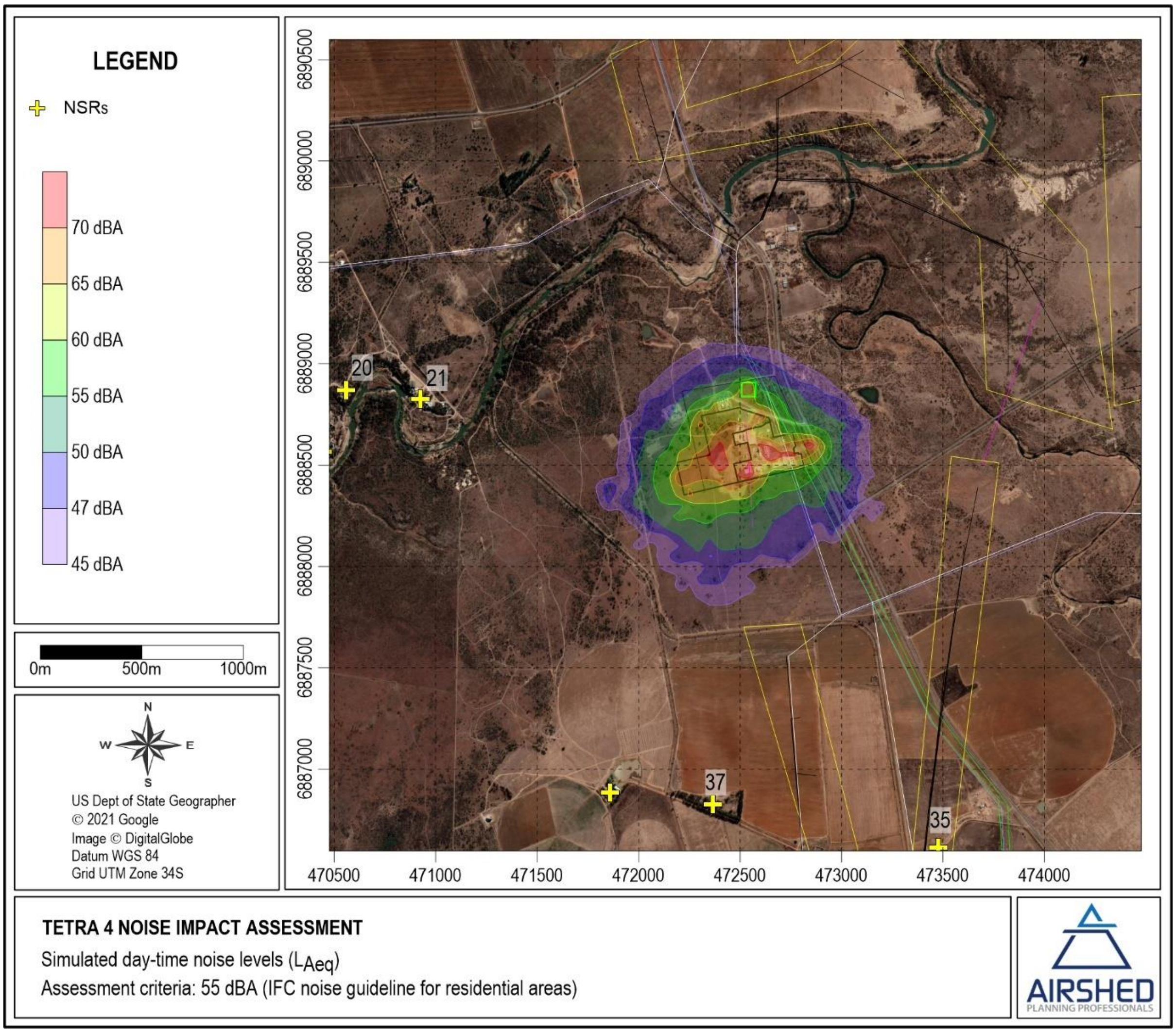



*Figure 4-15: Isopleths indicating the simulated day-time noise levels (LAeq) due to Plant and Compressor Station operational activities at the plant site*

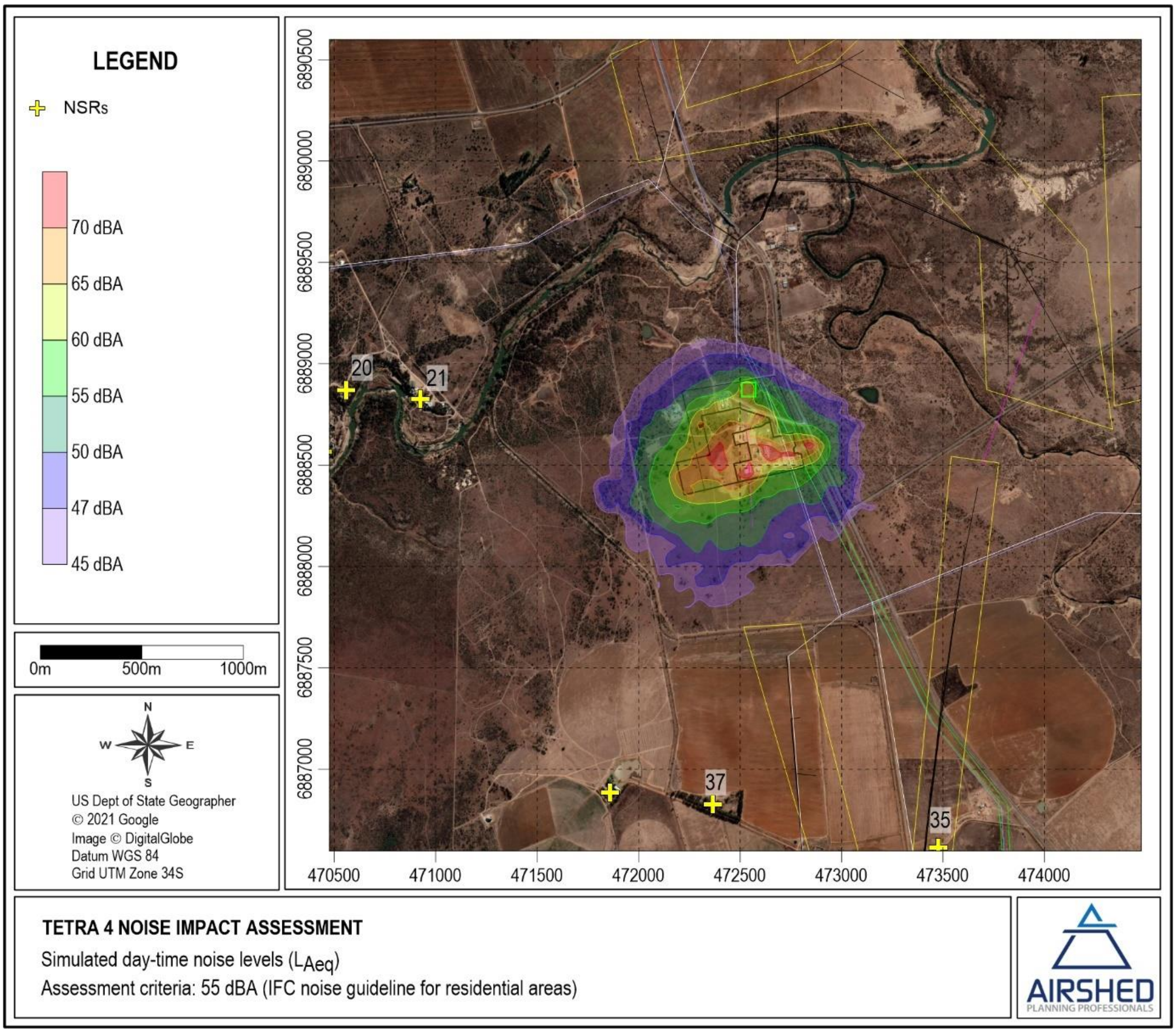



*Figure 4-16: Isopleths indicating the simulated night-time noise levels (LAeq) due to Plant and Compressor Station operational activities at the plant site*

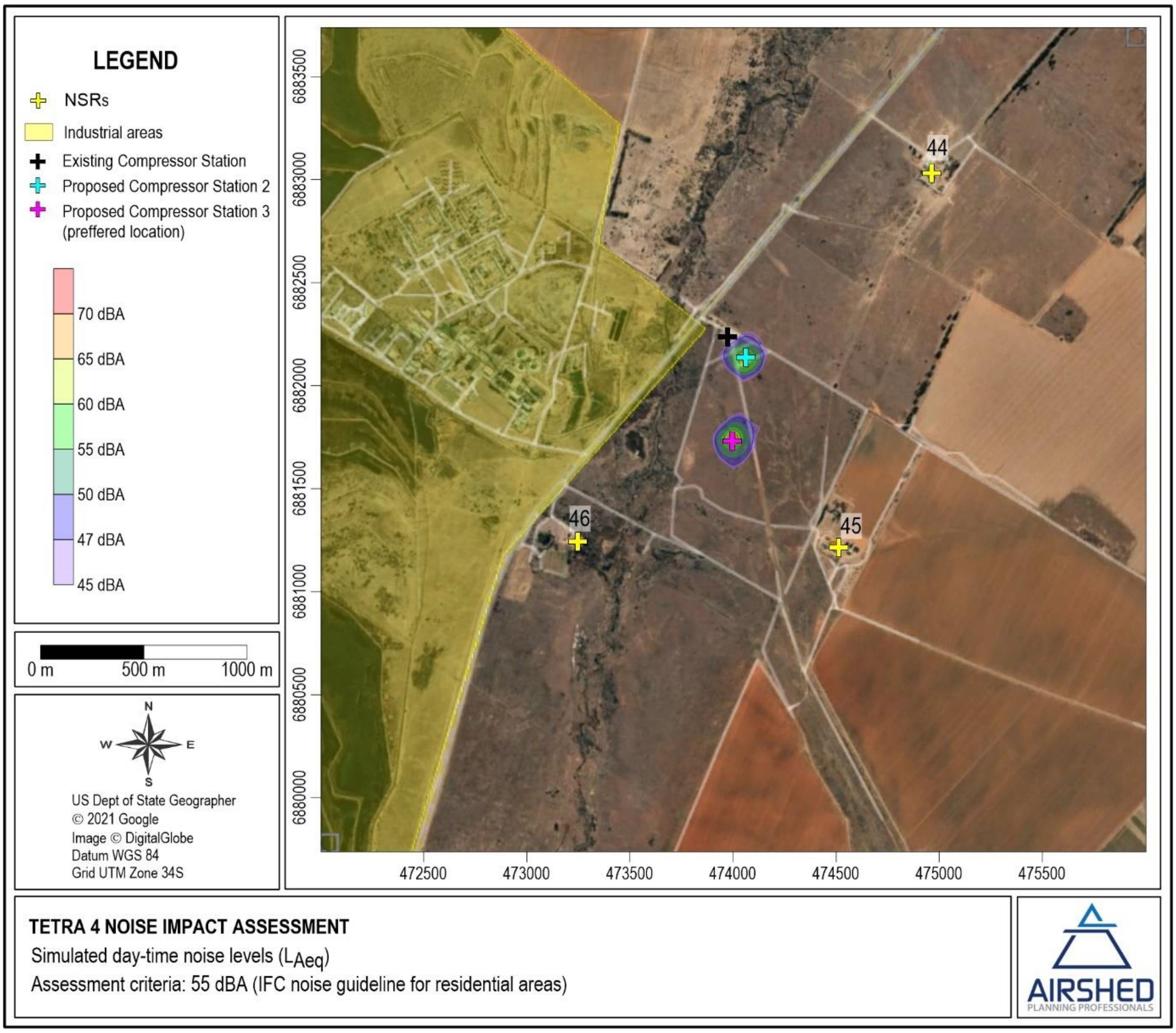



*Figure 4-17: Isopleths indicating the simulated day-time noise levels (LAeq) due to Compressor Station operational activities at the CS2 site (assuming the preferred CS3 location)*

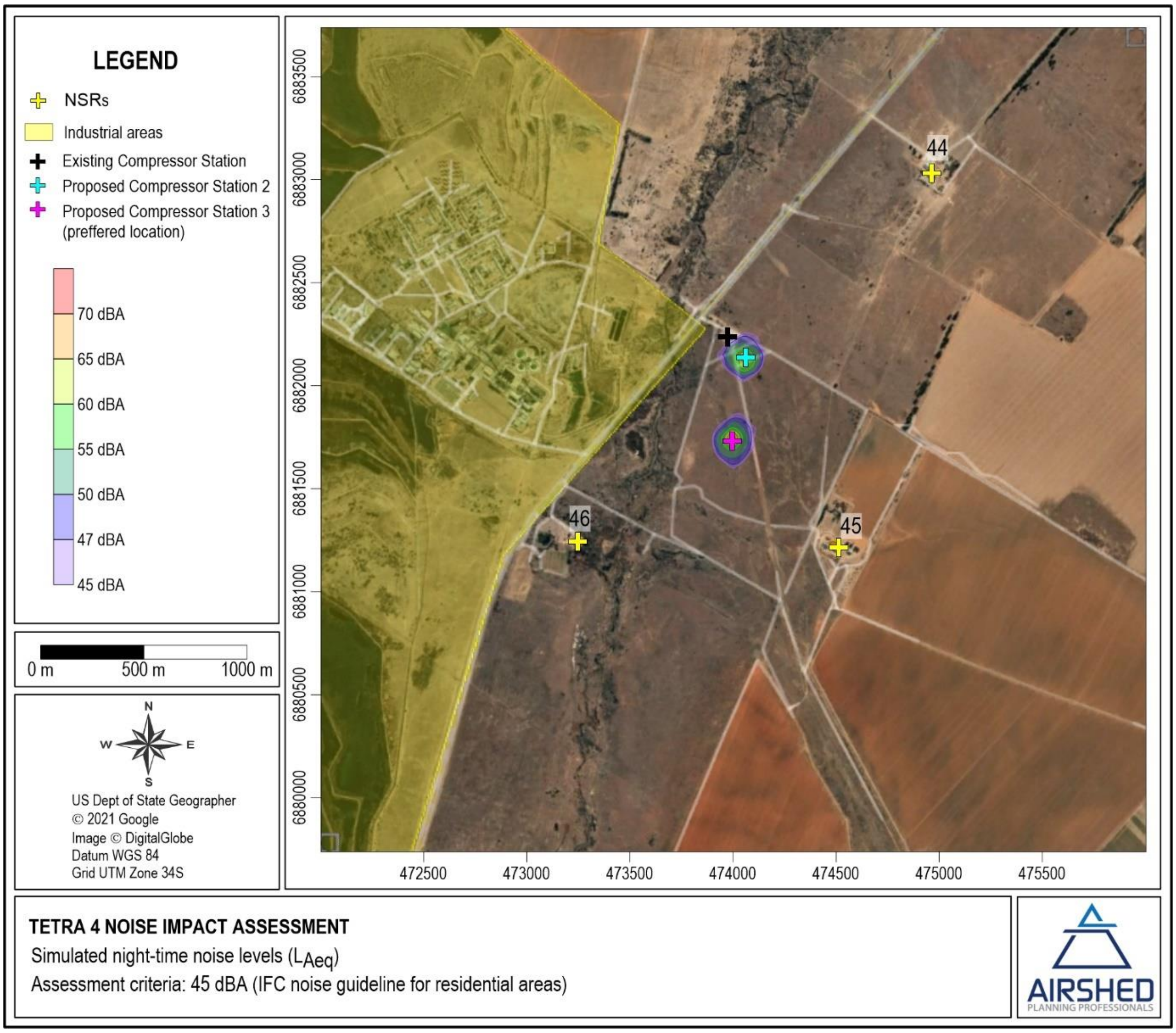



*Figure 4-18: Isopleths indicating the simulated night-time noise levels (LAeq) due to Compressor Station operational activities at the CS2 site (assuming the preferred CS3 location)*

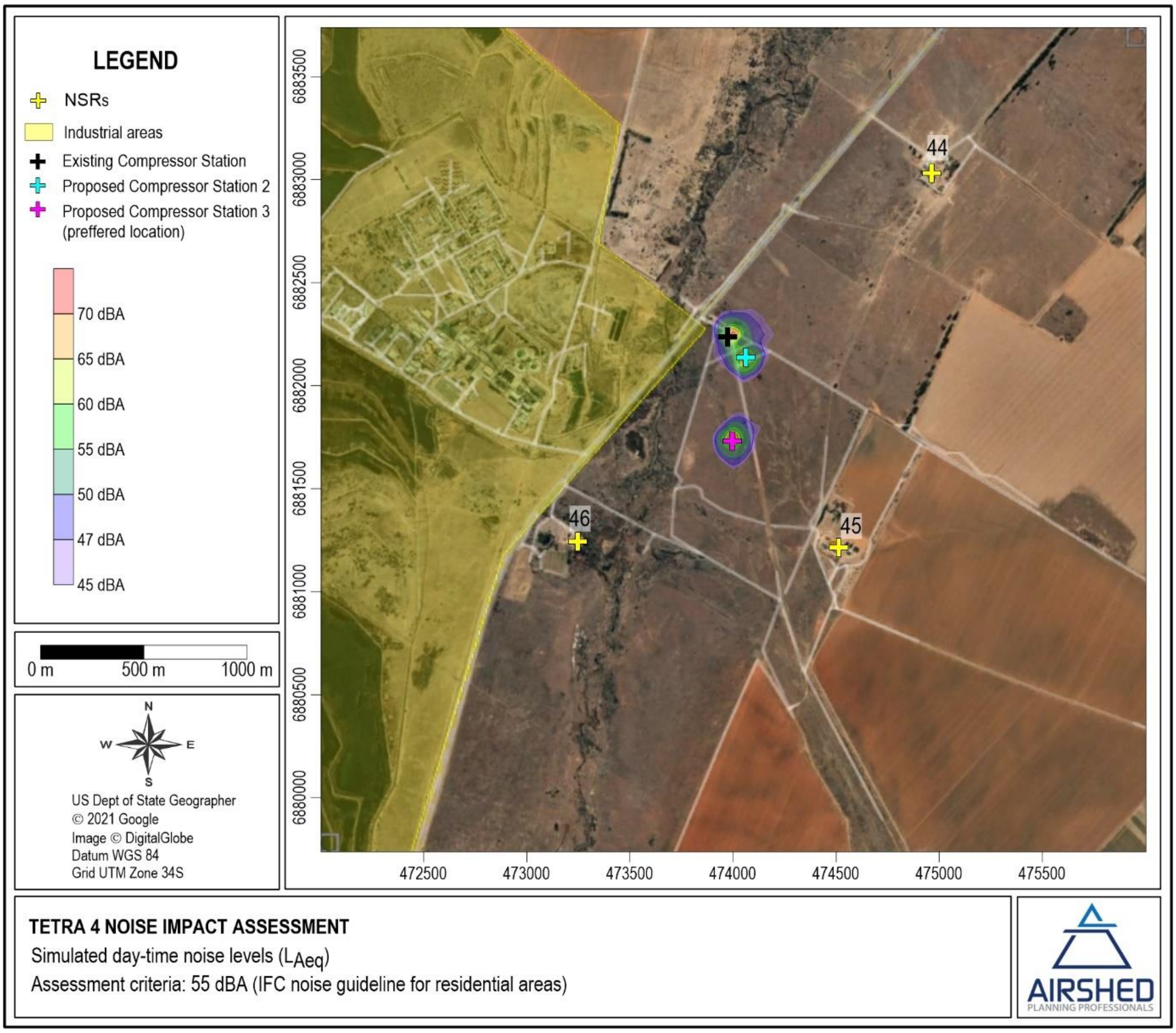



*Figure 4-19: Isopleths indicating the simulated day-time noise levels (LAeq) due to cumulative Compressor Station operations (Compressor Stations for Cluster 1 and Cluster 2) at the CS2 site (assuming the preferred CS3 location)*

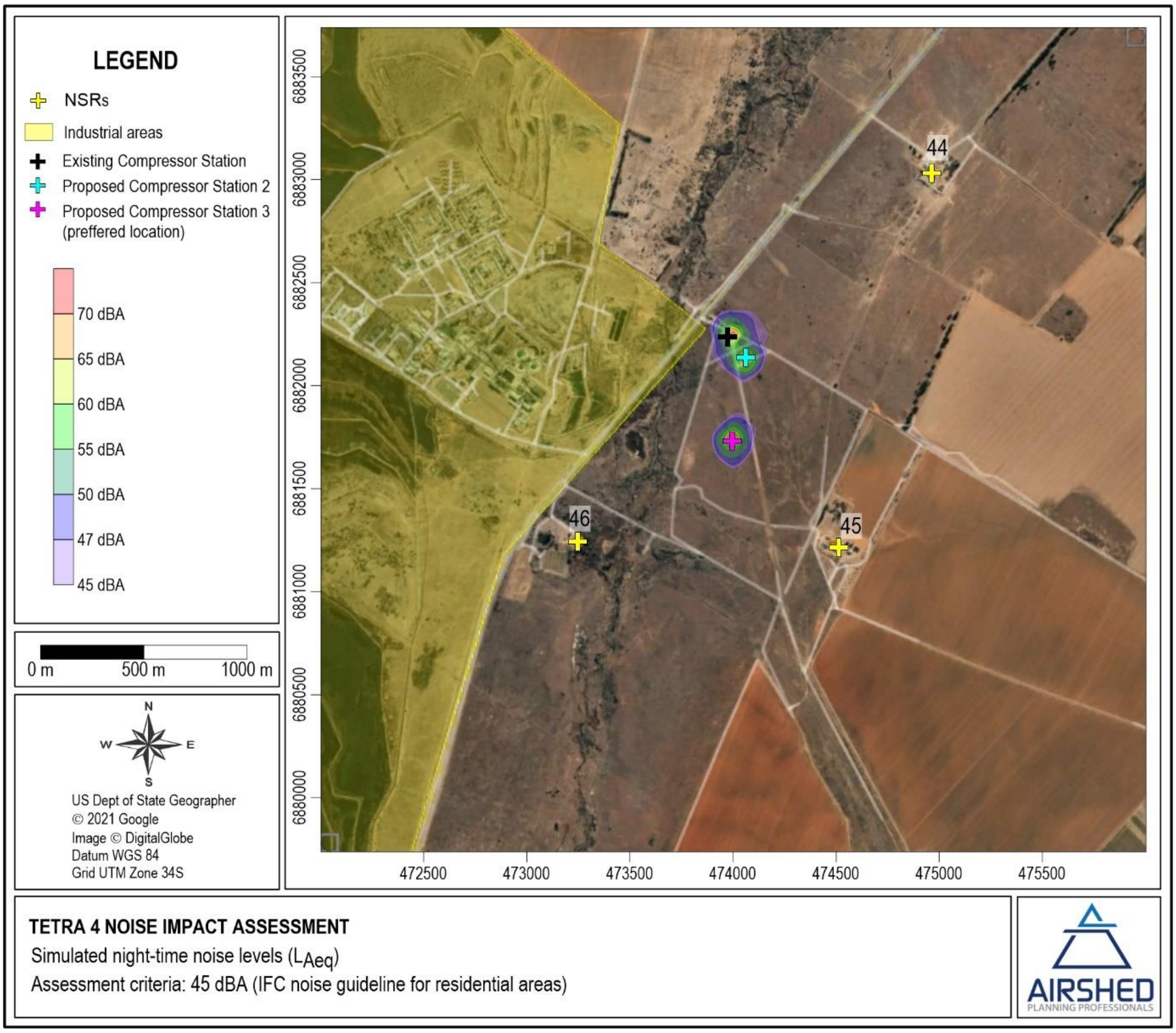



*Figure 4-20: Isopleths indicating the simulated night-time noise levels (LAeq) due to cumulative Compressor Station operations (Compressor Stations for Cluster 1 and Cluster 2) at the CS2 site (assuming the preferred CS3 location)*

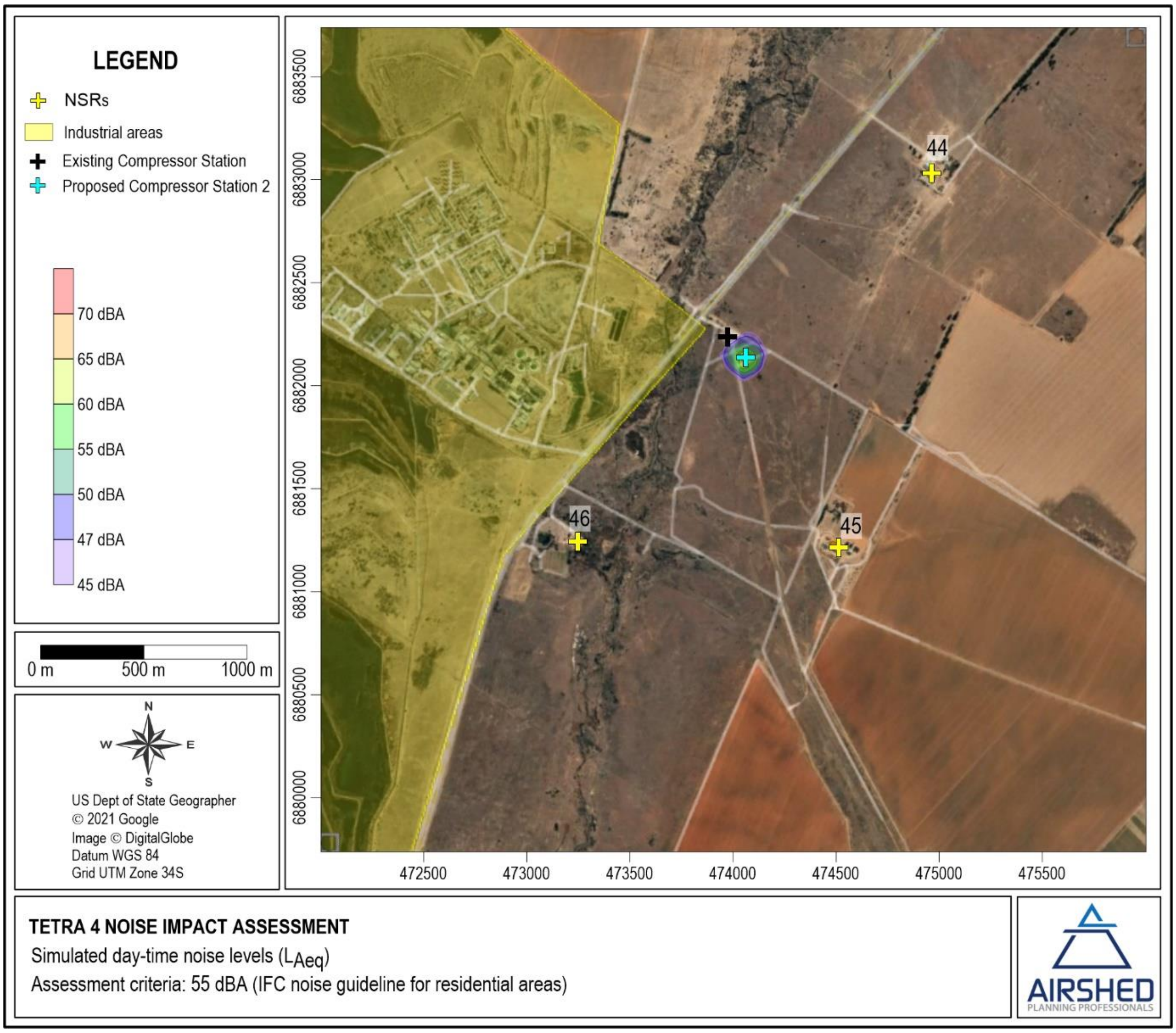



*Figure 4-21: Isopleths indicating the simulated day-time noise levels (LAeq) due to Compressor Station operational activities at the CS2 site (assuming the alternative CS3 location)*

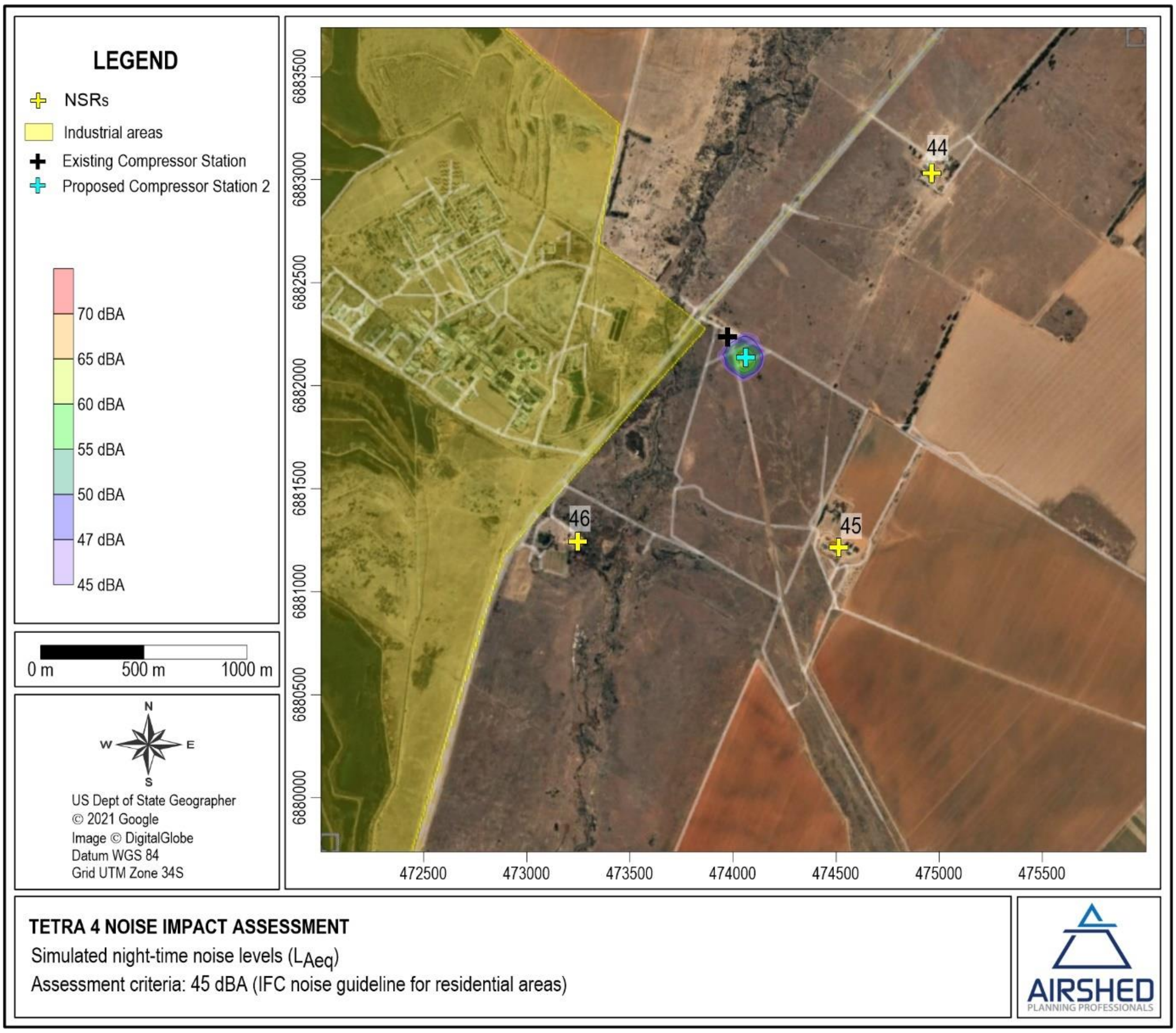



*Figure 4-22: Isopleths indicating the simulated night-time noise levels (LAeq) due to Compressor Station operational activities at the CS2 site (assuming the alternative CS3 location)*

*Table 4-9: Summary of simulated day-time noise levels (provided as dBA) due to the Plant and Compressor Station operation activities (assuming preferred location for CS3) and baseline noise measurements at NSRs within the vicinity of the project*

| Noise Sensitive Receptor | Comments | Project operations (a) | | Baseline | | Increase Above Baseline (b) | |
|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night |
| NSR1 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR2 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR3 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR4 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR5 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR6 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR7 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR8 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR9 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR10 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR11 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR12 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |

| Noise Sensitive Receptor | Comments | Project operations [a] | | Baseline | | Increase Above Baseline [b] | |
|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night |
| NSR13 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR14 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR15 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR16 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR17 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR18 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR19 | Baseline noise levels typical of rural districts | 23.8 | 25.0 | 45.0 | 35.0 | 0.0 | 0.4 |
| NSR20 | Baseline noise levels typical of rural districts | 25.9 | 27.0 | 45.0 | 35.0 | 0.1 | 0.6 |
| NSR21 | Baseline noise levels typical of rural districts | 30.7 | 31.8 | 45.0 | 35.0 | 0.2 | 1.7 |
| NSR22 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR23 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR24 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR25 | Baseline noise levels typical of urban districts (<550m from road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR26 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR27 | Baseline noise levels typical of suburban districts (<1000m from road) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR28 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR29 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR30 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR31 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR32 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR33 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR34 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR35 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR36 | Baseline noise levels typical of suburban districts (<1000m from R30) | 28.8 | 28.6 | 50.0 | 40.0 | 0.0 | 0.3 |
| NSR37 | Baseline noise levels typical of rural districts | 34.3 | 34.4 | 45.0 | 35.0 | 0.4 | 2.7 |
| NSR38 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR39 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR40 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR41 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR42 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR43 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR44 | Baseline noise levels typical of rural districts | 13.4 | 12.2 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR45 | Baseline noise levels typical of rural districts | 21.7 | 20.9 | 45.0 | 35.0 | 0.0 | 0.2 |
| NSR46 | Baseline noise levels typical of rural districts | 19.0 | 19.8 | 45.0 | 35.0 | 0.0 | 0.1 |
| NSR47 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR48 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR49 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR50 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR51 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR52 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR53 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR54 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR55 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |

| Noise Sensitive Receptor | Comments | Project operations (a) | | Baseline | | Increase Above Baseline (b) | |
|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night |
| NSR56 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR57 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR58 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR59 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |

**Notes:**

(c) Exceedances of IFC guideline (55 dBA for day-time and 45 dBA for night-time at residential areas) are provided in bold.

(d) Likely community response in accordance with the SANS 10103:

| <3 dBA | <5 dBA | <10 dBA | <15 dBA | <20 dBA |
|---|---|---|---|---|
| *Change imperceptible* | *No reaction* | *'Little' reaction with sporadic complaints* | *'Medium' reaction with widespread complaints* | *'Strong' to 'very strong' reaction with threats of community action or vigorous community action.* |

*Table 4-10: Summary of simulated day-time noise levels (provided as dBA) due to the Plant and Compressor Station operation activities (assuming alternative location for CS3) and baseline noise measurements at NSRs within the vicinity of the project*

| Noise Sensitive Receptor | Comments | Project operations (a) | | Baseline | | Increase Above Baseline (b) | |
|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night |
| NSR1 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR2 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR3 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR4 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR5 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR6 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR7 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR8 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR9 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR10 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR11 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR12 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR13 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR14 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR15 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR16 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR17 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR18 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR19 | Baseline noise levels typical of rural districts | 23.8 | 25.0 | 45.0 | 35.0 | 0.0 | 0.4 |
| NSR20 | Baseline noise levels typical of rural districts | 25.9 | 27.0 | 45.0 | 35.0 | 0.1 | 0.6 |
| NSR21 | Baseline noise levels typical of rural districts | 30.7 | 31.8 | 45.0 | 35.0 | 0.2 | 1.7 |
| NSR22 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR23 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR24 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR25 | Baseline noise levels typical of urban districts (<550m from road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR26 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR27 | Baseline noise levels typical of suburban districts (<1000m from road) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR28 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR29 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |

| Noise Sensitive Receptor | Comments | Project operations [a] | | Baseline | | Increase Above Baseline [b] | |
|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night |
| NSR30 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR31 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR32 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR33 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR34 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR35 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR36 | Baseline noise levels typical of suburban districts (<1000m from R30) | 28.8 | 28.6 | 50.0 | 40.0 | 0.0 | 0.3 |
| NSR37 | Baseline noise levels typical of rural districts | 34.3 | 34.4 | 45.0 | 35.0 | 0.4 | 2.7 |
| NSR38 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR39 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR40 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR41 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR42 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR43 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR44 | Baseline noise levels typical of rural districts | 11.9 | 10.6 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR45 | Baseline noise levels typical of rural districts | 16.9 | 16.3 | 45.0 | 35.0 | 0.0 | 0.1 |
| NSR46 | Baseline noise levels typical of rural districts | 13.6 | 14.3 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR47 | Baseline noise levels typical of rural districts | 19.0 | 19.9 | 45.0 | 35.0 | 0.0 | 0.1 |
| NSR48 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR49 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR50 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR51 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR52 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR53 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR54 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR55 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR56 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR57 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR58 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR59 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |

**Notes:**

(a) Exceedances of IFC guideline (55 dBA for day-time and 45 dBA for night-time at residential areas) are provided in bold.

(b) Likely community response in accordance with the SANS 10103:

| <3 dBA | <5 dBA | <10 dBA | <15 dBA | <20 dBA |
|---|---|---|---|---|
| *Change imperceptible* | *No reaction* | *'Little' reaction with sporadic complaints* | *'Medium' reaction with widespread complaints* | *'Strong' to 'very strong' reaction with threats of community action or vigorous community action.* |

*Table 4-11: Summary of simulated day-time noise levels (provided as dBA) due to the Plant and cumulative Compressor Station operations (Compressor Stations for Cluster 1 and Cluster 2 operations) (assuming preferred location for CS3) and baseline noise measurements at NSRs within the vicinity of the project*

| Noise Sensitive Receptor | Comments | Project operations [a] | | Baseline | | Increase Above Baseline [b] | |
|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night |
| NSR1 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR2 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR3 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR4 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR5 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR6 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR7 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR8 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR9 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR10 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR11 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR12 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR13 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR14 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR15 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR16 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR17 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR18 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR19 | Baseline noise levels typical of rural districts | 23.8 | 25.0 | 45.0 | 35.0 | 0.0 | 0.4 |
| NSR20 | Baseline noise levels typical of rural districts | 25.9 | 27.0 | 45.0 | 35.0 | 0.1 | 0.6 |
| NSR21 | Baseline noise levels typical of rural districts | 30.7 | 31.8 | 45.0 | 35.0 | 0.2 | 1.7 |
| NSR22 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR23 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR24 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR25 | Baseline noise levels typical of urban districts (<550m from road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR26 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR27 | Baseline noise levels typical of suburban districts (<1000m from road) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR28 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR29 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR30 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR31 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR32 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR33 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR34 | Baseline noise levels assumed to be typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR35 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR36 | Baseline noise levels typical of suburban districts (<1000m from R30) | 28.8 | 28.6 | 50.0 | 40.0 | 0.0 | 0.3 |
| NSR37 | Baseline noise levels typical of rural districts | 34.3 | 34.4 | 45.0 | 35.0 | 0.4 | 2.7 |
| NSR38 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR39 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR40 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |

| Noise Sensitive Receptor | Comments | Project operations (a) | | Baseline | | Increase Above Baseline (b) | |
|---|---|---|---|---|---|---|---|
| | | Day | Night | Day | Night | Day | Night |
| NSR41 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR42 | Baseline noise levels typical of suburban districts (<1000m from R30) | 0.0 | 0.0 | 50.0 | 40.0 | 0.0 | 0.0 |
| NSR43 | Baseline noise levels typical of urban districts (<500m from R30 road) | 0.0 | 0.0 | 55.0 | 45.0 | 0.0 | 0.0 |
| NSR44 | Baseline noise levels typical of rural districts | 15.9 | 14.6 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR45 | Baseline noise levels typical of rural districts | 22.5 | 21.8 | 45.0 | 35.0 | 0.0 | 0.2 |
| NSR46 | Baseline noise levels typical of rural districts | 20.0 | 20.8 | 45.0 | 35.0 | 0.0 | 0.2 |
| NSR47 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR48 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR49 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR50 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR51 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR52 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR53 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR54 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR55 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR56 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR57 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR58 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |
| NSR59 | Baseline noise levels typical of rural districts | 0.0 | 0.0 | 45.0 | 35.0 | 0.0 | 0.0 |

**Notes:**

(a) Exceedances of IFC guideline (55 dBA for day-time and 45 dBA for night-time at residential areas) are provided in bold.

(b) Likely community response in accordance with the SANS 10103:

| <3 dBA | <5 dBA | <10 dBA | <15 dBA | <20 dBA |
|---|---|---|---|---|
| *Change imperceptible* | *No reaction* | *'Little' reaction with sporadic complaints* | *'Medium' reaction with widespread complaints* | *'Strong' to 'very strong' reaction with threats of community action or vigorous community action.* |

# 5 Impact Significance Rating

The significance of environmental noise impacts was assessed according to the methodology adopted by EIMS (Appendix F).

### 5.1.1 Construction

The assumption is that construction activities would be during day-time hours only.

Given the nature of construction activities for the pipeline, wells and Blower Stations (where the location may vary depending on the gas reserves in the area) the noise levels at the nearest residential receptors to the construction areas may exceed IFC guidelines for residential areas (55 dBA). If there are exceedances of this guideline, it would be of short duration. The negative noise impacts are therefore considered to be of **medium** significance without mitigation and **low** significance with mitigation at the nearest receptors due to these activities (Table 5-1 and Table 5-2).

*Table 5-1: Significance rating for potential noise impacts due to the construction of the pipeline*

| **Impact Name** | **Increase in noise levels due to construction of the pipeline** | | | | |
|---|---|---|---|---|---|
| **Alternative** | **NA** | | | | |
| **Phase** | **Construction** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 4 | 3 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 2 | 2 |
| Duration of Impact | 2 | 2 | Probability | 4 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -11.00 |
| Mitigation Measures | | | | | |
| As construction will only take place during day-time hours and will be of limited duration, NSRs within 90 m of the pipeline construction site should be notified of the activities and potential disturbance durations prior to construction taking place.<br>Additional mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -7.50 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 2 |
| *Issue has received a meaningful and justifiable public response* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.17 |
| **Final Significance** | | | | | -8.75 |

*Table 5-2: Significance rating for potential noise impacts due to the construction of the wells and Blower Stations*

| **Impact Name** | **Increase in noise levels due to construction of the wells and Blower Stations** | | | | |
|---|---|---|---|---|---|
| **Alternative** | **NA** | | | | |
| **Phase** | **Construction** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 4 | 3 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 2 | 2 |
| Duration of Impact | 3 | 2 | Probability | 4 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -12.00 |
| Mitigation Measures | | | | | |
| As construction will only take place during day-time hours and will be of limited duration, NSRs within 400 m radius of all well construction sites and 600 m from Blower Station construction sites should be notified of the activities and potential disturbance durations prior to construction taking place.<br>The noise levels due to Blower Station operations is likely to exceed the IFC night-time noise guideline for residential areas up to 150 m from the operations. Care should be taken to site the Blower Stations at least 150 m from all NSRs.<br>Additional mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -7.50 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 2 |
| *Issue has received a meaningful and justifiable public response* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.17 |
| **Final Significance** | | | | | -8.75 |

The noise levels at the nearest residential receptors due to the construction activities of the Plant and Compressor Stations are not likely to exceed day-time IFC guidelines for residential areas (55 dBA). The negative noise impacts are therefore considered to be of **low** significance without and with mitigation at the nearest receptors due to these activities (Table 5-3 and Table 5-4).

*Table 5-3: Significance rating for potential noise impacts due to the construction of the plant and Compressor Stations (assuming the preferred location for CS3)*

| **Impact Name** | **Increase in noise levels due to construction of the Plant and Compressor Stations** | | | | |
|---|---|---|---|---|---|
| **Alternative** | **Assuming preferred location for CS3** | | | | |
| **Phase** | **Construction** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 3 | 2 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 2 | 2 |
| Duration of Impact | 3 | 3 | Probability | 3 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -8.25 |
| Mitigation Measures | | | | | |
| Mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -7.50 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 2 |
| *Issue has received a meaningful and justifiable public response* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.17 |
| **Final Significance** | | | | | -8.75 |

*Table 5-4: Significance rating for potential noise impacts due to the construction of the plant and Compressor Stations (assuming the alternative location for CS3)*

| Impact Name | Increase in noise levels due to construction of the Plant and Compressor Stations | | | | |
|---|---|---|---|---|---|
| **Alternative** | **Assuming the alternative location for CS3** | | | | |
| **Phase** | **Construction** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 3 | 2 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 2 | 2 |
| Duration of Impact | 3 | 3 | Probability | 3 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -8.25 |
| Mitigation Measures | | | | | |
| Mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -7.50 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 2 |
| *Issue has received a meaningful and justifiable public response* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.17 |
| **Final Significance** | | | | | -8.75 |

### 5.1.2 Operation

The operational activities would take place during day- and night-time conditions.

The noise levels due to Blower Station operations is likely to exceed the IFC night-time noise guideline for residential areas up to 150 m from the operations. Care should be taken to site the Blower Stations at least 150 m from all NSRs. With careful siting, IFC noise guidelines for residential areas should not be exceeded at NSRs. The negative noise impacts are therefore considered to be of **low** significance at the nearest receptors (Table 5-5).

Given the location of the Plant and the Compressor Stations and the potential noise levels due to operations, it is unlikely that IFC noise guidelines for residential areas will be exceeded at NSRs. The negative noise impacts are therefore considered to be of **low** significance at the nearest receptors (Table 5-6 and Table 5-7).

*Table 5-5: Significance rating for potential noise impacts due to the operation of the Blower Stations*

| **Impact Name** | **Increase in noise levels due to Blower Station operation** | | | | |
|---|---|---|---|---|---|
| **Alternative** | **NA** | | | | |
| **Phase** | **Operation** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 3 | 2 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 3 | 3 |
| Duration of Impact | 4 | 4 | Probability | 3 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -9.75 |
| Mitigation Measures | | | | | |
| The noise levels due to Blower Station operations is likely to exceed the IFC night-time noise guideline for residential areas up to 150 m from the operations. Care should be taken to site the Blower Stations at least 150 m from all NSRs.<br>Mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -9.00 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 1 |
| *Low: Issue not raised in public responses* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.00 |
| **Final Significance** | | | | | -9.00 |

*Table 5-6: Significance rating for potential noise impacts due to the operation of the Plant and Compressor Stations (assuming the preferred location for CS3)*

| **Impact Name** | **Increase in noise levels due to Plant and Compressor Station operation** | | | | |
|---|---|---|---|---|---|
| **Alternative** | **Assuming preferred location for CS3** | | | | |
| **Phase** | **Operation** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 3 | 2 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 3 | 3 |
| Duration of Impact | 4 | 4 | Probability | 3 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -9.75 |
| Mitigation Measures | | | | | |
| Mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -9.00 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 1 |
| *Low: Issue not raised in public responses* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.00 |
| **Final Significance** | | | | | -9.00 |

*Table 5-7: Significance rating for potential noise impacts due to the operation of the Plant and Compressor Stations (assuming the alternative location for CS3)*

| Impact Name | Increase in noise levels due to Plant and Compressor Station operation | | | | |
|---|---|---|---|---|---|
| **Alternative** | **Assuming the alternative location for CS3** | | | | |
| **Phase** | **Operation** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 3 | 2 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 3 | 3 |
| Duration of Impact | 4 | 4 | Probability | 3 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -9.75 |
| Mitigation Measures | | | | | |
| Mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -9.00 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 1 |
| *Low: Issue not raised in public responses* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.00 |
| **Final Significance** | | | | | -9.00 |

### 5.1.3 Decommissioning and Closure

The assumption is that decommissioning would be during day-time hours only. Given the nature of decommissioning activities, and the extent of the process, IFC noise guidelines for residential areas may be exceeded sporadically at NSRs. Attenuation measures, however, can be implemented to reduce noise levels. The negative noise impacts are therefore considered to be of **medium** significance without mitigation and **low** significance with mitigation at the nearest receptors (Table 5-8 and Table 5-9).

*Table 5-8: Significance rating for potential noise impacts due to the decommissioning and closure phase of the project (assuming the preferred location for CS3)*

| **Impact Name** | **Increase in noise levels** | | | | |
|---|---|---|---|---|---|
| **Alternative** | **Assuming preferred location for CS3** | | | | |
| **Phase** | **Decommissioning** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 4 | 3 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 2 | 2 |
| Duration of Impact | 2 | 2 | Probability | 4 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -11.00 |
| Mitigation Measures | | | | | |
| Mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -7.50 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 1 |
| *Low: Issue not raised in public responses* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.00 |
| **Final Significance** | | | | | -7.50 |

*Table 5-9: Significance rating for potential noise impacts due to the decommissioning and closure phase of the project (assuming the alternative location for CS3)*

| **Impact Name** | **Increase in noise levels** | | | | |
|---|---|---|---|---|---|
| **Alternative** | **Assuming the alternative location for CS3** | | | | |
| **Phase** | **Decommissioning** | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 4 | 3 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 2 | 2 |
| Duration of Impact | 2 | 2 | Probability | 4 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -11.00 |
| Mitigation Measures | | | | | |
| Mitigation measures are detailed in Section 6. | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -7.50 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Public Response | | | | | 1 |
| *Low: Issue not raised in public responses* | | | | | |
| Cumulative Impacts | | | | | 1 |
| *Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.* | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| *The impact is unlikely to result in irreplaceable loss of resources.* | | | | | |
| Prioritisation Factor | | | | | 1.00 |
| **Final Significance** | | | | | -7.50 |

# 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 will be met at all off-site noise sensitive receptors.

The measures discussed in this section are measures typically applicable to industrial sites and are considered good practice by the IFC (2007) and British Standard BSI (2008).

It should be noted that not all mitigation measures are to be implemented, but should the need arise the mitigation measures as discussed in this section can be considered.

The mitigation measured discussed also takes into account the existing management measures utilised for the existing Cluster 1 Environmental Management Programme (EIMS, 2019). The approach adopted for this section is as follows:

- If the current mitigation measures for a particular impact are considered adequate, reference will be made to the existing mitigation measures (using the mitigation reference numbers provided in the 2019 Environmental Management Programme (EMPr));
- If the current mitigation measures are inadequate, amendments will be provided; and,
- If additional mitigation measures are required, these will be highlighted as additional to the existing approved EMPr.

## 6.1 Controlling Noise at the Source

### 6.1.1 General Good Practice Measures

Although the current EMPr (number 50) specifies complaints need to be registered it is recommended that the complaints register description be expanded (for number 50 and number 78) as follows:

- A complaints register, including the procedure which governs how complaints are received, managed and responses given, must be implemented, and maintained.

The existing EMPr specifies that construction activities should where possible be during day-time (number 50). It is recommended that this be expanded as follows (applying to all phases of the project):

- Unless it is an emergency situation, non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.

### 6.1.2 Specifications and Equipment Design

It is recommended that the current EMPr include the following specifications for equipment (number 50 and number 78):

- 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

The existing EMPr specifies enclosures (number 50). The following additional information could be included:

- 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 (additional measures to be included in the EMPr (number 50 and number 78)):

a) Machines and mobile equipment used intermittently 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) Acoustic covers of engines should be kept closed when in use or idling.

### 6.1.5 Noise Impacts at Sensitive Receptors

The current EMPr (number 50) specifies that construction activities should not be within 500 m from sensitive receptors if occurring at night. Construction activities were specified for the current assessment to be taking place at night. The distance from sensitive receptors (day-time) can be amended to 600 m as this is the predicted noise impacts for construction of blower stations. Alternatively, distances for noise impacts, due to various activities, can be specified as follows:

- Construction (day-time):
    - Wells: 400 m
    - Pipeline: 90 m
    - Blower station: 600 m
    - Plant: 430 m
    - Compressors: 420 m
- Operation (day-time):
    - Blower station: 50 m
    - Plant: 170 m
    - Compressors: 80 m
- Operation (night-time):
    - Blower station: 150 m
    - Plant: 580 m
    - Compressors: 150 m

### 6.1.6 Maintenance

Regular and effective maintenance of equipment are included in the current EMPr (number 50). This should also be included for the operational phase (number 78).

## 6.2 Monitoring

In the event that noise related complaints are received, the existing EMPr makes provision for short term ambient noise measurements. The EMPr specifies that the noise levels should be co-ordinated with the 10-m wind speed. It should be noted that it is good practice to undertake noise measurements when wind speeds are less than 5 m/s and it is recommended that this description be ammended.

It is also recommended that the following procedure be adopted and included in the EMPr 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 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.

# 7 Conclusion

Based on the findings of the assessment and provided the recommended general “good practice” management and mitigation measures are in place, it is the specialist opinion that the project may be authorised.

# 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.

BSI, 2014. *Code of practice for noise and vibration control on construction and open sites - Part 1: Noise.* s.l.:s.n.

Bugliarello, G., Alexandre, A., Barnes, J. & Wakstein, C., 1976. *The impact of noise pollution | A socio-technological introduction.* s.l.:Pergamon Press.

De Jager, M., 2016. *Environmental Noise Impact Assessment for the Development of a Gas Field near Virginia, Free State Province,* 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

| CURRICULUM VITAE | RENEÉ VON GRUENEWALDT |
|---|---|

## *FULL CURRICULUM VITAE*

| | |
|---|---|
| **Name of Firm** | Airshed Planning Professionals (Pty) Ltd |
| **Name of Staff** | Reneé von Gruenewaldt (*nee* Thomas) |
| **Profession** | Air Quality and Environmental Noise Scientist |
| **Date of Birth** | 13 May 1978 |
| **Years with Firm** | 19 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

Reneé von Gruenewaldt (Air Quality Scientist): Reneé joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over nineteen (19) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and eight (8) years of experience in the field of environmental 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 air quality 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 air emission models includes Tanks 4.0 (for the quantification of tank emissions), WATER9 (for the quantification of wastewater 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 for propagation of industrial, road and rail noise sources.

Having worked on projects throughout Africa (i.e., South Africa, Mozambique, Malawi, Kenya, Angola, Democratic Republic of Congo, Namibia, Madagascar and Egypt for Air Quality Impact Assessments and Mozambique, Namibia, Botswana, Kenya, Ghana, Suriname and Afghanistan for Environmental Noise Impact Assessments) Reneé 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 (AIR QUALITY)

### Mining and Ore Handling

Reneé 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. Reneé 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

Reneé 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).

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

## RELEVANT EXPERIENCE (NOISE)

### Mining

Reneé has undertaken numerous environmental noise assessments for mining operations. These include environmental noise impact assessments including baseline noise surveys for Balama (Mozambique), Masama Coal (Botswana), Lodestone (Namibia), Prieska (SA), Kolomela (SA) Heuningkranz (SA), Syferfontein (SA), South 32 (SA), Mamatwan and Marula Platinum Mine (SA).

### Power Generation

Environmental noise assessments have been completed for numerous Eskom coal fired power station studies in SA including the Kriel Fabric Filter Plant, Kendal ash facility, Medupi ash facility. Apart from Eskom projects, power plant assessments have also been completed in Botswana (Morupule), Kenya (Or Power geothermal power plants), Suriname (EBS power plant) and SA (Richards Bay combined cycle power plant).

### Process Operations

Environmental noise assessments have been undertaken for various process operations including waste disposal facilities (Bon Accord in Gauteng), bottling and drink facilities (Imali and Isanti Project in Gauteng) and Smelter (Gamsberg in Northern Cape).

### Transport

An environmental noise assessment was completed for the Obetsebi road expansion and flyover project in Ghana.

### Gas Pipelines

An environmental noise assessment is currently being undertaken for the Sheberghan gas pipeline in Afghanistan.

### Baseline Noise Surveys

Baseline noise surveys have been undertaken for numerous mining and process operation activities (including Raumix quarries and Sibanye Stillwater Platinum Mines (SA)) in support of onsite Environmental Management Programmes.

## 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)<br>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)<br>Environmental Management and Impact Assessments |
| **B.Sc Earth Sciences** | University of Pretoria, RSA, (2000)<br>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, Botswana, Ghana, Suriname, Afghanistan, 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 | Fair | Fair |

## CERTIFICATION

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

| | |
|---|---|
| _______________________ | 24/05/2021 |
| Signature of staff member | Date (Day / Month / Year) |

Full name of staff member: Reneé Georgeinna von Gruenewaldt

# Appendix B – Declaration of Independence

**SPECIALIST DECLARATION**

I, Reneé von Gruenewaldt, hereby declare that:

- I act as the independent specialist in this application.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant.
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity.
- I will comply with the Act, Regulations and all other applicable legislation.
- I have not, and will not engage in, conflicting interests in the undertaking of the activity.
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority.
- All the particulars furnished by me in this form are true and correct.
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

21 June 2022

## Appendix C – Sound Level Meter Calibration Certificates

sanas
Calibration Laboratory
148
1302

**M AND N ACOUSTIC SERVICES (Pty) Ltd**
Co. Reg. No: 2012/123238/07 VAT NO: 4300255876 BEE Status: Level 4
P.O. Box 61713, Pierre van Ryneveld, 0045

No. 15, Mustang Avenue
Pierre van Ryneveld, 0045

Tel: 012 689-2007 ( 076 920 3070) • Fax: 086 211 4690
E-mail: admin@mnacoustics.co.za
Website: www.mnacoustics.co.za

# CERTIFICATE OF CONFORMANCE

| | |
|---|---|
| CERTIFICATE NUMBER | 2021-AS-0246 |
| ORGANISATION | AIRSHED PLANNING PROFESSIONALS (PTY) LTD |
| ORGANISATION ADDRESS | P.O. BOX 5260, HALFWAY HOUSE, 1685 |
| CALIBRATION OF | ACOUSTIC CALIBRATOR |
| MANUFACTURER | SVANTEK |
| MODEL NUMBER | SV 33 |
| SERIAL NUMBER | 43170 |
| DATE OF CALIBRATION | 02 MARCH 2021 |
| RECOMMENDED DUE DATE | -------------------- |
| PAGE NUMBER | PAGE 1 OF 3 |

*This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and M and N Acoustic Services.*

*Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA.*

*The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.*

*The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org*

| Calibrated by: | Authorized/Checked by: | Date of Issue: |
|---|---|---|
| W.S. SIBANYONI (CALIBRATION TECHNICIAN) | M. NAUDÉ (SANAS TECHNICAL SIGNATORY) | 02 MARCH 2021 |

Director: Marianka Naudé

**Conditions under Which M and N Acoustic Services (Pty) Ltd Will Perform Work**

In this document, reference to a service of services will include: calibration, measurement analysis or conformance work performed by M and N Acoustics on behalf of the Applicant.

1. Services are carried out at the discretion of M and N Acoustic Services, which reserves the right to decline any application for performance or services when deemed to be outside the scope of services of this Company.

2. Through acceptance of the original quotation, the Applicant agrees to the quoted fee and the conditions state herein. In cases where M and N Acoustic Services has not published the amount of the fee, M and N Acoustic Services will in good faith give estimates of the time and cost of the service based upon its previous experience.

3. Payment is strictly COD, or 30 days from the date of invoice, or as mutually agreed in writing between the Applicant and M and N Acoustic Services before the service is commenced. M and N Acoustic Services retains the right to ask for a deposit for services.

4. All instruments, items of equipment, etc. sent by the Applicant for performance of service shall be delivered and collected at the Applicant's own cost and risk.

5. M and N Acoustic Services cannot guarantee to complete the work within the estimated time and cost but will consult the Applicant of it becomes apparent that either estimate will be exceeded.

6. If a service is not completed because of defects or deficiencies in the item submitted by the applicant, an appropriate reduction in the fee may be allowed depending on the amount of work already performed. The normal practice will be to charge the fee in full.

7. The Applicant hereby consents that the legal liability of M and N Acoustic Services with regard to any damage whatsoever or a mistake made by M and N Acoustic Services in services performed for the Applicant will be limited to the original quoted fee.

8. Regarding certificates and reports:

   - A certificate or report will be furnished to the Applicant on completion of the service.
   - Additional certified copies of certificates, or re-issued certificates will be subjected to an additional fee, as determined on a case by case basis.
   - The values in the issued certificates are correct at the time of calibration. Subsequently the accuracy will depend on such factors as the care exercised in handling and use of the instrument and the frequency of use.
   - Re-calibration should be performed after a period which has been chosen to ensure that the instrument's accuracy remains within the desired limits.

## 1. PROCEDURE

The UUT was calibrated according to the procedures 1002/P/001 and also to the IEC 60942 specifications for Sound Level Calibrators as well as the manufacturer's specifications.

## 2. MEASURING EQUIPMENT

| | | | |
|---|---|---|---|
| Keysight | 34461A | Digital Multimeter | MY 53223905 |
| Greysinger | 80 CL | Environmental Logger | 02304030/1/2 |
| G.R.A.S | 42 AP | Piston Phone | 256092 |
| G.R.A.S | 26 AJ | ½" Pre-Amplifier | 188476 |
| B&K | 2363 | Measuring Amplifier | 1232647 |
| G.R.A.S | 40 AG | ½" Microphone | 19721 |
| Leader | LDM-170 | Distortion Meter | 0100240 |
| Svantek | SV 35 | Acoustic Calibrator | 58106 |
| LG | FC-7015 | Universal Counter | 00022701 |
| Agilent | 34461A | Digital Multimeter | MY 53205694 |
| G.R.A.S | 42 AG | Multi-Frequency Calibrator | 279025 |

## 3. RESULTS

3.1 The following parameters of the Calibrator were calibrated:

| | |
|---|---|
| Output Level | IEC 60942: Section 5.2.3 |
| Output Frequency | IEC 60942: Section 5.3.3 |
| Selective Distortion | IEC 60942: Section A.4.9 |

The Calibrator output level was found to be 114,1 dB at 1 000 Hz.
No adjustment was made.

These results were corrected to the ambient condition of 1 013,25 Pa.

Conclusion: The Calibrator complied with the above-specified clauses of the IEC 60942 specification and requirements according to ARP 0109:2014. **Class 1.**

| *Calibrated by:* | *Authorized/Checked by:* |
|---|---|
| *W.S. SIBANYONI*<br>*(CALIBRATION TECHNICIAN)* | *M. NAUDÉ*<br>*(SANAS TECHNICAL SIGNATORY)* |

*Director: Marianka Naudé*

## 4. REMARKS

4.1 The reported expanded uncertainties of measurements are based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95,45 %, the uncertainties of measurements have been estimated in accordance with the principles defined in the GUM (Guide to Uncertainty of Measurement) ISO, Geneva, 1993.

4.2 The environmental conditions were:

| | |
|---|---|
| Temperature: | (23 ± 2) °C |
| Relative Humidity: | (50 ± 15) %RH |

4.3 Calibration labels bearing cal date, due date (if requested), certificate number and serial number have been affixed to the instrument.

4.4 The above statement of conformance is based on the measurement values obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limits

4.5 The uncertainty of measurements was estimated as follows:

Acoustic Calibrator: ± 0,19 dB

4.6 The results on this Certificate relates only to the items and parameters calibrated.

**------------SECTION 4.5 THE END OF CERTIFICATE-----------**

| *Calibrated by:* | *Authorized/Checked by:* |
|---|---|
| *W.S. SIBANYONI (CALIBRATION TECHNICIAN)* | *M. NAUDÉ (SANAS TECHNICAL SIGNATORY)* |

*Director: Marianka Naudé*

Calibration Laboratory

148
1302

**M AND N ACOUSTIC SERVICES (Pty) Ltd**
Co. Reg. No: 2012/123238/07 VAT NO: 4300255876 BEE Status: Level 4
P.O. Box 61713, Pierre van Ryneveld, 0045
No. 15, Mustang Avenue
Pierre van Ryneveld, 0045
Tel: 012 689-2007 (076 920 3070) • Fax: 086 211 4690
E-mail: admin@mnacoustics.co.za
Website: www.mnacoustics.co.za

# CERTIFICATE OF CALIBRATION

| | |
|---|---|
| CERTIFICATE NUMBER | 2021-AS-0250 |
| ORGANISATION | AIRSHED PLANNING PROFESSIONALS (PTY) LTD |
| ORGANISATION ADRESS | P.O. BOX 5260, HALFWAY HOUSE, 1685 |
| CALIBRATION OF | SOUND & VIBRATION ANALYZER complete with built-in ⅓-OCTAVE/OCTAVE FILTER, ½" PRE-AMPLIFIER and ½" MICROPHONE |
| MANUFACTURERS | SVANTEK and ACO |
| MODEL NUMBERS | SVAN 977, SV 12L and 7052E |
| SERIAL NUMBERS | 36183, 40659 and 78692 |
| DATE OF CALIBRATION | 01-02 MARCH 2021 |
| RECOMMENDED DUE DATE | ------------------------- |
| PAGE NUMBER | PAGE 1 OF 6 |

*This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and M and N Acoustic Services.*

*The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the number of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.*

*The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org*

| Calibrated by: | Authorized/~~Checked by~~: | Date of Issue: |
|---|---|---|
| W.S. SIBANYONI (CALIBRATION TECHNICIAN) | M. NAUDÉ (SANAS TECHNICAL SIGNATORY) | 03 MARCH 2021 |

Director: Marianka Naudé

## Conditions under Which M and N Acoustic Services (Pty) Ltd Will Perform Work

In this document, reference to a service of services will include: calibration, measurement analysis or conformance work performed by M and N Acoustics on behalf of the Applicant.

1. Services are carried out at the discretion of M and N Acoustic Services, which reserves the right to decline any application for performance or services when deemed to be outside the scope of services of this Company.

2. Through acceptance of the original quotation, the Applicant agrees to the quoted fee and the conditions state herein. In cases where M and N Acoustic Services has not published the amount of the fee, M and N Acoustic Services will in good faith give estimates of the time and cost of the service based upon its previous experience.

3. Payment is strictly COD, or 30 days from the date of invoice, or as mutually agreed in writing between the Applicant and M and N Acoustic Services before the service is commenced. M and N Acoustic Services retains the right to ask for a deposit for services.

4. All instruments, items of equipment, etc. sent by the Applicant for performance of service shall be delivered and collected at the Applicant's own cost and risk.

5. M and N Acoustic Services cannot guarantee to complete the work within the estimated time and cost but will consult the Applicant of it becomes apparent that either estimate will be exceeded.

6. If a service is not completed because of defects or deficiencies in the item submitted by the applicant, an appropriate reduction in the fee may be allowed depending on the amount of work already performed. The normal practice will be to charge the fee in full.

7. The Applicant hereby consents that the legal liability of M and N Acoustic Services with regard to any damage whatsoever or a mistake made by M and N Acoustic Services in services performed for the Applicant will be limited to the original quoted fee.

8. Regarding certificates and reports:

   - A certificate or report will be furnished to the Applicant on completion of the service.
   - Additional certified copies of certificates, or re-issued certificates will be subjected to an additional fee, as determined on a case by case basis.
   - The values in the issued certificates are correct at the time of calibration. Subsequently the accuracy will depend on such factors as the care exercised in handling and use of the instrument and the frequency of use.
   - Re-calibration should be performed after a period which has been chosen to ensure that the instrument's accuracy remains within the desired limits.

## 1. PROCEDURE

The Integrating Sound Level Meter was calibrated according to procedure 1002/P/013 and to the IEC 61672-3:2006 specifications as well as the manufacturer's specifications.

The ½" Microphone was calibrated according to procedure 1002/P/002 and 1002/P/011 as well as the manufacturer's specifications.

The ⅓-Octave/Octave Filter was calibrated according to procedure 1002/P/008 and to the IEC 61260 specification as well as the manufacturer's specifications.

## 2. MEASURING EQUIPMENT

| | | | |
|---|---|---|---|
| JFW | 50BR-022 | 50 Ohm Step Attenuator | 4610290708 |
| Agilent | 33522A | Function Generator | MY 50005443 |
| Agilent | 34461A | Digital Multimeter | MY 53224004 |
| Onset | UX100-011 | Environmental Logger | 2047747 |
| Majortech | MT669 | Environmental Logger | 150828469 |
| Svantek | SV 35 | Acoustical Calibrator | 58106 |
| Keysight | 34461A | Digital Multimeter | MY 53223905 |
| G.R.A.S | 42 AP | Piston Phone | 256092 |
| G.R.A.S | 26 AJ | ½" Pre-Amplifier | 188476 |
| G.R.A.S | 40 AG | ½" Microphone | 19721 |
| B&K | 4226 | Multi-Functional Calibrator | 3081642 |
| Greysinger | 80 CL | Data Logger | 02304030/1/2 |
| Gems | 3500B0001A01B000 | Pressure Sensor | 1606-0204475 |
| B&K | 2829 | 4-Ch Microphone Power Supply | 2329283 |

*Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA.*

| Calibrated by: | Authorized/Checked by: |
|---|---|
| W.S. SIBANYONI<br>(CALIBRATION TECHNICIAN) | M. NAUDÉ<br>(SANAS TECHNICAL SIGNATORY) |

Director: Marianka Naudé

## 3. RESULTS - ACCORDING TO THE IEC 61672-3: 2006:

**3.1** The following parameters of the Integrating Sound Level Meter were calibrated:

| Parameter | Specification | Uncertainty of Measurement in dB |
|---|---|---|
| Calibration Check Frequency at 114,0 dB at 1 000 Hz at Nominal Range: High | IEC 61672-3: Clause 9 | ± 0,3 |
| Self-Generated Noise:<br>A-Weighted with Microphone 37,7 dB<br>A-Weighted Electrical 1,1 dB<br>C-Weighted Electrical 0,0 dB<br>Z-Weighted Electrical 3,7 dB<br>B-Weighted Electrical - 0,2 dB | IEC 61672-3: Clause 10 | ------- |
| Level Linearity at 8 000 Hz<br>Nominal Range: High<br>Reference Level at 114,0 dB:<br>(59,3 dB to 148,9 dB) | IEC 61672-3: Clause: 14 | ± 0,3 |
| Level Range Control at 1 000 Hz<br>Reference Level at 114,0 dB<br>Nominal Range: High<br>Low Range | IEC 61672-3: Clause: 15 | ± 0,3 |
| Frequency and Time Weightings at 1 000 Hz at 114,0 dB | IEC 61672-3: Clause 13 | ± 0,3 |
| Tone Burst Response<br>(Max. Fast, Max. Slow, $LA_{eq}$ and SEL) | IEC 61672-3: Clause 16 | ± 0,3 |

| *Calibrated by:* | *Authorized/Checked by:* |
|---|---|
| *W.S. SIBANYONI*<br>*(CALIBRATION TECHNICIAN)* | *M. NAUDÉ*<br>*(SANAS TECHNICAL SIGNATORY)* |

*Director: Marianka Naudé*

| Parameter | Specification | Uncertainty of Measurement in dB |
|---|---|---|
| A-Weighting Network (31,5 to 20 000) Hz | IEC 61672-3: Clause 12 | ± 0,3 |
| C-Weighting Network (31,5 to 20 000) Hz | IEC 61672-3: Clause 12 | ± 0,3 |
| Z- Weighting Network (31,5 to 20 000) Hz | IEC 61672-3: Clause 12 | ± 0,3 |
| B- Weighting Network (31,5 to 20 000) Hz | IEC 61672-3: Clause 12 | ± 0,3 |
| Peak, C Low Peak Range | IEC 61672-3: Clause 17 | ± 0,3 |

Conclusion: The Integrating Sound Level Meter complied with the above-specified clauses of the IEC 61672-3:2006 specifications and requirements according to ARP 0109:2014. **Class 1.**

**3.2** The following parameters of the built-in ⅓-Octave/Octave Filter were calibrated:

| | |
|---|---|
| Octave Frequency Response (31,5 to 16 000) Hz | IEC 61260: Sections 4.7 & 5.6 |
| ⅓-Octave Frequency response (25 to 20 000) Hz | IEC 61260: Sections 4.7 & 5.6 |

The uncertainty of measurement was estimated as follows: ± 0,3 dB

Conclusion: The built-in Octave Filter complied with the above-specified clauses of the IEC 61260 specification, **Class 1.**

| Calibrated by: | Authorized/Checked by: |
|---|---|
| W.S. SIBANYONI (CALIBRATION TECHNICIAN) | M. NAUDE (SANAS TECHNICAL SIGNATORY) |

Director: Marianka Naudé

**3.3** The following parameters of the ½" Microphone were calibrated and the results were corrected to the ambient condition of 1 013,25 mBar:

Output Sensitivity at 250 Hz at 94,0 dB
Frequency Response (31,5 to 16 000) Hz

The uncertainty of measurements was estimated as follows: ± 0,3 dB

Conclusion: The parameters measured for the ½" Microphone, complied with the manufacturer's specification.

**3.4** The ½" Microphone was calibrated Electroacoustic according to Clause 12 of IEC 61672-3: 2006 complete with Integrating Sound Level Meter and Svantek SV 12L ½" Pre-amplifier Serial No: 25686, free-field corrections were taken into consideration and the results were corrected to the ambient condition of 1 013,25 mBar:

| FREQUENCY (Hz) | CALCULATED EXPECTED VALUE (dB) | MEASURED VALUE (dB) | DEVIATION (dB) | UoM (dB) |
|---|---|---|---|---|
| 1 000 (Ref) | 114,1 | 114,1 | 0,0 | ± 0,3 |
| 31,5 | 111,3 | 111,2 | - 0,1 | ± 0,3 |
| 63 | 113,4 | 113,3 | - 0,1 | ± 0,3 |
| 125 | 113,9 | 113,9 | 0,0 | ± 0,3 |
| 250 | 114,1 | 114,0 | - 0,1 | ± 0,3 |
| 500 | 114,0 | 114,0 | 0,0 | ± 0,3 |
| 1 000 | 114,1 | 114,1 | 0,0 | ± 0,3 |
| 2 000 | 113,9 | 113,9 | 0,0 | ± 0,3 |
| 4 000 | 113,4 | 113,5 | + 0,1 | ± 0,3 |
| 8 000 | 109,4 | 109,2 | - 0,2 | ± 0,3 |
| 12 500 | 106,5 | 106,9 | + 0,4 | ± 0,3 |
| 16 000 | 103,3 | 104,0 | + 0,7 | ± 0,3 |

| *Calibrated by:* | *Authorized/Checked by:* |
|---|---|
| *W.S. SIBANYONI* *(CALIBRATION TECHNICIAN)* | *M. NAUDE* *(SANAS TECHNICAL SIGNATORY)* |

Director: Marianka Naudé

## 4. REMARKS

**4.1** The reported expanded uncertainties of measurements are based on a standard uncertainty multiplied by a coverage factor of *k=2*, providing a level of confidence of approximately 95,45 %, the uncertainties of measurements have been estimated in accordance with the principles defined in the GUM (Guide to Uncertainty of Measurement) ISO, Geneva, 1993

**4.2** The environmental conditions during calibration of items in section 3 were:
Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %RH

**4.3** Calibration labels bearing cal date, due date (if requested), certificate number and serial number have been affixed to the instrument.

**4.4** The above statement of conformance is based on the measurement values obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limits

**4.5** The microphone's frequency range determines the useful frequency range of the sound level meter and vice versa.

**4.6** The results on this Certificate relates only to the items and parameters calibrated.

**4.7** Abbreviation:
UoM = Uncertainty of Measurement

**------------SECTION 4.7 THE END OF CERTIFICATE-----------**

| *Calibrated by:* | *Authorized/Checked by:* |
|---|---|
| *W.S. SIBANYONI* <br> *(CALIBRATION TECHNICIAN)* | *M. NAUDÉ* <br> *(SANAS TECHNICAL SIGNATORY)* |

*Director: Marianka Naudé*

# Appendix D – Survey Site Photos


*Figure D-1: Photographs of environmental noise survey Site L2*


*Figure D-2: Photographs of environmental noise survey Site L1*

Facing north

Facing east

Facing south

Facing west

*Figure D-3: Photographs of environmental noise survey Site L3*

Facing north

Facing east

Facing south

Facing west

*Figure D-4: Photographs of environmental noise survey Site S1*


*Figure D-5: Photographs of environmental noise survey Site S2*


*Figure D-6: Photographs of environmental noise survey Site S3*

Facing north

Facing east

Facing south

Facing west

*Figure D-7: Photographs of environmental noise survey Site S6*

Facing north

Facing east

Facing south

Facing west

*Figure D-8: Photographs of environmental noise survey Site S7*

Facing north

Facing east

Facing south

Facing west

*Figure D-9: Photographs of environmental noise survey Site S8*

Facing north

Facing east

Facing south

Facing west

*Figure D-10: Photographs of environmental noise survey Site S9*

Facing north

Facing east

Facing south

Facing west

*Figure D-11: Photographs of environmental noise survey Site S10*

Facing north

Facing east

Facing south

Facing west

*Figure D-12: Photographs of environmental noise survey Site S11*

Facing north

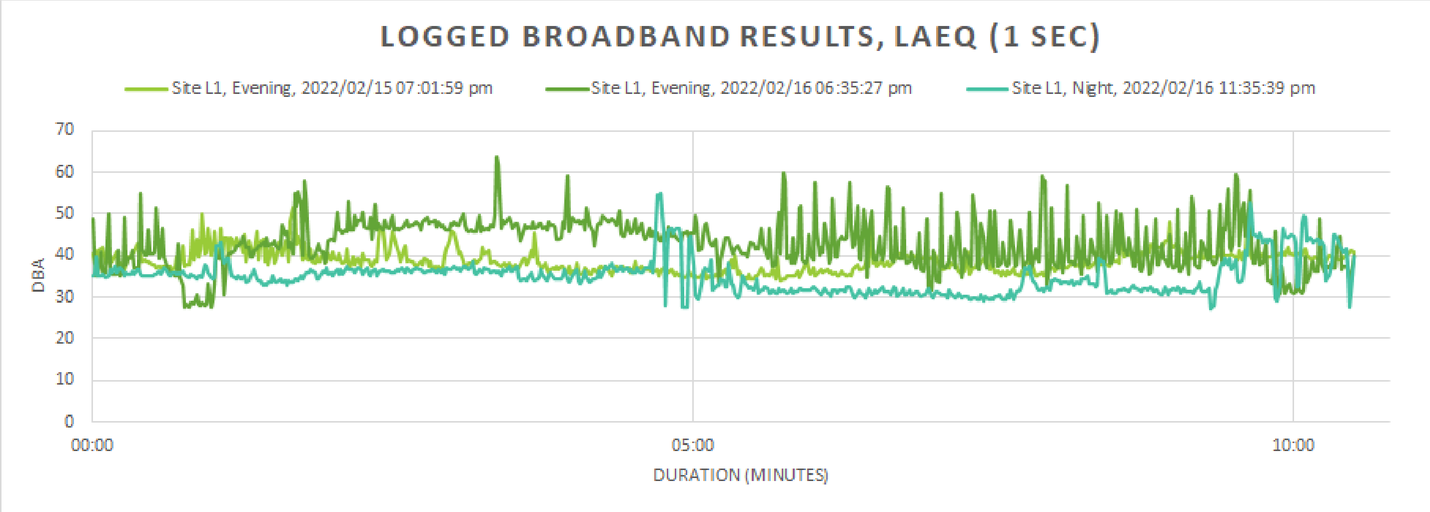
Facing east

WFacing south

Facing west

*Figure D-13: Photographs of environmental noise survey Site S12*

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



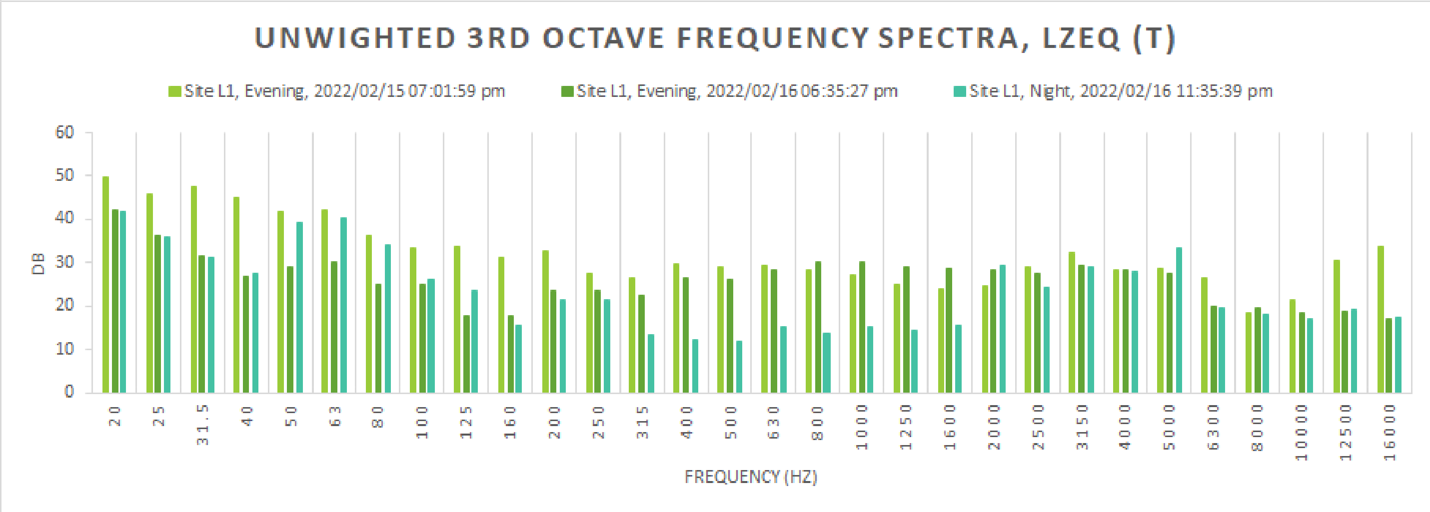




*Figure E-1: Detailed day- and night-time survey results for Site L1*

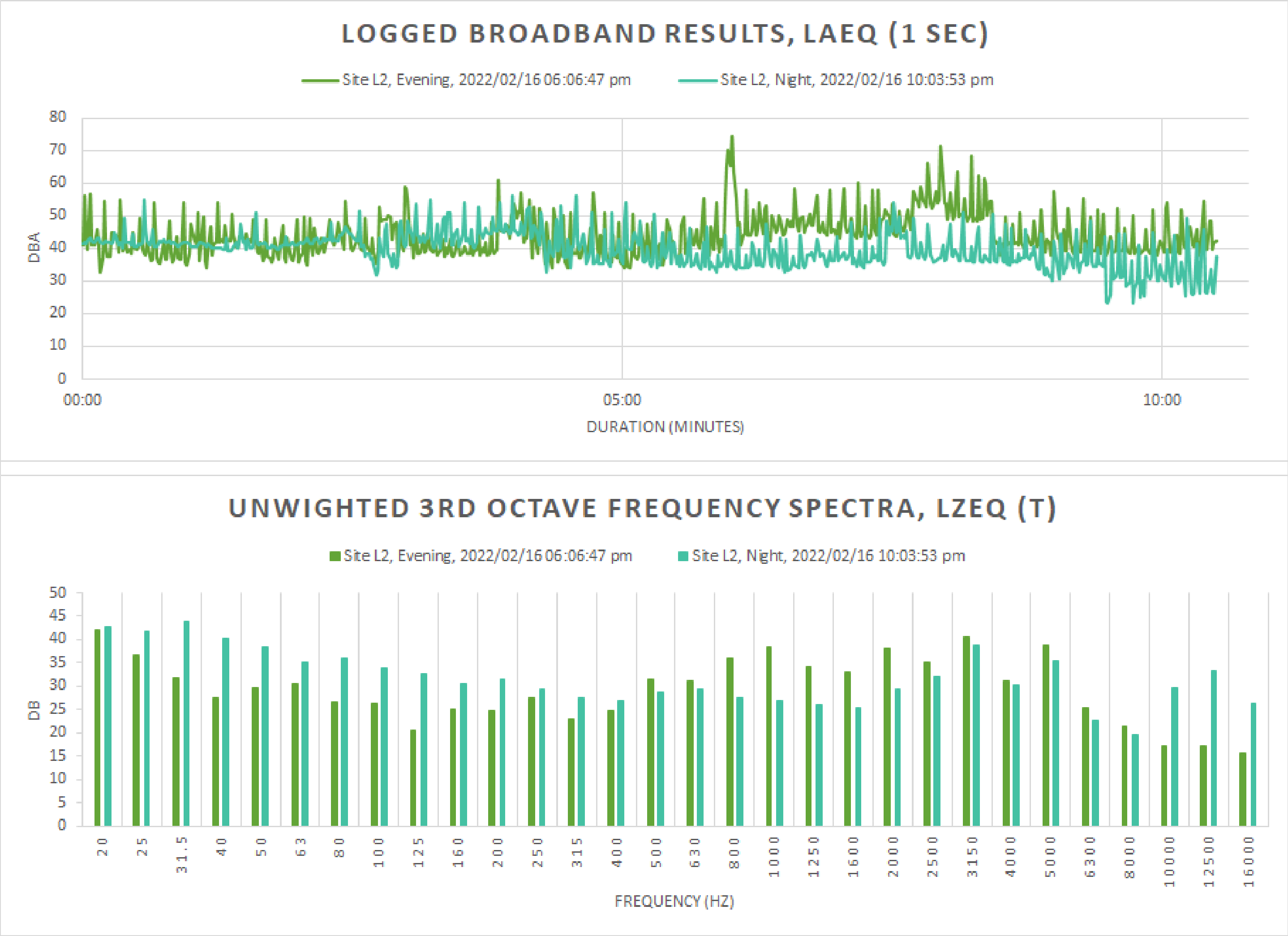



*Figure E-2: Detailed day- and night-time survey results for Site L2*

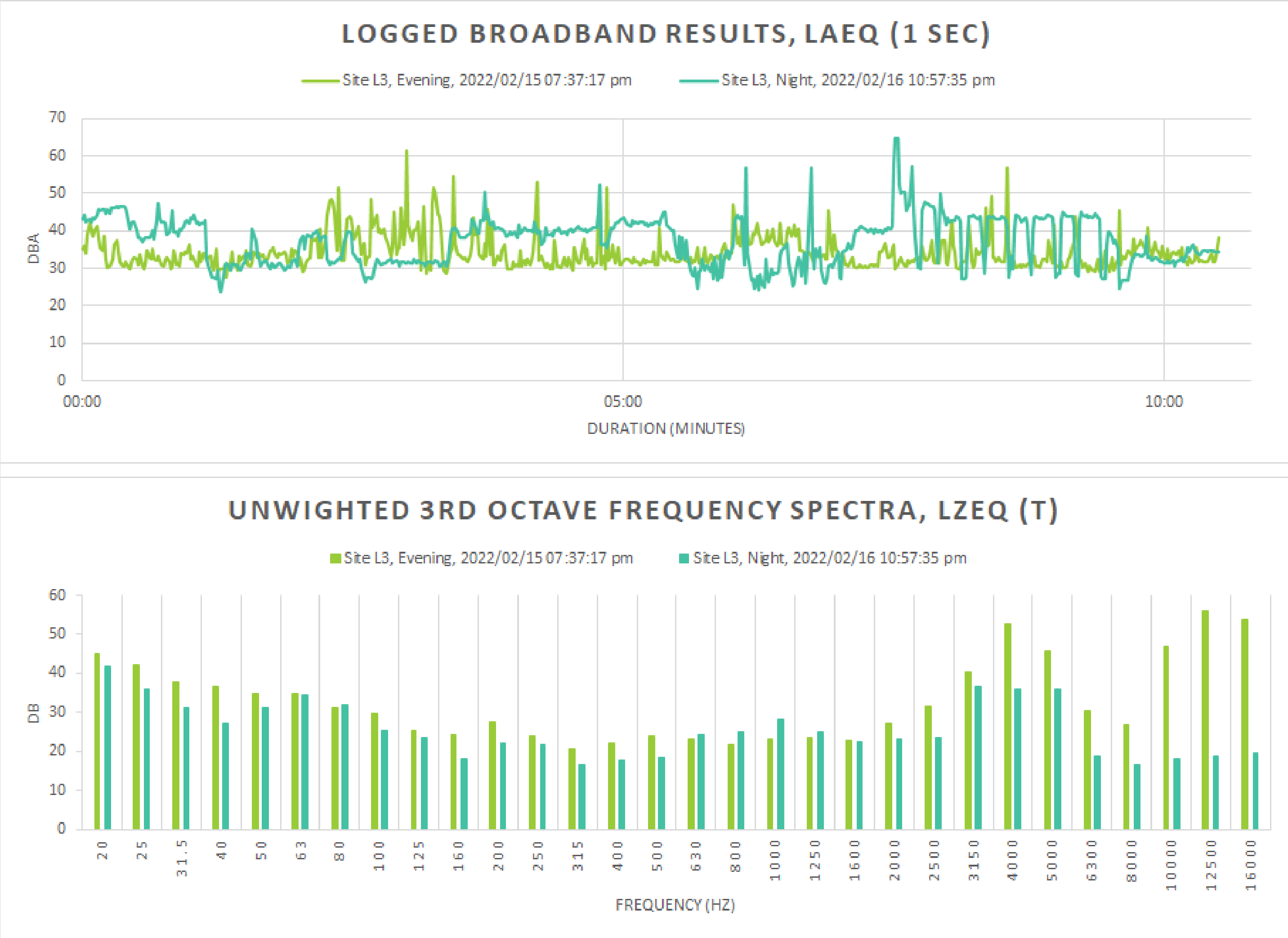



*Figure E-3: Detailed day- and night-time survey results for Site L3*

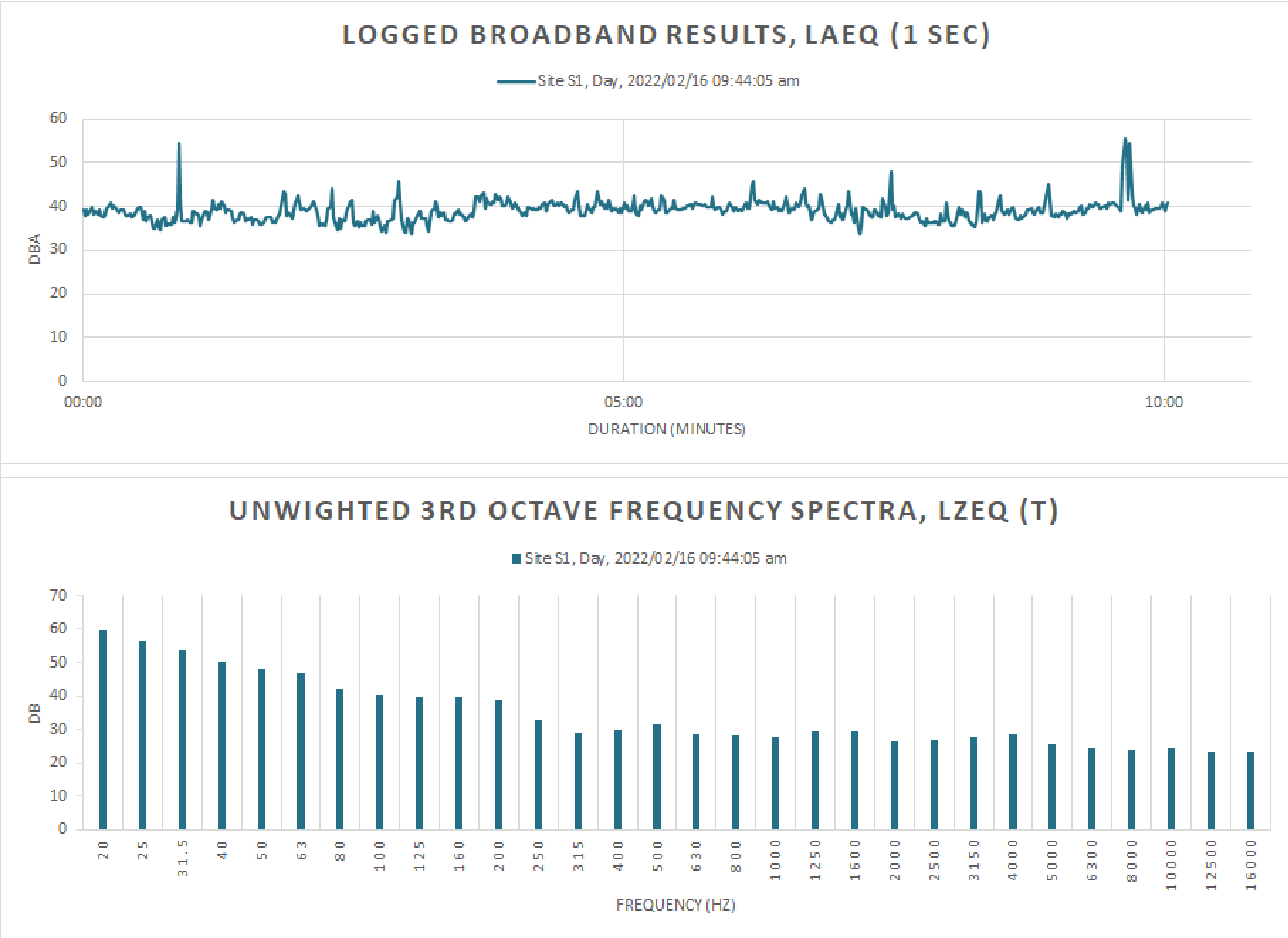



*Figure E-4: Detailed day-time survey results for Site S1*

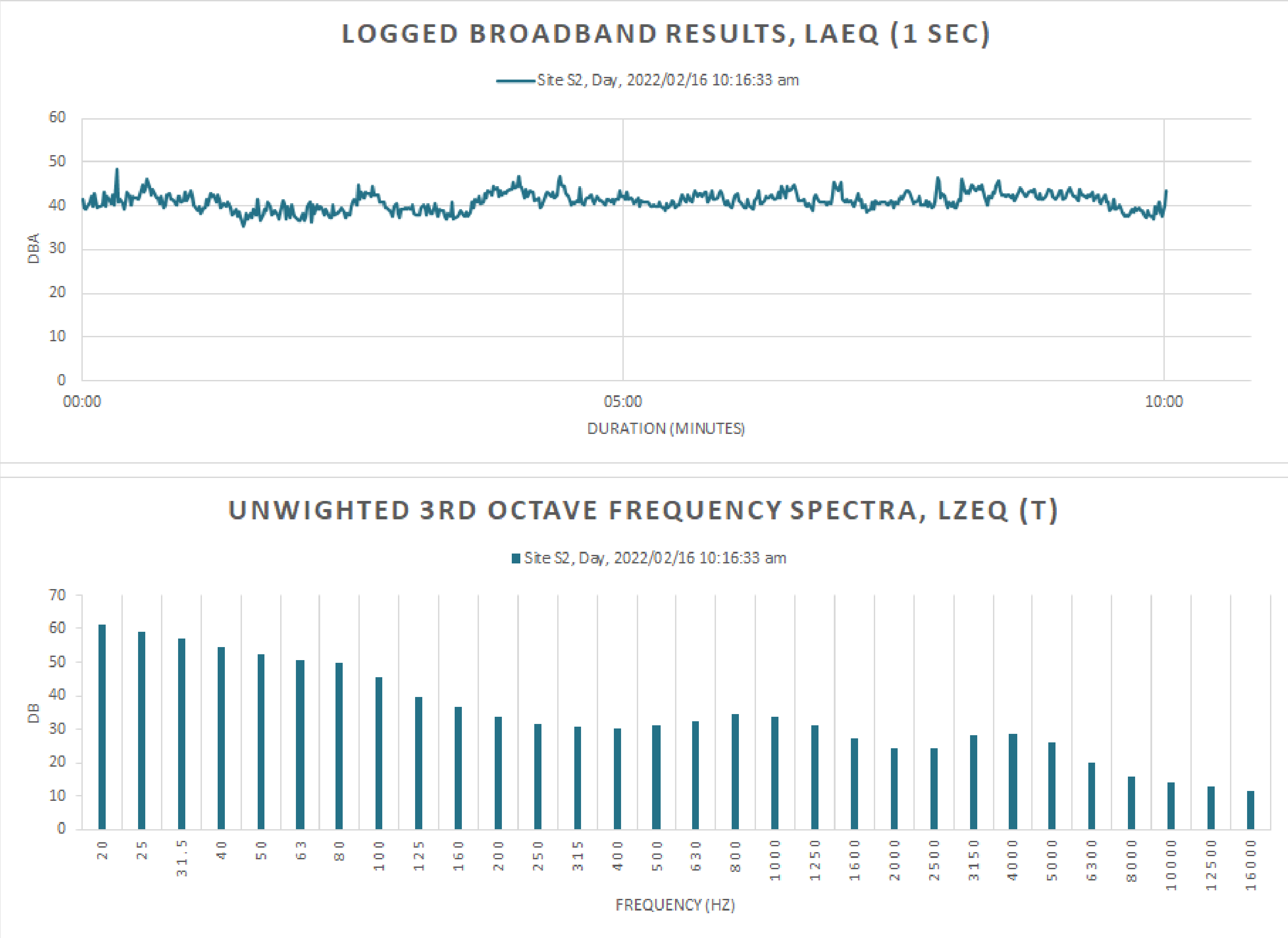



*Figure E-5: Detailed day-time survey results for Site S2*

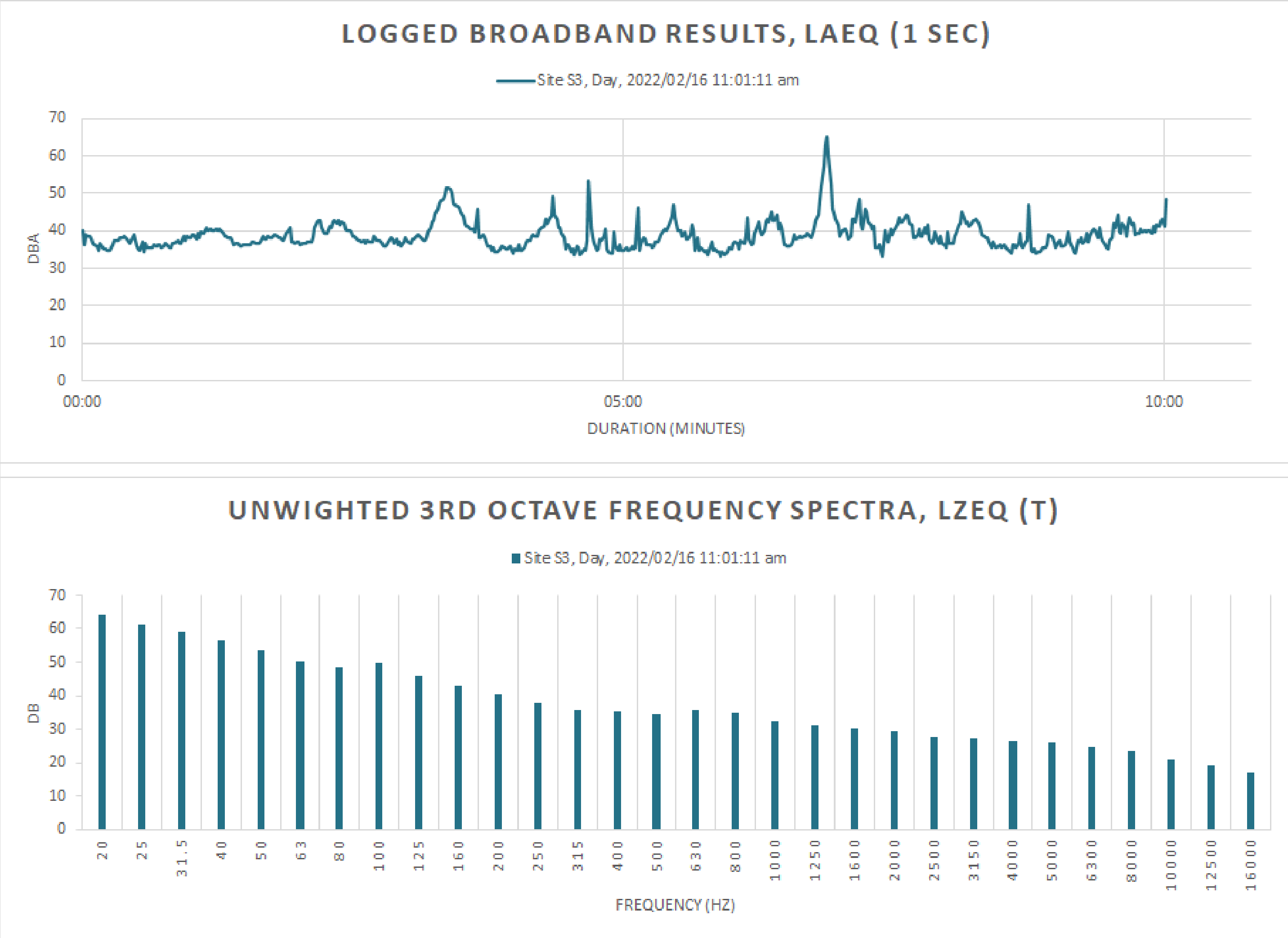



*Figure E-6: Detailed day-time survey results for Site S3*

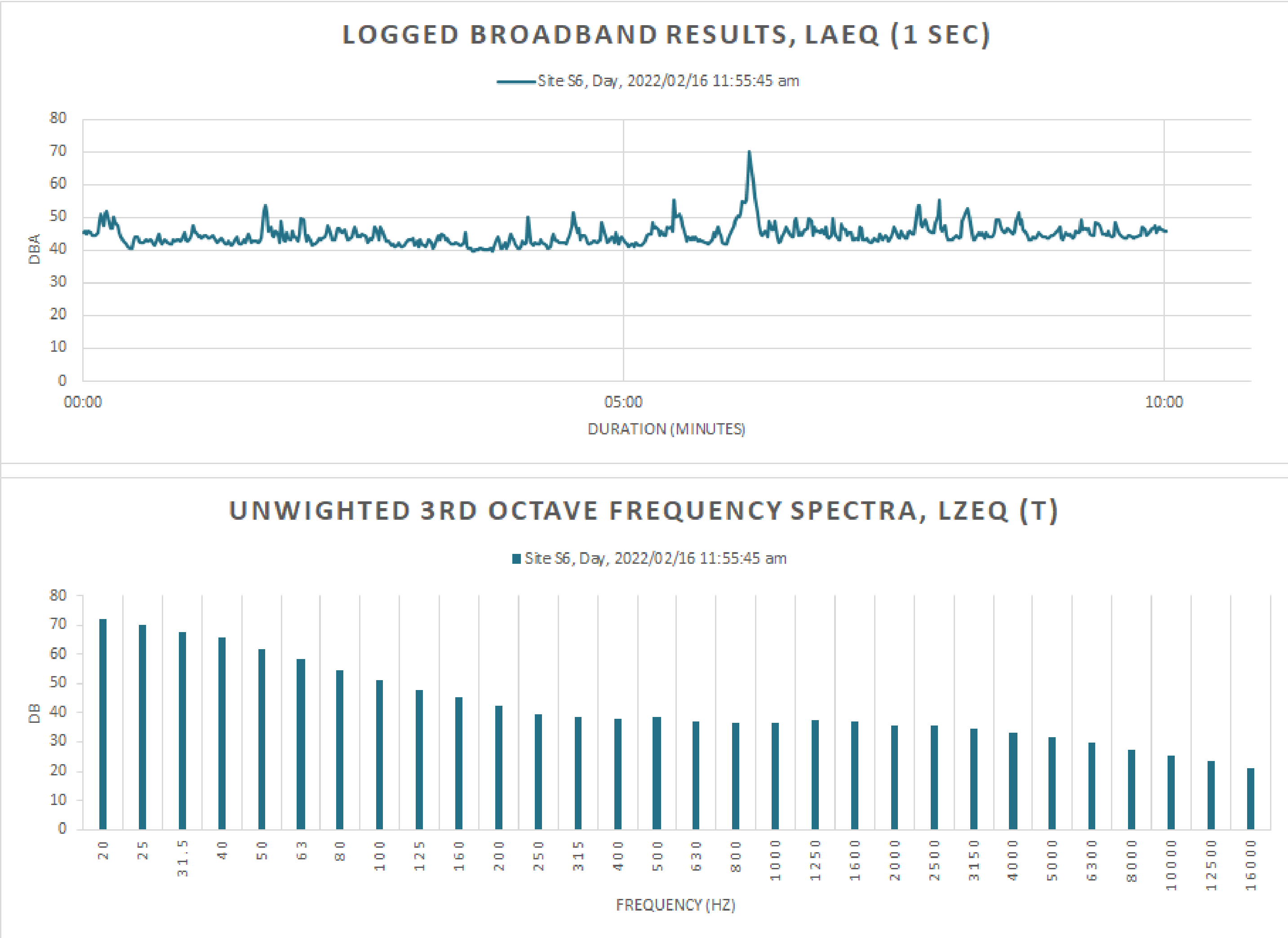



*Figure E-7: Detailed day-time survey results for Site S6*

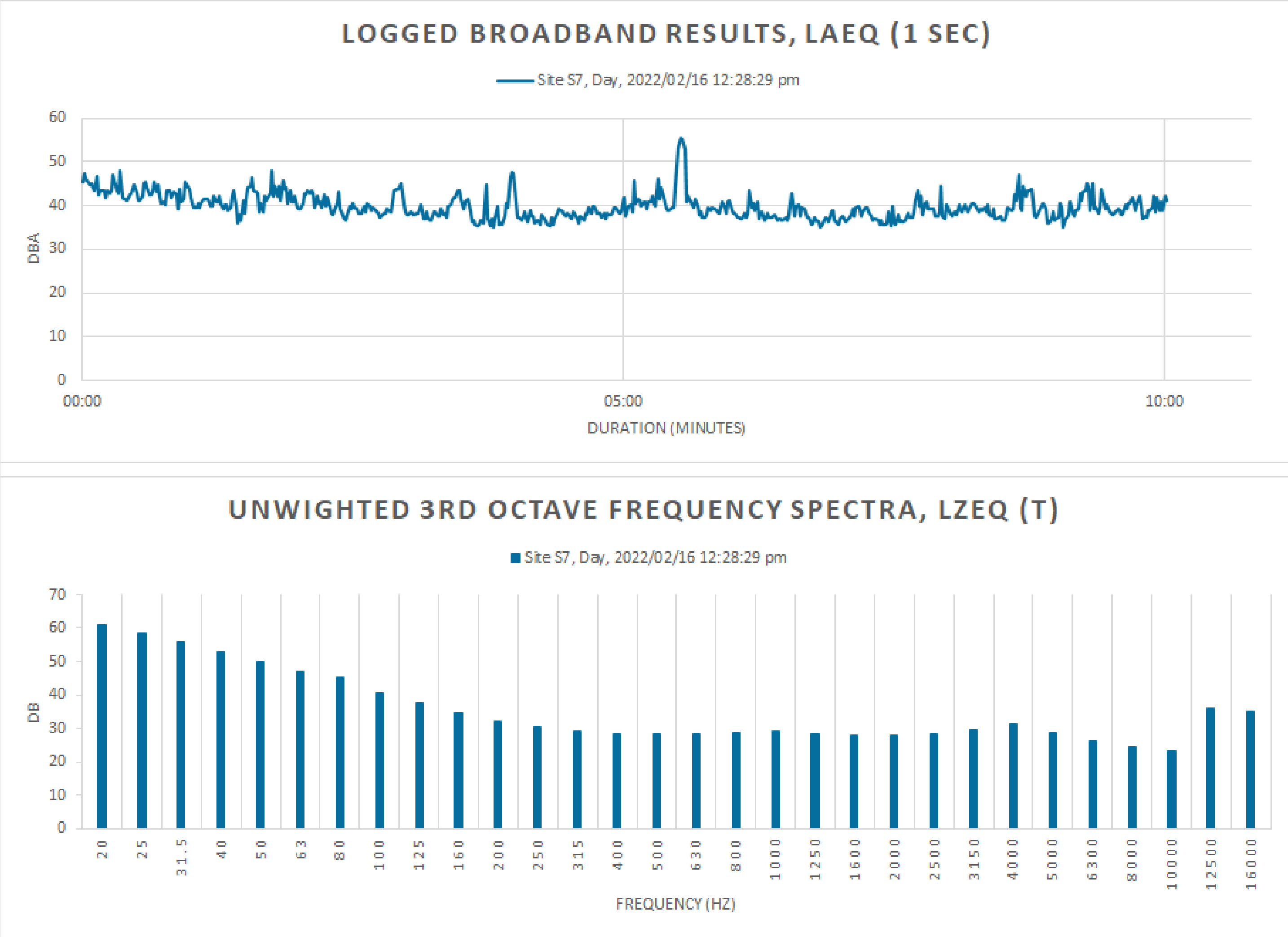



*Figure E-8: Detailed day-time survey results for Site S7*

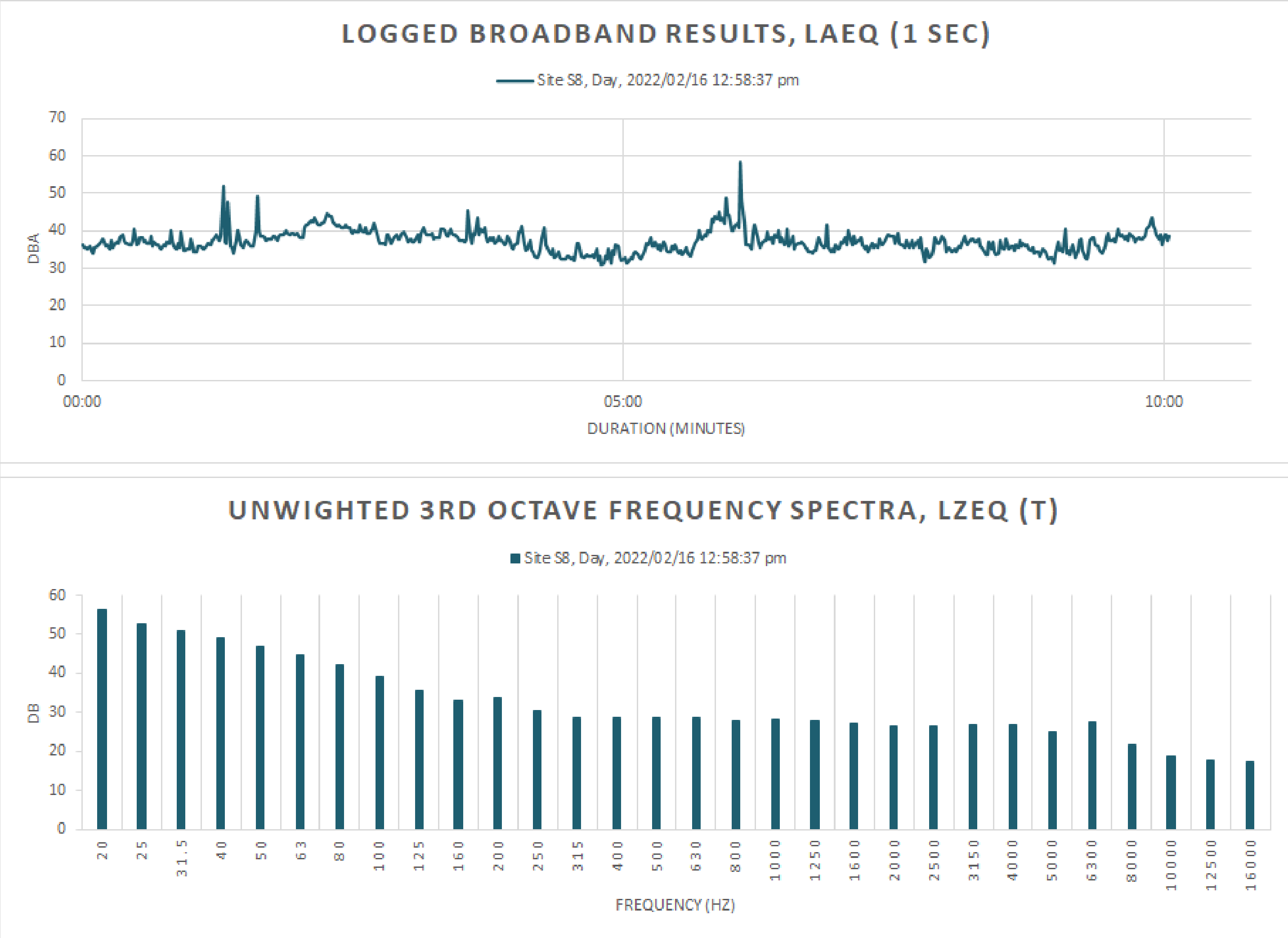



*Figure E-9: Detailed day-time survey results for Site S8*

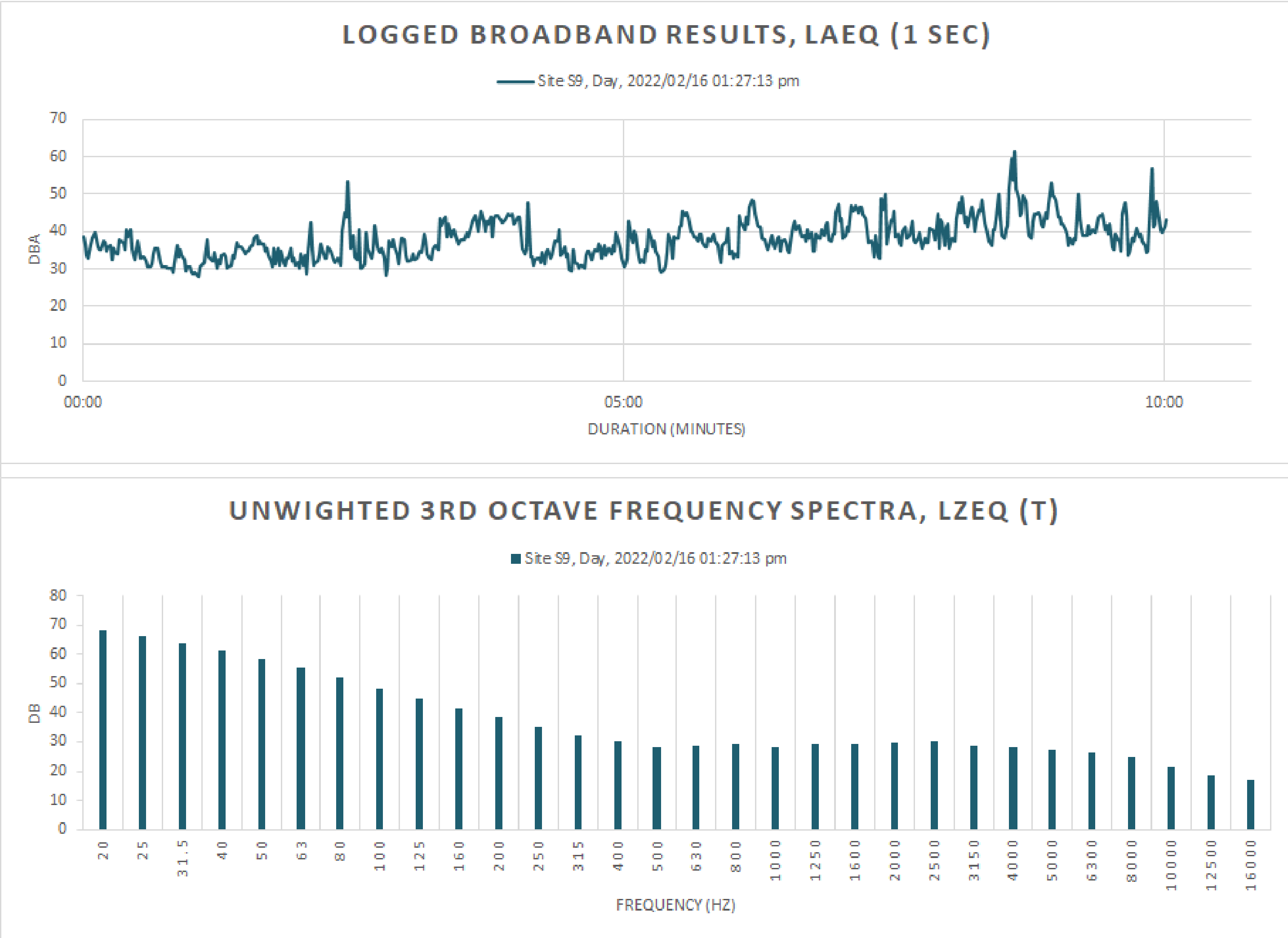
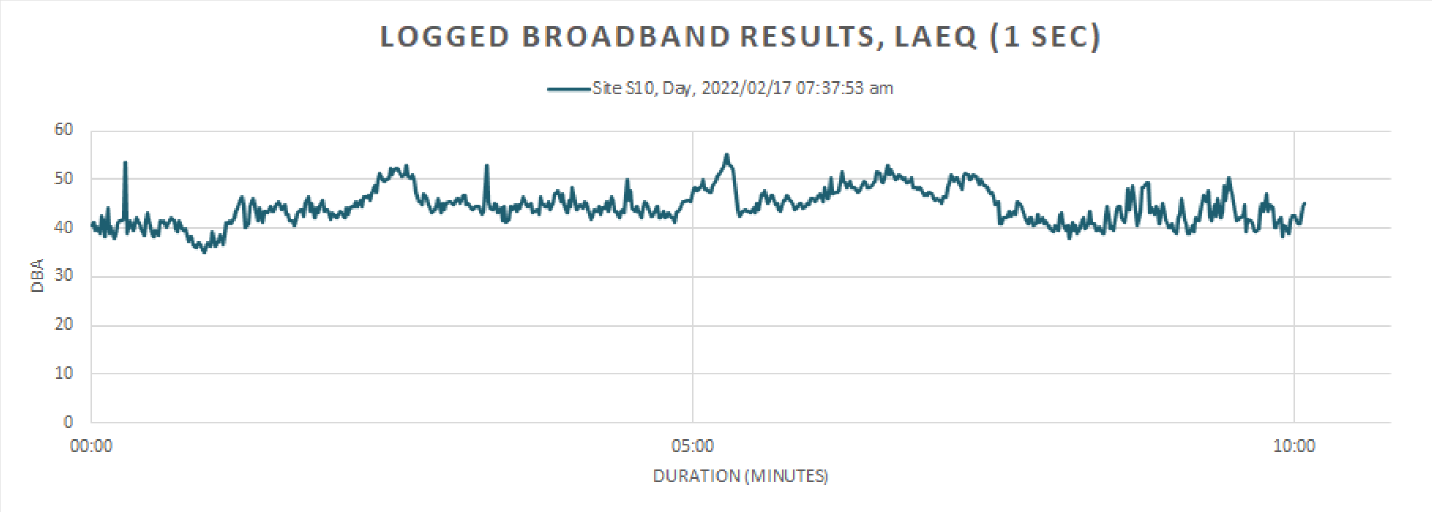



*Figure E-10: Detailed day-time survey results for Site S9*



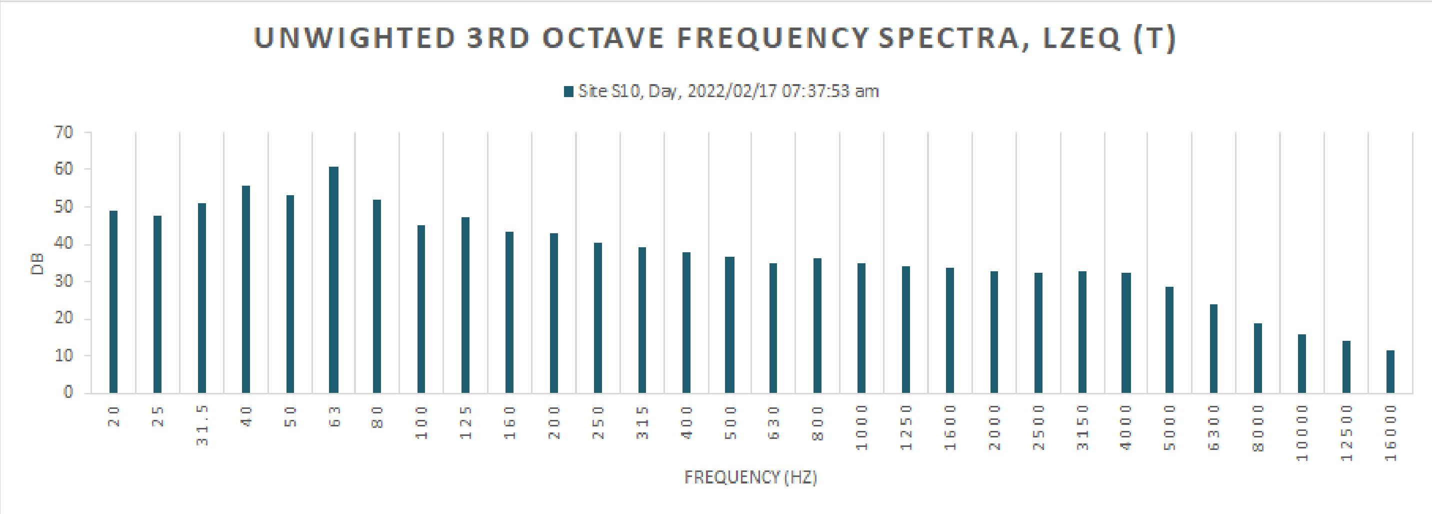




*Figure E-11: Detailed day-time survey results for Site S10*

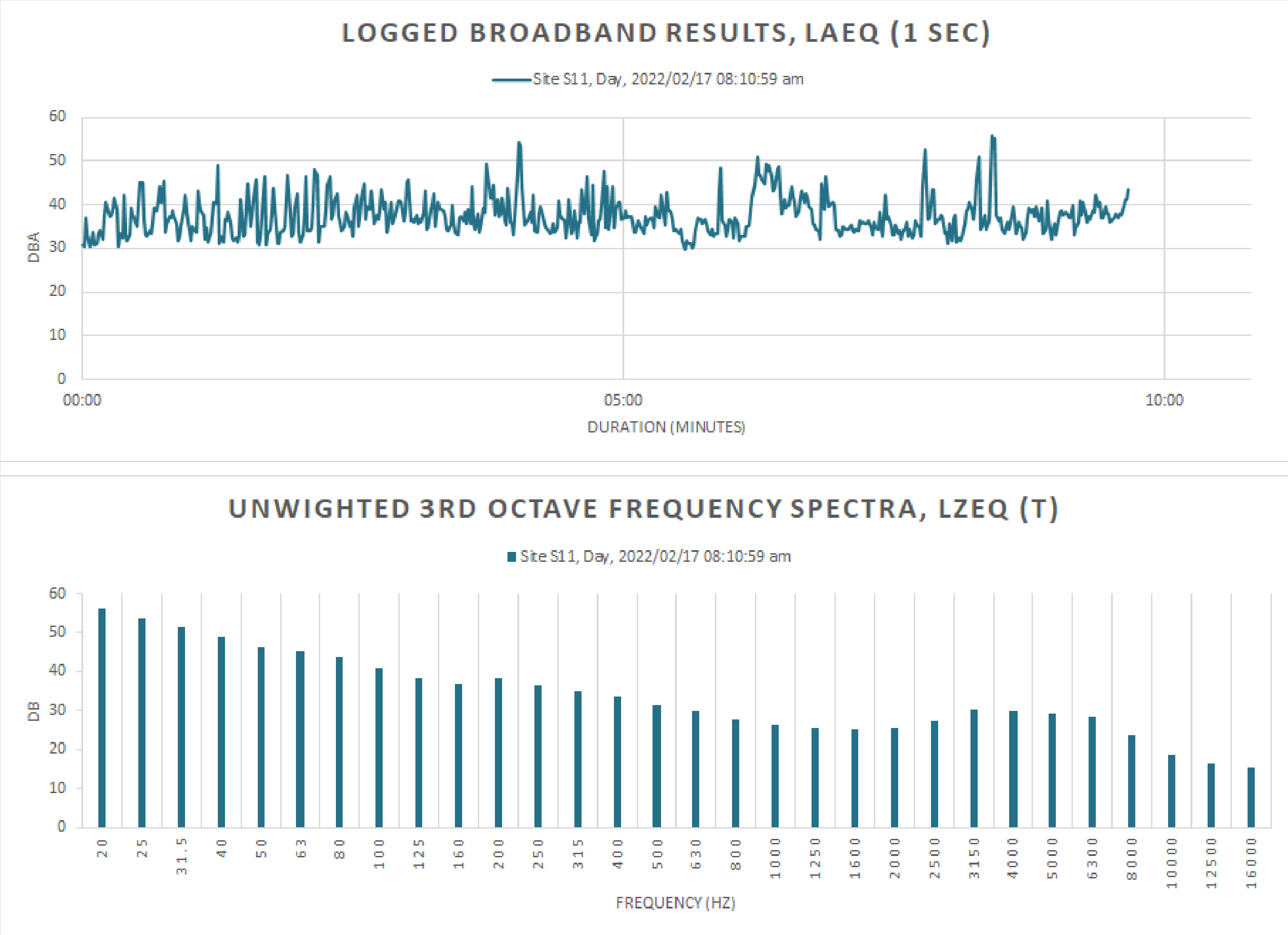



*Figure E-12: Detailed day-time survey results for Site S11*

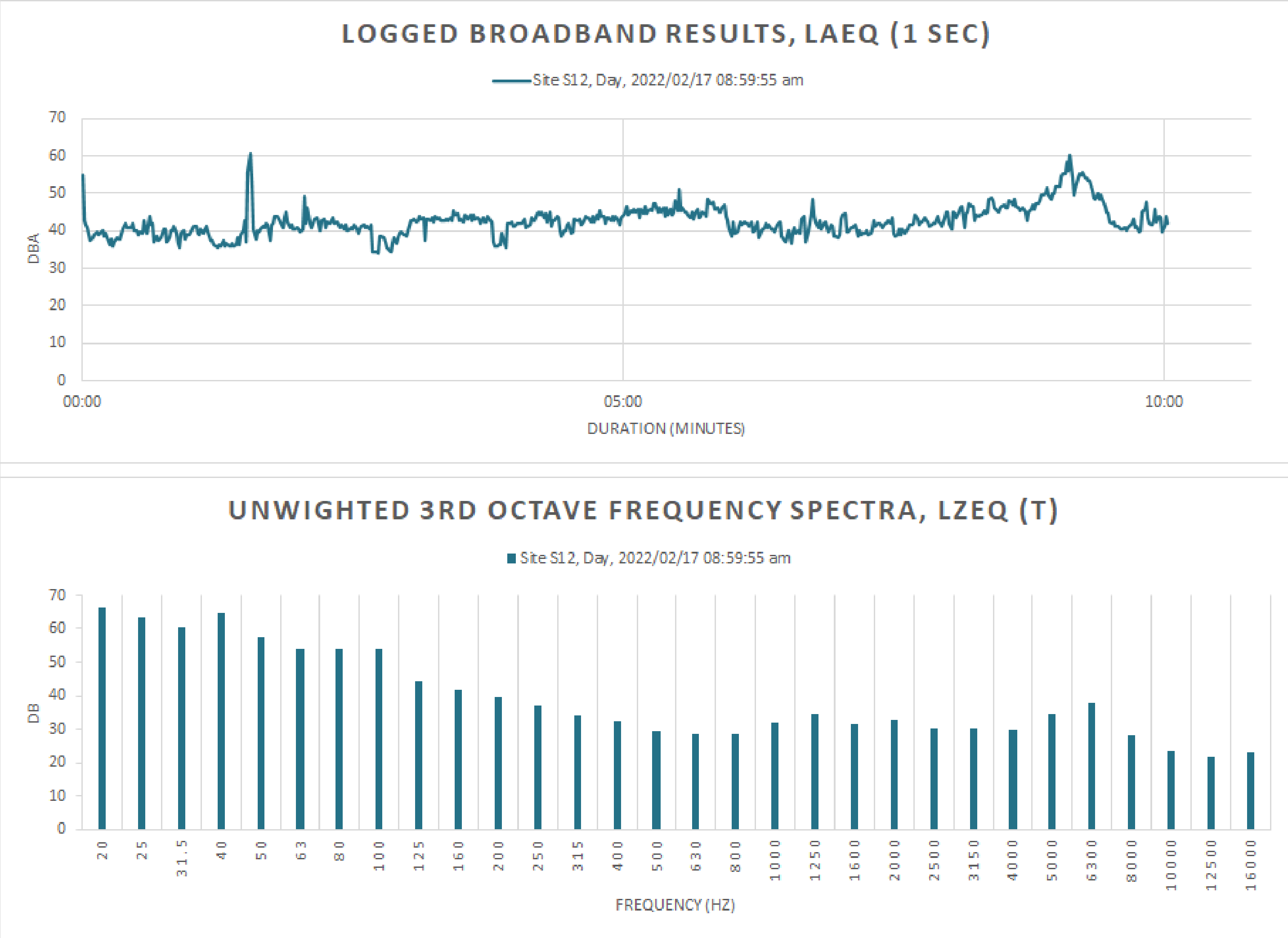



*Figure E-13: Detailed day-time survey results for Site S12*

# Appendix F – Impact Significance Rating Methodology

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

Determination of Environmental Risk:

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \underline{(E+D+M+R)} \times N$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table F-1.

*Table F-1: Criteria for determining impact consequence*

| Aspect | Score | Definition |
|---|---|---|
| Nature | - 1 | Likely to result in a negative/ detrimental impact |
| | +1 | Likely to result in a positive/ beneficial impact |
| Extent | 1 | Activity (i.e. limited to the area applicable to the specific activity) |
| | 2 | Site (i.e. within the development property boundary), |
| | 3 | Local (i.e. the area within 5 km of the site), |
| | 4 | Regional (i.e. extends between 5 and 50 km from the site |
| | 5 | Provincial / National (i.e. extends beyond 50 km from the site) |
| Duration | 1 | Immediate (<1 year) |
| | 2 | Short term (1-5 years), |
| | 3 | Medium term (6-15 years), |
| | 4 | Long term (the impact will cease after the operational life span of the project), |
| | 5 | Permanent (no mitigation measure of natural process will reduce the impact after construction). |
| Magnitude/ Intensity | 1 | Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected), |
| | 2 | Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected), |
| | 3 | Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way), |
| | 4 | High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or |

| Aspect | Score | Definition |
|---|---|---|
| | 5 | Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease). |
| Reversibility | 1 | Impact is reversible without any time and cost. |
| | 2 | Impact is reversible without incurring significant time and cost. |
| | 3 | Impact is reversible only by incurring significant time and cost. |
| | 4 | Impact is reversible only by incurring prohibitively high time and cost. |
| | 5 | Irreversible Impact |

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table F-2.

*Table F-2: Probability scoring*

| | | |
|---|---|---|
| Probability | 1 | Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%), |
| | 2 | Low probability (there is a possibility that the impact will occur; >25% and <50%), |
| | 3 | Medium probability (the impact may occur; >50% and <75%), |
| | 4 | High probability (it is most likely that the impact will occur- > 75% probability), or |
| | 5 | Definite (the impact will occur), |

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

**ER= C x P**

*Table F-3: Determination of environmental risk*

| | | | | | | |
|---|---|---|---|---|---|---|
| Consequence | 5 | 5 | 10 | 15 | 20 | 25 |
| | 4 | 4 | 8 | 12 | 16 | 20 |
| | 3 | 3 | 6 | 9 | 12 | 15 |
| | 2 | 2 | 4 | 6 | 8 | 10 |
| | 1 | 1 | 2 | 3 | 4 | 5 |
| | | 1 | 2 | 3 | 4 | 5 |
| | **Probability** | | | | | |

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table F-4.

*Table F-4: Significance classes*

| **Environmental Risk Score** | |
|---|---|
| **Value** | **Description** |
| < 9 | Low (i.e. where this impact is unlikely to be a significant environmental risk), |
| ≥9; <17 | Medium (i.e. where the impact could have a significant environmental risk), |
| ≥ 17 | High (i.e. where the impact will have a significant environmental risk). |

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation:

In accordance with the requirements of Regulation 31 (2)(l) of the EIA Regulations (GNR 543), and further to the assessment criteria presented in the Section above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition, it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision-making process.

In an effort to ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

*Table F-5: Criteria for determining prioritisation*

| | | |
|---|---|---|
| **Public response (PR)** | Low (1) | Issue not raised in public response. |
| | Medium (2) | Issue has received a meaningful and justifiable public response. |
| | High (3) | Issue has received an intense meaningful and justifiable public response. |
| **Cumulative Impact (CI)** | Low (1) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change. |
| | Medium (2) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change. |
| | High (3) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change. |
| **Irreplaceable loss of resources (LR)** | Low (1) | Where the impact is unlikely to result in irreplaceable loss of resources. |
| | Medium (2) | Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited. |
| | High (3) | Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions). |

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table F-5. The impact priority is therefore determined as follows:

**Priority = PR + CI + LR**

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (refer to Table F-6).

*Table F-6: Determination of prioritisation factor*

| Priority | Ranking | Prioritisation Factor |
|---|---|---|
| 3 | Low | 1 |
| 4 | Medium | 1.17 |
| 5 | Medium | 1.33 |
| 6 | Medium | 1.5 |
| 7 | Medium | 1.67 |
| 8 | Medium | 1.83 |
| 9 | High | 2 |

In order to determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

*Table F-7: Final environmental significance rating*

| **Environmental Significance Rating** | |
|---|---|
| **Value** | **Description** |
| < 10 | Low (i.e. where this impact would not have a direct influence on the decision to develop in the area), |
| ≥10 <20 | Medium (i.e. where the impact could influence the decision to develop in the area), |
| ≥ 20 | High (i.e. where the impact must have an influence on the decision process to develop in the area). |