Noise Specialist Report for the Proposed Siyanda Ferrochrome Smelter near Northam in the Limpopo Province

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

Report compiled by:
Nicolette von Reiche

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

Report Details

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Prepared by	Nicolette von Reiche, BEng Hons (Mech.) (University of Pretoria)
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Document Record

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NEMA Regulation (2014), Appendix 6

NEMA Regulations (2014) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report.	Report Details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Section 8: Annex A – Specialist's Curriculum Vitae (page 34)
A declaration that the person is independent in a form as may be specified by the competent authority.	Report Details (page i)
An indication of the scope of, and the purpose for which, the report was prepared.	Section 1.1: Purpose (page 1) Section 1.2: Scope of Work (page 1)
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Section 3.3: Sampled Baseline and Representative Pre-Development Noise Levels (page 17) Note: Seasonal changes immaterial to study outcome
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 1.5: Approach and Methodology (page 9)
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 3: Description of the Receiving Environment (page 15)
An identification of any areas to be avoided, including buffers.	Not applicable
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 1.3: Description of Activities from a Noise Perspective and Selection of Assessment Scenarios, Figure 1 (page 5)
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 1.6: Limitations and Assumptions (page 12)
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Section 4: Impact Assessment (page 20) Site alternatives were not considered.
Any mitigation measures for inclusion in the EMPr.	Section 5: Management, Mitigation and Recommendations (page 30)
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Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 5.4: Monitoring (page 31)
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 5: Management, Mitigation and Recommendations (page 30)
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan.	Section 5: Management, Mitigation and Recommendations (page 30)
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable.
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Any other information requested by the competent authority.	Not applicable.

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
ASG	Atmospheric Studies Group
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
DC	Direct Current
EC	European Commission
EHS	Environmental, Health, and Safety (IFC)
EIA	Environmental Impact Assessment
EMP	Enviromental Management Plan
FeCr	Ferrochrome
Hz	Frequency in Hertz
IEC	International Electro Technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
kW	Power in kilo Watt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{Aleq} (T)	The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
$L_{Req,d}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
$L_{Req,n}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
$L_{R,dn}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period
L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)
L_{PZ}	Un-weighted sound pressure level (in dB)
L_W	Sound Power Level (in dB)
Mtpa	Million tonnes per annum
MW	Power in mega Watt
NEMAQA	National Environment Management Air Quality Act
PNR	Potential noise receptor
p	Pressure in Pa
p_{ref}	Reference pressure, 20 μPa

rpm	Rotational speed in revolutions per minute
SABS	South African Bureau of Standards
SANS	South African National Standards
SCSC	Siyanda Chrome Smelting Company
SLM	Sound Level Meter
SLR	SLR Consulting (Africa) (Pty) Ltd
SoW	Scope of Work
USGS	United States Geological Survey
WG-AEN	Working Group – Assessment of Environmental Noise (EC)
WHO	World Health Organisation

Executive Summary

SLR Environmental Consulting (Africa) (Pty) Ltd (SLR) has commissioned Airshed Planning Professionals (Pty) Ltd (Airshed) to undertake a noise impact study as part of the Environmental Impact Assessment (EIA) for the proposed Siyanda FeCr Project.

The Siyanda Chrome Smelting Company (Pty) Ltd (SCSC) proposes the construction of a new ferrochrome (FeCr) smelter on the farm Grootkuil 409 KQ, adjacent to the existing Union Section Mine approximately 8 km north-west of Northam in the Thabazimbi Local Municipality, Limpopo Province. SCSC proposes the processing of UG2 chrome concentrate from surrounding platinum mines and in broad terms, the project will comprise a railway siding, a raw materials offloading area, two 70 mega Watt (MW) direct current (DC) FeCr furnaces, crushing and screening plant, mineralized waste facility and related facilities such as material stockpiles, workshops, stores and various support infrastructure and services including powerlines, access and internal roads and pipelines.

The main objective of this study was to establish baseline/pre-development noise levels in the study area and to quantify the extent to which ambient noise levels will change as a result of the project. The baseline and impact study then informed the noise management and mitigation measures recommended for adoption as part of the project's Environmental Management Plan (EMP).

To achieve this 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 potential noise receptors (PNRs) from available maps;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from the survey conducted by Airshed.
4. An impact assessment, including:
    a. The establishment of a source inventory for the operational phase of the project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. A specialist noise impact assessment report.

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

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

- The nearest residences are those of the Swartklip Mine Village (located immediately adjacent to the Union Section Mine) which lies to the west approximately 500 m from the mid-point of furnaces. There are also several individual houses/farmsteads/buildings within a few kilometres of the farm Grootkuil 409. Sefikile is located approximately 5 km south and Northam approximately 8 km east-south-east of project infrastructure and not likely to be affected by noise from its activities.

- Atmospheric conditions are more conducive to noise attenuation during the day.
- On average, noise impacts are expected to be most notable to the south, west and north-west of the project.
- Baseline noise levels are affected by road and rail traffic, domestic animals, birds and insects. Noise levels are currently low and comparable to levels typically found in rural districts except for occasional railway noise. Representative day- and night-time as well as 24-hour baseline noise levels of 47.9 dBA, 43.1 dBA and 50.4 dBA respectively were calculated from survey results.

Sound power levels for main equipment were determined from equipment specifications and area wide calculations. The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 5 km east-west by 5 km north-south. The area was divided into a grid matrix with a 25 m resolution and PNRs were included as discrete receptors. The following was found:

- Although not quantified, construction and decommissioning/closure phase impacts are expected to be similar or slightly less notable than operational phase impacts.
- Noise impacts during the operational phase will be more notable at night.
- The operational phase will result in noise levels in exceedance of the selected impact criteria at the nearest NSR, the Swartklip Mine Village. Little reaction with sporadic complaints from individuals at this location may be expected if impacts remain unmitigated.
- The maximum impact is expected to occur at night during the operational phase when the increase above the baseline at the nearest NSR would be 4 dBA.

It is important to note the following conservative assumption when interpreting results summarised above; baseline noise levels on the lower side of what was measured were applied in calculations. The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in the project area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels.

It was concluded that, given the conservative nature of the assessment, the implementation of the basic good practice management measures recommended in this report will ensure low significance noise impact levels. From a noise perspective the project may proceed provided that the management and mitigation measures are implemented as part of the conditions of environmental authorisation.

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1 INTRODUCTION

The Siyanda Chrome Smelting Company (Pty) Ltd (SCSC) proposes the construction of a new ferrochrome (FeCr) smelter on the farm Grootkuil 409 KQ, adjacent to the existing Union Section Mine approximately 8 km north-west of Northam in the Thabazimbi Local Municipality, Limpopo Province. SCSC proposes the processing of UG2 chrome concentrate from surrounding platinum mines and in broad terms, the project will comprise a railway siding, a raw materials offloading area, two 70 mega Watt (MW) direct current (DC) FeCr furnaces, crushing and screening plant, mineralized waste facility and related facilities such as material stockpiles, workshops, stores and various support infrastructure and services including powerlines, access and internal roads and pipelines.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (Africa) (Pty) Ltd (SLR) to undertake a noise impact assessment for the proposed project.

1.1 Purpose

The main purpose of the noise study was to determine the potential impact on the acoustic climate and noise sensitive receptors (PNRs) given activities proposed as part of the project.

1.2 Scope of Work

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 PNRs from available maps;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from a survey conducted in June 2015.
4. An impact assessment, including:
    a. The establishment of a source inventory for the project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. A specialist noise impact assessment report.

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

As indicated in the introduction, SCSC is proposing to establish a smelter complex to process the UG2 chrome concentrate from chrome recovery plants of nearby operations. In broad terms, the project will comprise a railway siding, a raw materials offloading area, two 70 MW DC furnaces, crushing and screening plant, mineralised waste facility, and related facilities such as material stockpiles, workshops, stores and various support infrastructure and services including powerlines, roads and pipelines. The project infrastructure layout is shown in Figure 1.

Noise will be generated during the project's construction, operational and decommissioning/closure phases. A short description of construction, operational, decommissioning/closure phase activities[1] are included below and likely sources of noise identified.

1.3.1 Construction Phase

During the construction phase several facilities need to be established. These include; contractor's laydown areas, workshops (instrumentation, electrical, mechanical, diesel), stores for the storing and handling of fuel, lubricants, solvents, paints and construction materials, a wash bay, laboratory, construction waste collection and storage facilities, a store, a parking area for cars and equipment, mobile site offices, portable ablution facilities, temporary electricity supply (diesel generators), portable water supply (bowsers), change houses and a clinic, soil stockpiles, water management infrastructure, security and access control and the main access road. These facilities will either be removed at the end of the construction phase or incorporated into the layout of the operational phase facilities.

Access to site will be via a main project access road. Three alternatives for the access road alignment is being considered (See Figure 2). It is planned that this road will be constructed at the beginning of the construction phase in order to provide site access for construction phase traffic. An already existing dirt access road traversing the Siyanda property, may be used in addition to the main access road during the construction phase

In order to establish the above facilities, the following activities are proposed:

- Site establishment of construction phase facilities;
- Clearing of vegetation;
- Stripping and stockpiling of soil resources and earthworks;
- Collection, storage and removal of construction related waste; and
- Construction of all infrastructure required for the operational phase.

It is anticipated that the construction phase activities would continue for a period of 24 months, 24-hours per day, Monday to Sunday. During this time, noise will be generated by mobile construction equipment, metal and masonry/concrete works, ancillary equipment such as welders, compressors and generators as well as traffic for the delivery of materials and construction staff transport.

1.3.2 Operational Phase

The proposed Project will comprise two 70MW DC furnaces which will be used to process approximately 850 000 tons per annum (t/a) of UG2 chrome concentrate from nearby chrome recovery plants. A short summary of the process is included in Table 1. With the exception of the crusher plant, the smelter complex will be operational 24-hours a day, 7 days a week. The crusher plant will be operational 8 hours per day, 7 days per week.

[1] Extracted from the *Scoping Report for the Proposed Development of the Siyanda Ferrochrome Smelter* dated February 2016 as compiled by SLR.

Table 1: Operational phase process summary

Activity	Description
Transportation and handling and storage of raw materials	Raw materials (chrome concentrate, flux/reductant) will be transported to site by rail and road and temporarily stored in bunkers prior to use. Dust generated during handling will be captured and passed through a baghouse to reduce PM emissions. Captured dust will be returned to the raw materials system for processing.
Drying	In order to eliminate moisture in the raw materials, concentrate and reductant/flux will move through dryers prior to being fed into proportioning bins in preparation for furnace feeding. Duel fuel burners capable of using liquid petroleum gas (LPG) or cleaned CO rich furnace off-gas will be used. Off-gas from the dryers will be passed through baghouses to reduce PM emissions before being released to the atmosphere. Captured dust will be returned to the raw materials system for processing.
Pre-heating	Gas Suspension Pre-heating (GSPH) is defined as the direct heating of material particles in a "solids in suspension" environment using pre-heated gases and cyclone gas/solids separation technology. For this application of the GSPH, CO rich cleaned furnace off-gas may be used as the energy source. Cleaned CO gas is ducted to a combustion chamber, where it is burned, together with atmospheric air, and fed into the GSPH. It is expected that combustion off-gas will be emitted through a separate, dedicated stack.
Smelting	Two 70 MW DC furnaces will be used to smelt raw materials (chrome concentrate and flux and reductant). Off-gas generated by the furnaces will be extracted through primary off-gas systems, cooled, passed through baghouses to reduce PM and used as a fuel source for various plant processes and/or flared. During emergencies, uncleaned off-gas may be directly released to the atmosphere through an emergency stack. Baghouse dust will be slurried and disposed onto the baghouse slurry dam.
Tapping of metal and slag	Secondary fumes released during tapping of metal and slag will be captured and passed through the secondary off-gas cleaning system which consists of a baghouse that also serves to reduce PM emissions from the furnace feed bins. Baghouse dust will be slurried and disposed onto the baghouse slurry dam. Slag will be disposed of onto the slag dump.
Crushing and screening	Cast/broken alloy ingots will be transferred to a cooling area after which they will pass through a crushing and screening plant for sizing to client specifications.
Product transport	FeCr product will we loaded to rail carriages for dispatch.
Slag and baghouse dust disposal	Slag and baghouse dust will be disposed of at separate mineralized waste facilities.

The following are likely sources of noise during the operational phase:

- Road traffic noise, incl.:
  - Delivery of raw materials; and
  - Staff transport.
- Railway rolling noise; incl.:
  - Delivery of concentrate; and
  - Export of FeCr product.
- Materials handling/transfer related noise, incl.:
  - Off-loading at road and rail boxes;
  - Raw materials, product and slag handling by mobile equipment;
  - Conveyor transfer points; and
  - Rail loading.
- Diesel mobile equipment, incl.:
  - Front-end loaders;
  - Slag carriers; and
  - Trucks
- Mechanical/electrical/pneumatic/hydraulic noise from plant equipment, incl.:

  - Vibrating structures such crushers, screens, hoppers and feed bins;
  - Electric motors, pumps, fans, compressors;
  - Gas valves, ducting and gas cleaning plant stacks/flares;
  - Piping; and
  - Substation, transformers and supply.
- General noise from offices, workshops, stores, the laboratory, change house and clinic. It may include air conditioning, warning sirens, announcements etc.

Whereas dryer, furnace, conveyor, crushing and gas cleaning systems will generate noise fairly constantly; materials handling, transport activities and diesel mobile equipment will generate noise that is intermittent and variable over 24 hours.

1.3.3 Decommissioning and Closure Phase

The removal of infrastructure as well as sloping and revegetation of the mineralised waste facility are planned for the decommission phase. Diesel mobile equipment and demolition activities will generate noise. During closure, the phase when the site has been rehabilitated, there will be no noise impacts.

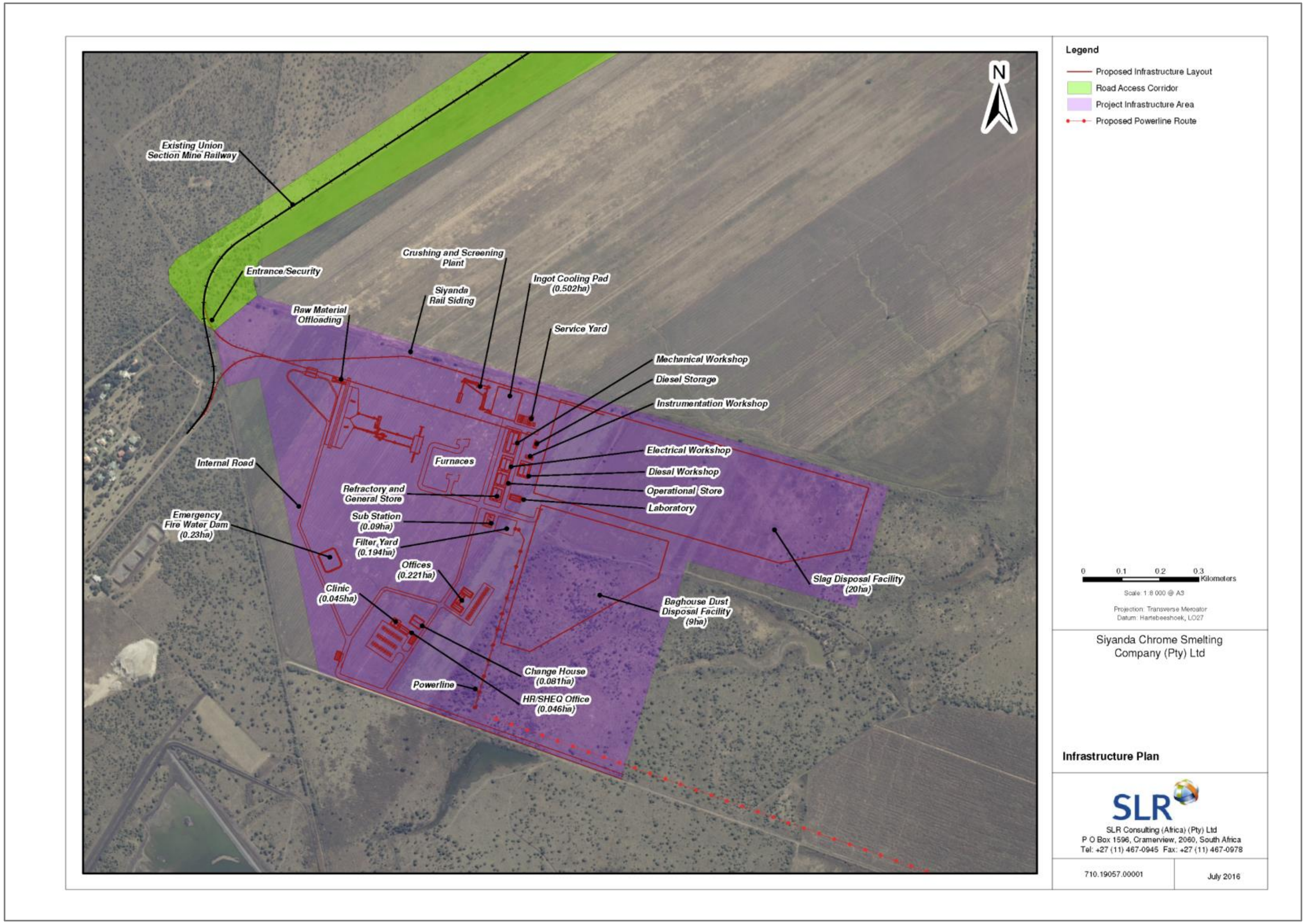


Figure 1: Project layout

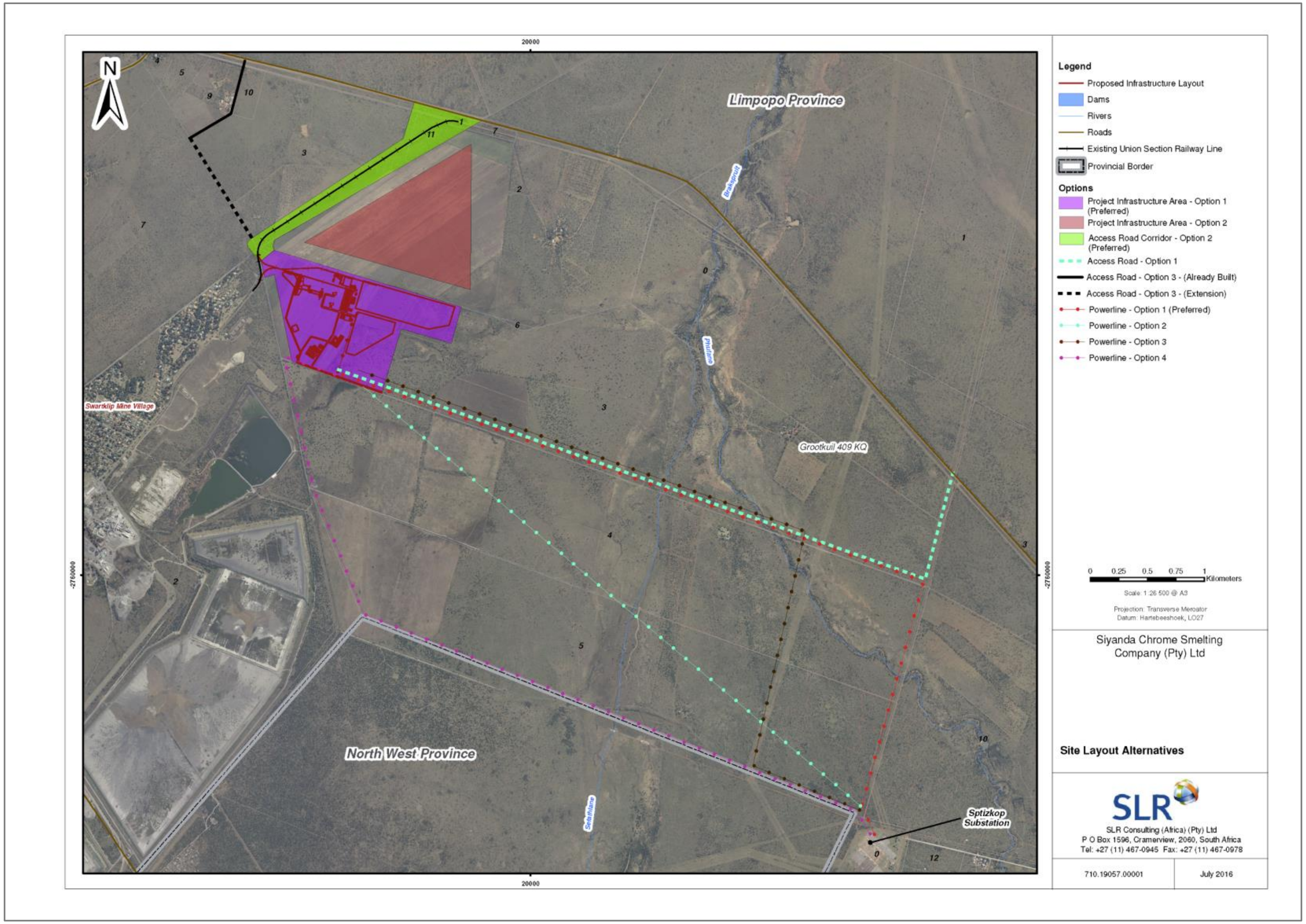


Figure 2: Site layout alternatives

1.4 Background to Environmental Noise and the Assessment Thereof

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

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

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

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

Where:

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

1.4.1 Perception of Sound

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

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

1.4.2 Frequency Weighting

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

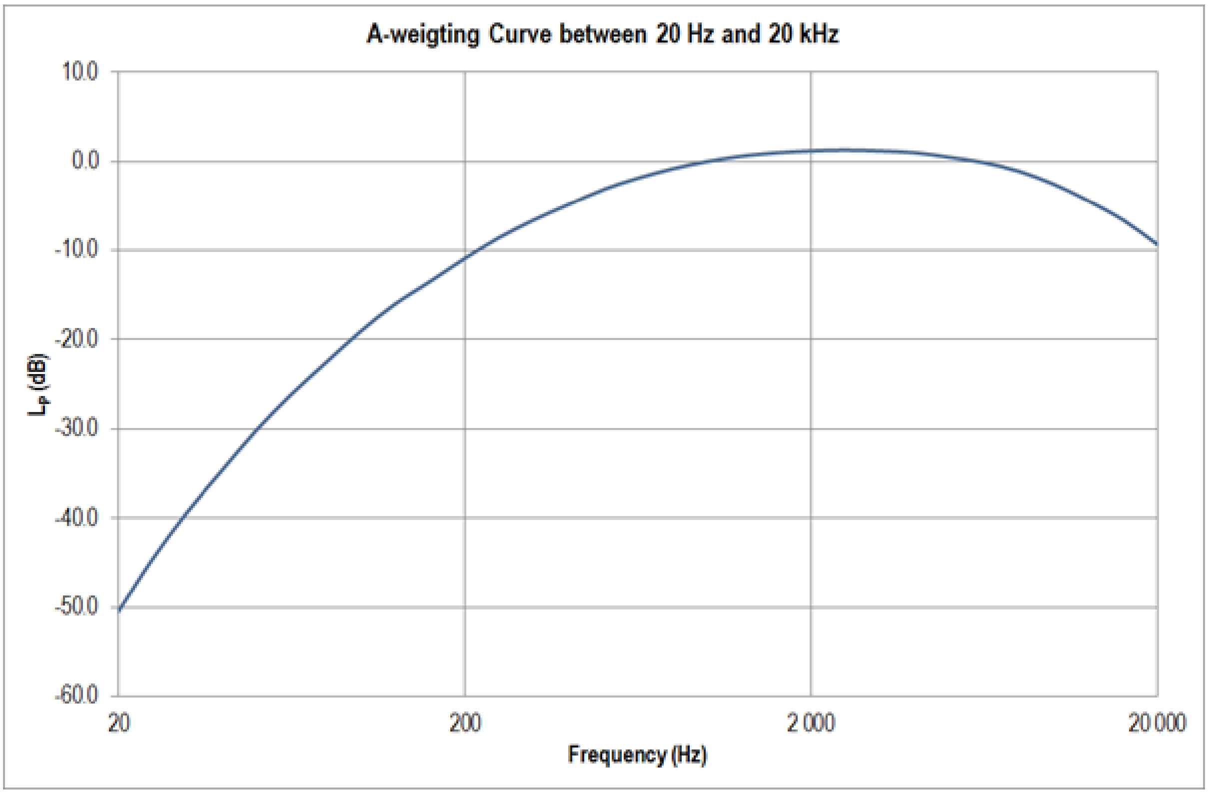


Figure 3: A-weighting curve

1.4.3 Adding Sound Pressure Levels

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

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

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

1.4.4 Environmental Noise Propagation

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

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

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

1.4.5 Environmental Noise Indices

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

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

1.5 Approach and Methodology

The assessment included a study of the legal requirements pertaining to noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels (L_W's) (noise 'emissions') and sound pressure levels (L_P's) (noise impacts) associated with the 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.

1.5.1 Information Review

All project related information referred to in this study was provided by SLR and the SCSC project team. It includes responses to a detailed information requirements list submitted upon commencement of the study, the *Scoping Report for the Proposed Development of the Siyanda Ferrochrome Smelter* prepared by SLR (dated February 2016) and, the *Pre-Feasibility Study* compiled by Tenova Minerals (Pty) Ltd (dated January 2014).

1.5.2 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 South African National Standard (SANS) 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication*'. These guidelines, which are in line with those published by the International Finance Corporation (IFC) and World Health Organisation (WHO), were considered in the assessment.

1.5.3 Study of the Receiving Environment

PNRs generally include private residences, community buildings such as schools, hospitals and any publically accessible areas outside the industrial facility's property. Homesteads and residential areas which were included in the assessment as PNRs 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. In the absence of site/area representative measured data, the atmospheric attenuation potential was described based on simulated data for Northam (MM5 data[2]) for the period 2012 to 2014. Readily available terrain and land cover data was obtained from the Atmospheric Studies Group (ASG) via the United States Geological Survey (USGS) web site. A study was made of Shuttle Radar Topography Mission (STRM) (90 m, 3 arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa.

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in 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. Data from a baseline noise survey conducted by Airshed as part of the scope of work was studied to determine representative baseline noise levels for use in the assessment of cumulative impacts.

1.5.4 Source Inventory

The source noise inventory was informed by:

- Equipment specific L_W predictive equations for diesel mobile equipment as published by Crocker (1998);
- Generic area wide L_W's for industrial and commercial areas as published by the European Commission (EC WG-AEN, 2003);
- Process specific L_W's from similar operations as contained in the database of François Malherbe Acoustic Consulting.
- Trip generation and transport information.

1.5.5 Noise Propagation Simulations

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

[2] The MM5 (short for Fifth-Generation Penn State/NCAR Mesoscale Model) is a regional mesoscale model used for creating weather forecasts and climate projections. It is a community model maintained by Penn State University and the National Centre for Atmospheric Research (NCAR)

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. A basic representation of the model is given:

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

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*
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. It does however not apply to blast waves from mining.

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 at the proposed plant were quantified as point sources or areas 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/mining 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 5 km east-west by 5 km north-south with the proposed project located centrally. The area was divided into a grid matrix with a 25 m resolution and PNRs were included as discrete receptors. The model calculates L_P’s at each grid and discrete receptor point at a height of 1.5 m above ground level.

1.5.6 Presentation of Results

Noise impacts were calculated in terms of:

- Equivalent continuous day, night and day-night rating levels ($L_{Req,d}$, $L_{Req,n}$ and $L_{R,dn}$) as a result of the project in comparison with guidelines; and
- The effective increase ambient day, night and day-night noise levels over estimated baseline $L_{Req,d}$, $L_{Req,n}$ and $L_{R,dn}$ as a result of the project.

Results are presented in isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case L_P) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

Simulated noise levels were assessed according to guidelines published in SANS 10103 and by the IFC. To assess annoyance at nearby places of residence, reference was made to guidelines published in SANS 10103.

1.5.7 Recommendations of Management and Mitigation

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

1.6 Limitations and Assumptions

- Screening effects of buildings such as offices/warehouses/stores etc. was not accounted for in simulations.
- The quantification of sources of noise was restricted to activities associated with the Siyanda FeCr Project.
- All project information required to calculate noise impacts were provided by the technical project team.
- Routine noise impacts from mining operations were estimated and modelled.
- In the absence of on-site meteorological data, use was made of simulated data for Northam.
- Construction and decommissioning phase impacts were assumed to be similar/slightly less significant than operational phase impacts.
- There will be no noise impacts during the closure phase.

2 LEGAL REQUIREMENTS AND NOISE LEVEL GUIDELINES

2.1 SANS 10103 (2008)

SANS 10103 (2008) successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa, and is fully aligned with the WHO guidelines for Community Noise (WHO, 1999). The values given in Table 2 are typical rating levels that should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be considered to be annoying to the community.

Table 2: Typical rating levels for outdoor noise, SANS 10103 (2008)

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

Notes

(a) $L_{Req,d}$ =The L_{Aeq}[3] 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'. Δ = 10 dB is subjectively perceived as a doubling in the loudness of the noise;
- 10 dB < $\Delta \leq$ 20 dB: There will be a 'strong' reaction with 'threats of community action'; and
- 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'.

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

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

2.2 IFC Guidelines on Environmental Noise

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

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

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

Table 3: 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

2.3 Criteria Applied in this Assessment

Reference is made to the IFC guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these are -

(a) applicable to nearby PNRs which include residences and nearby mining towns; and
(b) in-line with SANS 10103 guidelines for urban districts.

For that reason, the 24-hour limit of 55 dBA was also used. The IFC's 3 dBA increase criterion is used to determine the potential for noise impact.

3 DESCRIPTION OF THE RECEIVING ENVIRONMENT

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

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

3.1 Potential Noise Receptors

Noise sensitive receptors generally include places of residence and areas where members of the public may be affected by noise generated by industrial activities. Those that could potentially be affected by noise from the project are presented in Figure 4. The nearest residences are those of the Swartklip Mine Village (no. 1) immediately adjacent to the existing union Section Mine and approximately 500 m west of the proposed location for the furnaces. There are also several individual houses/farmsteads/buildings within a few kilometres of the farm Grootkuil 409 (no. 2, 3, 4 and 5). The Young Farmstead on portion 9 of Kameelhoek (no. 4) lies directly adjacent access road Option 3. Tiramogo Lodge is situated 130 m from access road Option 1. Sefikile is located approximately 5 km south and Northam approximately 8 km east-south-east of project infrastructure and not likely to be affected by noise from its activities.

PNRs within residential areas are generally exposed to higher background noise levels than PNRs at farmsteads. Community noise such as traffic, television and radio, barking dogs etc. are main contributors to noise levels within residential areas. The proximity of the Swartklip Mine Village to mining activities further increases noise levels within the community. PNRs within community/residential areas are therefore generally less sensitive to intruding noise than PNRs within rural areas or on farms.

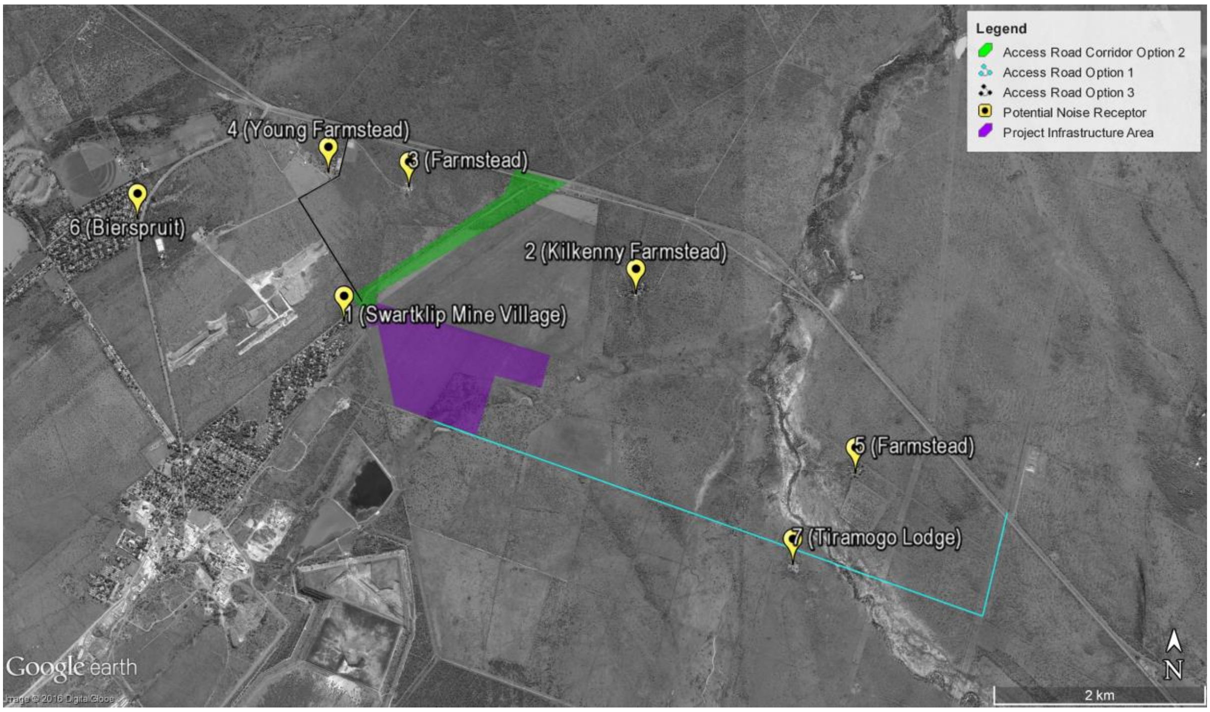


Figure 4: Location of PNRs

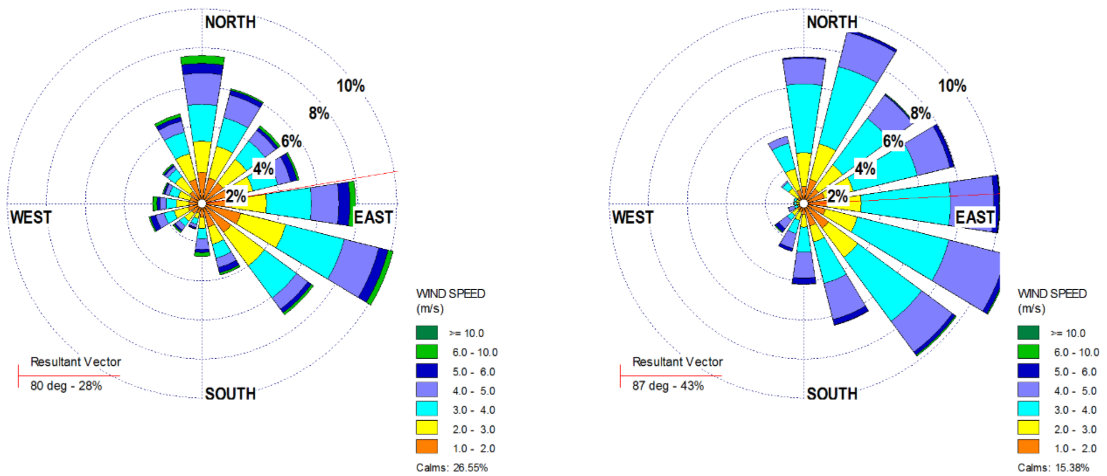
3.2 Environmental Noise Propagation and Attenuation potential

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 1.4.4). 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. Reference is made to MM5 data for the period January 2012 to December 2014.

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

The diurnal wind field is presented in Figure 5. 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. On average, noise impacts are expected to be most notable to the south, west and north-west of the project.



(a) Day-time wind field (06:00 to 22:00) **(b) Night-time wind field (22:00 to 06:00)**

Figure 5: Wind roses (MM5 data, 2012 to 2014)

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. An average temperature of 17°C and a humidity of 47% were applied in simulations.

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 the sound waves 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). There are however no significant natural features with the local study area that may act as acoustic barriers between the operations and PNRs. The terrain of the study area was included in simulations.

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 hard (not conducive to noise attenuation) due the area's semi-arid nature.

3.3 Sampled Baseline and Representative Pre-Development Noise Levels

Airshed conducted a baseline noise survey at the five locations shown in Figure 6, in June of 2015. The survey consisted of attended 30 minute samples during both the day and night (results summarised in Table 4).

Ambient noise levels are affected by road and rail traffic and natural noise sources such as birds and insects. Barking dogs and cattle also added to the acoustic climate. The acoustic climate at site Noise 1 is comparable to urban districts according to SANS 10103 (2008). At sites Noise 2 to 5 noise levels are currently low and comparable to levels typically found in rural districts except for occasional railway noise.

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

- $L_{Req,d}$ – 47.9 dBA;
- $L_{Req,n}$ – 43.1 dBA; and
- $L_{R,dn}$ – 50.4 dBA.

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Table 4: Summary of the noise survey conducted by Airshed on 1 and 2 June 2015

Site	Noise 1		Noise 2		Noise 3		Noise 4		Noise 5	
Time of Day	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Description	Leaf blower, occasional vehicle passing, occasional birds, occasional barking dog, aircraft.	Barking dogs, insects, occasional traffic.	Distant road traffic, birds, wind gusts, aircraft.	Barking dogs, birds.	Insects, distant cattle, wind.	Barking dog, birds, insects and occasional traffic.	Birds, wind, road traffic.	Traffic and train passing.	Birds, insects, traffic.	Traffic and train passing.
Project Name	150602 004	150601 005	150601 004	150602 001	150601 003	150601 006	150601 002	150602 002	150601 001	150602 003
Start Time	02/06/2015 9:58	01/06/2015 22:02	01/06/2015 15:48	02/06/2015 0:12	01/06/2015 14:57	01/06/2015 23:28	01/06/2015 14:03	02/06/2015 1:01	01/06/2015 12:37	02/06/2015 1:57
Elapsed Time	00:30:00	00:30:00	00:30:00	00:30:00	00:30:00	00:30:00	00:30:00	00:30:00	00:30:00	00:30:00
L_{AIeq} (dBA)[(a)]	49.7	42.8	31.5	24.0	32.5	25.5	31.7	25.6	34.5	41.2
L_{Aeq} (dBA)[(b)]	43.9	37.1	28.1	21.8	27.7	20.6	28.1	24.6	29.5	39.4
L_{A90} (dBA)[(c)]	28.3	23.9	23.2	19.0	24.6	17.6	23.7	16.7	23.9	23.7
C_t[(d)]	5	5	5	0.0	5	0.0	5	0.0	0.0	5
$L_{Req,T}$ (dBA)[(e)]	54.7	47.8	36.5	24.0	37.5	25.5	36.7	25.6	34.5	46.2
$L_{R,dn}$ (dBA)[(f)]	56.0		35.8		36.9		36.4		51.4	

Notes:

(a) 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)

(b) The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)

(c) 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)

(d) Correction factor for tonal character determined in accordance with SANS 10103 (2008)

(e) Equivalent continuous rating (in dBA)

(f) 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 10 dB in order to account for the additional disturbance caused by noise during the night

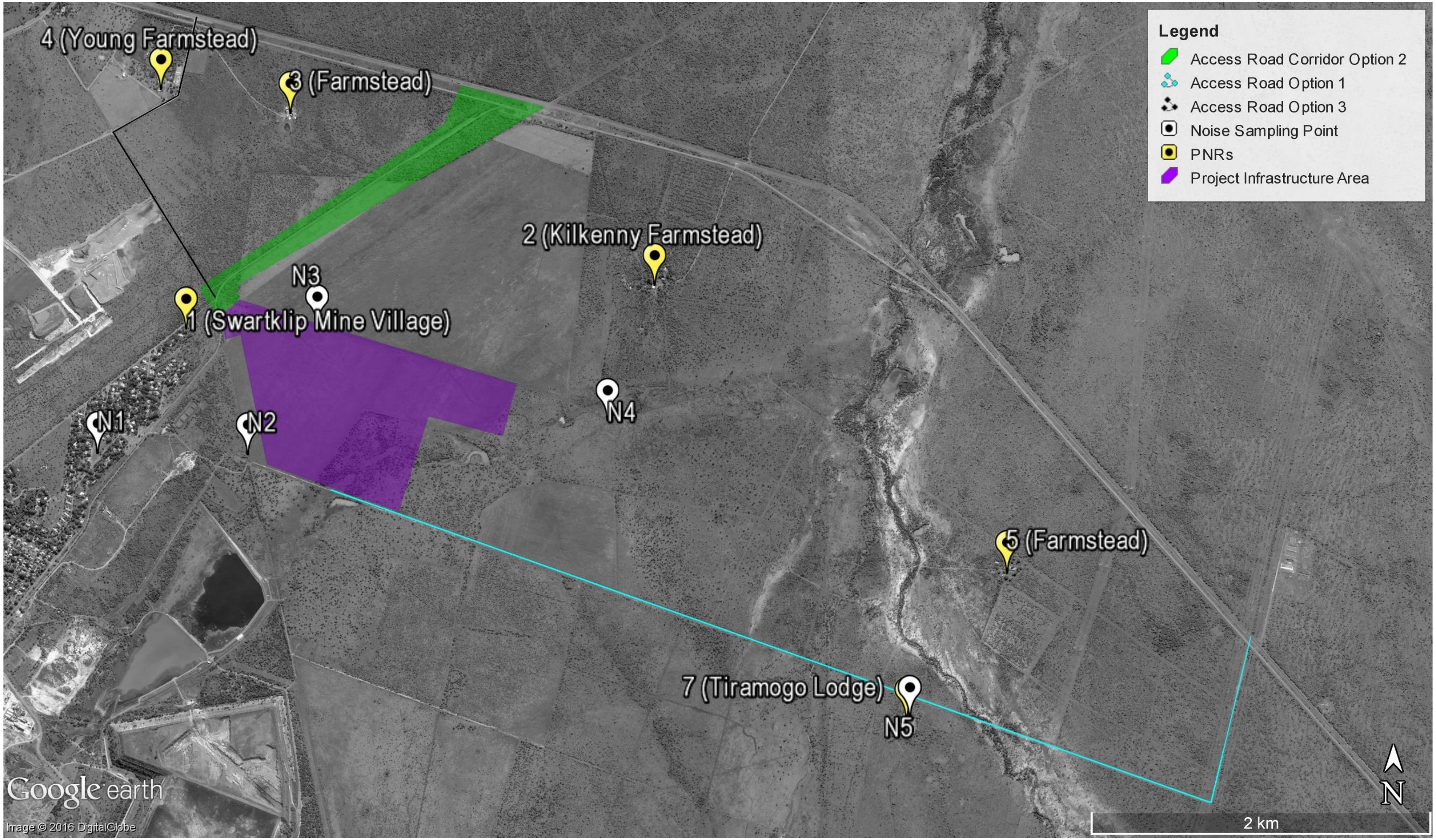

Figure 6: Baseline noise survey sites

4 IMPACT ASSESSMENT

The noise source inventory, noise propagation modelling and results for the operational phase of the project are discussed in Section 4.1and Section 4.2 respectively.

4.1 Noise Sources and Sound Power Levels

The source inventory and estimated L_W's for the project's operational phase, as established using the approach detailed in Section 1.5.4, is summarised in Table 5.

Table 5: Operational phase source noise inventory for the Siyanda FeCr project

Source	Source Type	LWA (dBA)	LWA/m² (dBA/m²)	LWA/m (dBA/m)	Trips per hour	Speed (km/h)	Op. hours
Ore Bypass CAT988	Point	109.6	-	-	-	-	24 hours
Reductant/Flux Bypass CAT988	Point	109.6	-	-	-	-	24 hours
Reductant & Flux Bypass Hopper	Point	95.4	-	-	-	-	24 hours
Ore Bypass Hopper	Point	95.4	-	-	-	-	24 hours
Metal Rail Loading (Handling)	Point	107.9	-	-	-	-	24 hours
Primary Jaw Crushing	Point	117.8	-	-	-	-	8 hours
Single Deck Primary Screen	Point	113.5	-	-	-	-	8 hours
Secondary Crusher	Point	124.3	-	-	-	-	8 hours
Secondary Screen	Point	113.3	-	-	-	-	8 hours
Tertiary Screen	Point	111.3	-	-	-	-	8 hours
Crusher Feed (Handling)	Point	107.9	-	-	-	-	8 hours
Product Storage (Handling)	Point	107.9	-	-	-	-	24 hours
Raw Material Offloading	Area	107.9	79.9	-	-	-	24 hours
Raw Material Bunkers	Area	101.7	65	-	-	-	24 hours
Reductant & Flux Drum Dryer	Area	92.3	65	-	-	-	24 hours
Ore Fluidised Bed Dryer	Area	92.2	65	-	-	-	24 hours
Silos	Area	94.9	65	-	-	-	24 hours
Furnace 1	Area	103.3	65	-	-	-	24 hours
Furnace 2	Area	103.3	65	-	-	-	24 hours
Mechanical Workshop	Area	97.5	65	-	-	-	24 hours
Electrical Workshop	Area	95.6	65	-	-	-	24 hours
Operational Store	Area	90.5	60	-	-	-	24 hours
Refractory and General Store	Area	90.7	60	-	-	-	24 hours
Laboratory	Area	86.7	60	-	-	-	24 hours
Diesel Workshop	Area	95.7	65	-	-	-	24 hours

Source	Source Type	LWA (dBA)	LWA/m² (dBA/m²)	LWA/m (dBA/m)	Trips per hour	Speed (km/h)	Op. hours
Instrumentation Workshop	Area	86.9	65	-	-	-	24 hours
Diesel Storage	Area	83.1	60	-	-	-	24 hours
Service Yard	Area	95	65	-	-	-	24 hours
Ingot Cooling Pad	Area	125.5	88.6	-	-	-	24 hours
Clinic	Area	86.4	60	-	-	-	24 hours
HSE SHEQ Office	Area	85.9	60	-	-	-	24 hours
Change House	Area	89.2	60	-	-	-	24 hours
Offices	Area	91.6	60	-	-	-	24 hours
Sub Station	Area	89.4	60	-	-	-	24 hours
Roadbox Conveyor	Line	102.3	-	86.9	-	-	24 hours
Rail box Conveyor	Line	102.2	-	86.9	-	-	24 hours
Reductant & Flux Dryer Feed Conveyor	Line	104.1	-	86.9	-	-	24 hours
Ore Dryer Feed Conveyor	Line	104.8	-	86.9	-	-	24 hours
Reductant & Flux Dryer Discharge Conveyor	Line	106.4	-	86.9	-	-	24 hours
Ore Dryer Discharge Conveyor	Line	105.6	-	86.9	-	-	24 hours
Silo Discharge Conveyor 1	Line	109.2	-	86.9	-	-	24 hours
Silo Discharge Conveyor 2	Line	109.3	-	86.9	-	-	24 hours
Crusher Conveyor 1	Line	100.9	-	86.9	-	-	24 hours
Crusher Conveyor 2	Line	104.1	-	86.9	-	-	24 hours
Crusher Conveyor 3	Line	100.6	-	86.9	-	-	24 hours
Crusher Conveyor 4	Line	101	-	86.9	-	-	24 hours
Crusher Conveyor 5	Line	101	-	86.9	-	-	24 hours
Crusher Conveyor 6	Line	101.1	-	86.9	-	-	24 hours
Crusher Conveyor 7	Line	104.5	-	86.9	-	-	24 hours
Crusher Conveyor 8	Line	101.6	-	86.9	-	-	24 hours
Crusher Conveyor 9	Line	98	-	86.9	-	-	24 hours
Slag Haul Road (Slag Carrier)	Moving Point Source	97.3	-	66.1	1.2	20	24 hours
Metal Haul Road (CAT988)	Moving Point Source	98.8	-	75.4	7.5	20	24 hours
Raw Materials Haul Road (CAT725)	Moving Point Source	101.4	-	66.7	3.6	40	24 hours

4.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the operational phase was calculated with CadnaA in accordance with ISO 9613. Meteorological and site specific acoustic parameters as discussed in Section 3.2.1 along with source data discussed in 4.1, were applied in the model.

Results are presented in tabular form (Table 6) and isopleth form (Figure 7 to Figure 12). An isopleth is a line on a map connecting points at which a given variable (in this case L_P) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

During the day (06:00 to 22:00), operational phase related noise is not expected to exceed the day-time guideline of 55 dBA at PNRs. Although low, the highest day-time impact is expected at Swartklip Mine Village (NSR01) with an increase above the baseline of 3 dBA. For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. According to SANS 10103 (2008), 'little' reaction with 'sporadic complaints' may be expected from the community.

As a result of atmospheric conditions less conducive to noise attenuation and stricter guidelines, night-time noise impacts (22:00 to 06:00) are generally more notable. The night-time guideline of 45 dBA is expected to be exceeded only at the Swartklip Mine Village (located immediately adjacent to the existing Union Section Mine). Proposed Siyanda FeCr Project activities are expected to result in a $L_{Req,n}$ of 45.5 dBA and an increase of 4.4 dBA above the baseline at the Swartklip Mine Village. This is in exceedance of the IFC 3 dBA guideline and, according to SANS 10103 (2008), 'little' reaction with 'sporadic complaints' can be expected.

Over 24-hours, the guideline of 55 dBA will not be exceeded at PNRs. An increase on 4.0 dBA above the baseline, which is more than the 3 dBA limit recommended by the IFC, is expected at the Swartklip Mine Village. According to SANS 10103 (2008), 'little' reaction with 'sporadic complaints' from residents of- or visitors to the area are likely.

Table 6: Noise propagation simulation results at PNRs

NSR	$L_{Req,d}$ (dBA)	$\Delta L_{Req,d}$ (dBA)	$L_{Req,n}$ (dBA)	$\Delta L_{Req,n}$ (dBA)	$L_{R,dn}$ (dBA)	$\Delta L_{R,dn}$ (dBA)
NSR01 (Swartklip Mine Village)	47.9	3.0[(a)]	45.5[(a)]	4.4[(a)]	52.3[(a)]	4.0[(a)]
NSR02	36.9	0.3	32.0	0.3	39.5	0.3
NSR03	41.6	0.9	37.7	1.1	44.9	1.1
NSR04	37.6	0.4	33.7	0.5	41.1	0.5

Notes:

(a) Exceeds selected noise criterion.

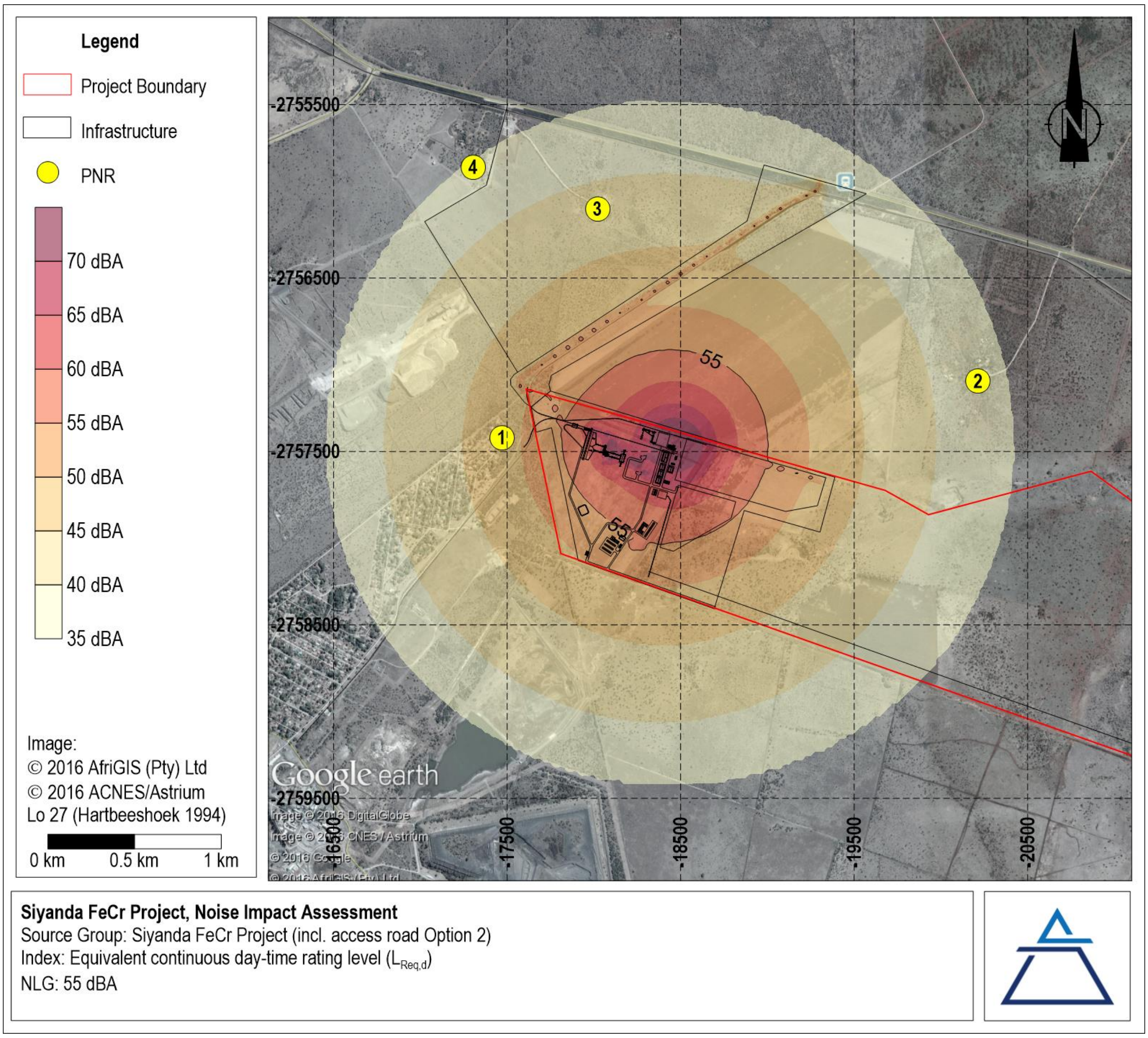

Figure 7: Simulated equivalent continuous day-time rating level ($L_{Req,d}$)

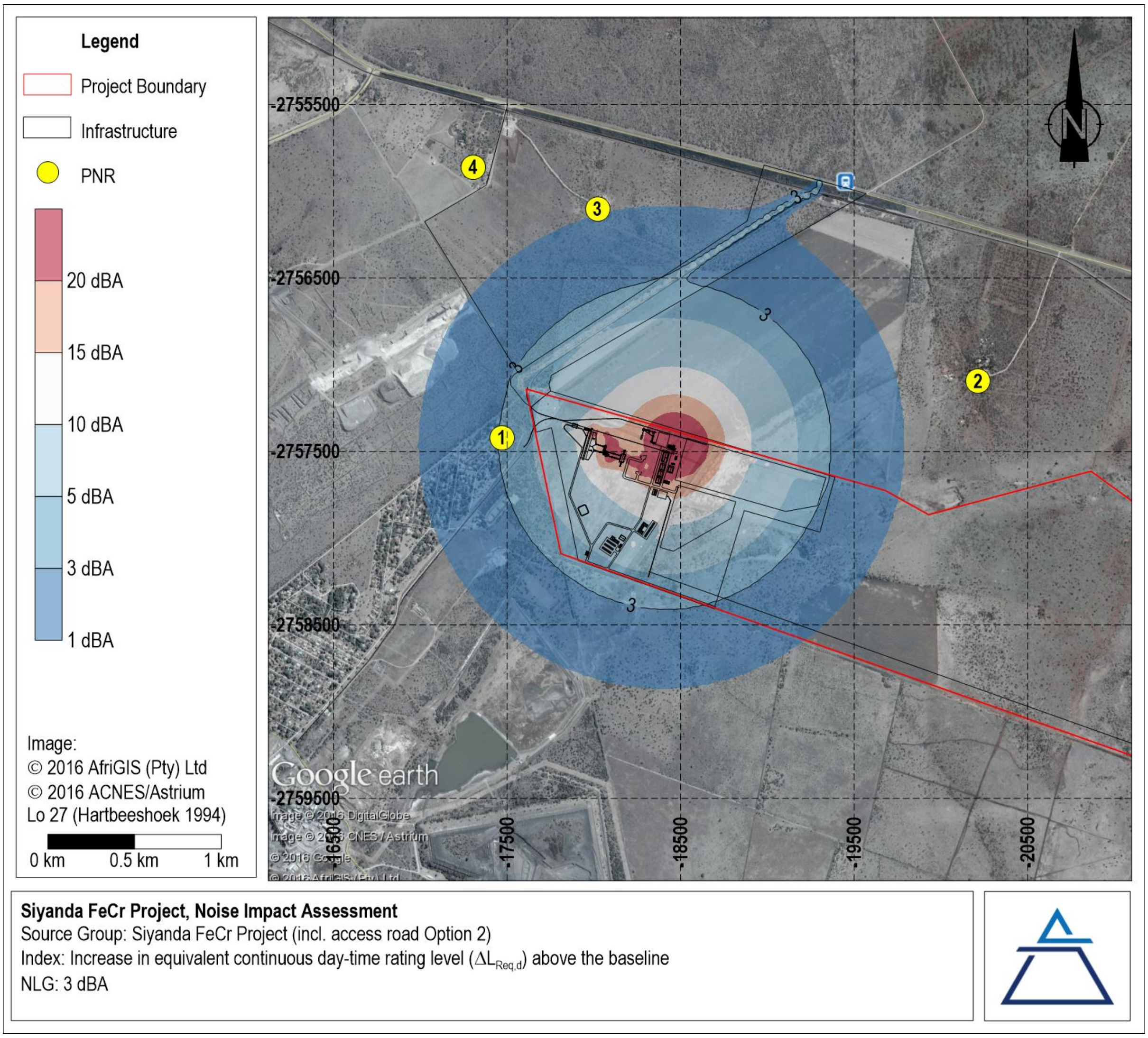

Figure 8: Simulated increase in equivalent continuous day-time rating level ($\Delta L_{Req,d}$) above the baseline

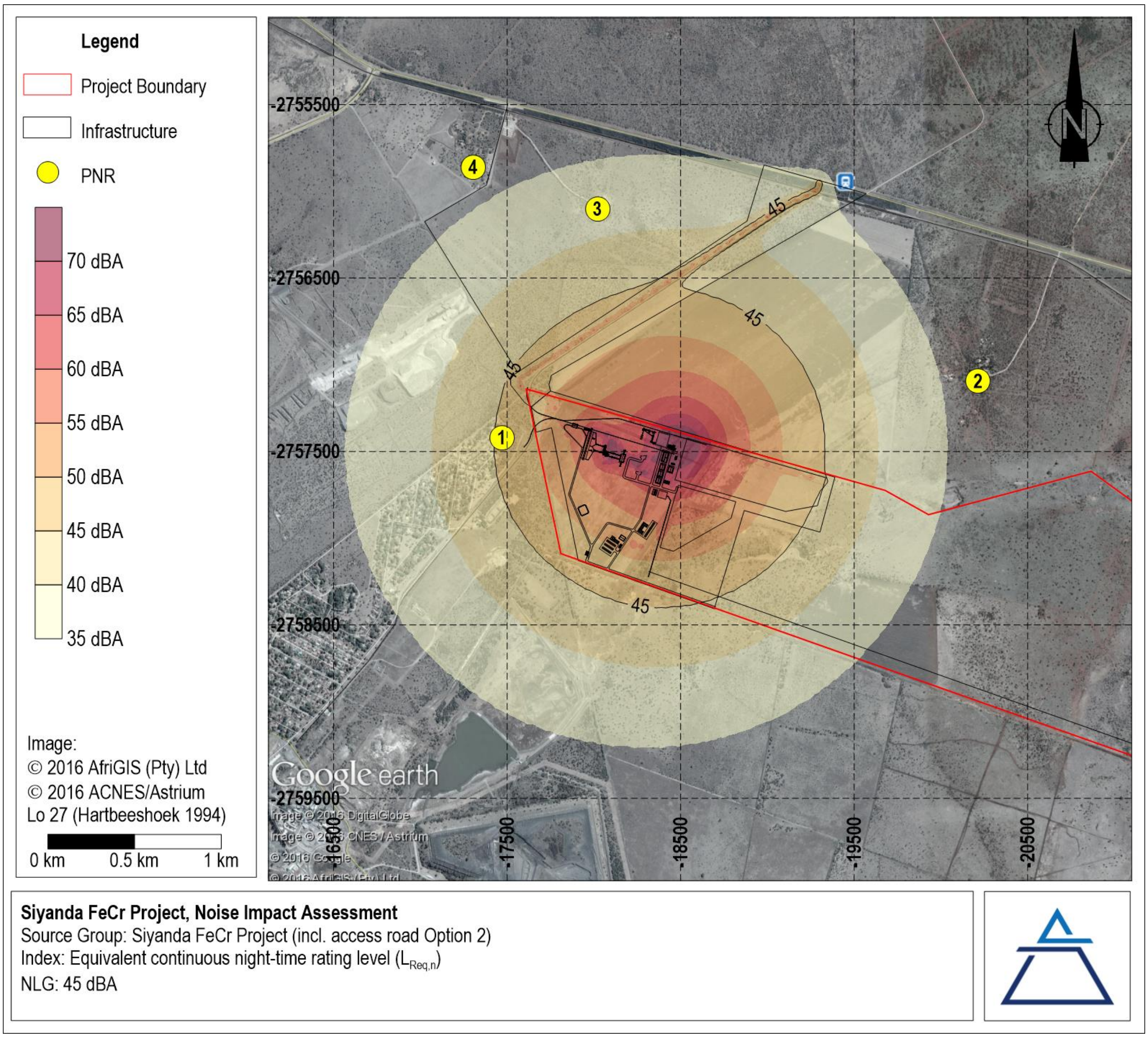

Figure 9: Simulated equivalent continuous night-time rating level ($L_{Req,n}$)

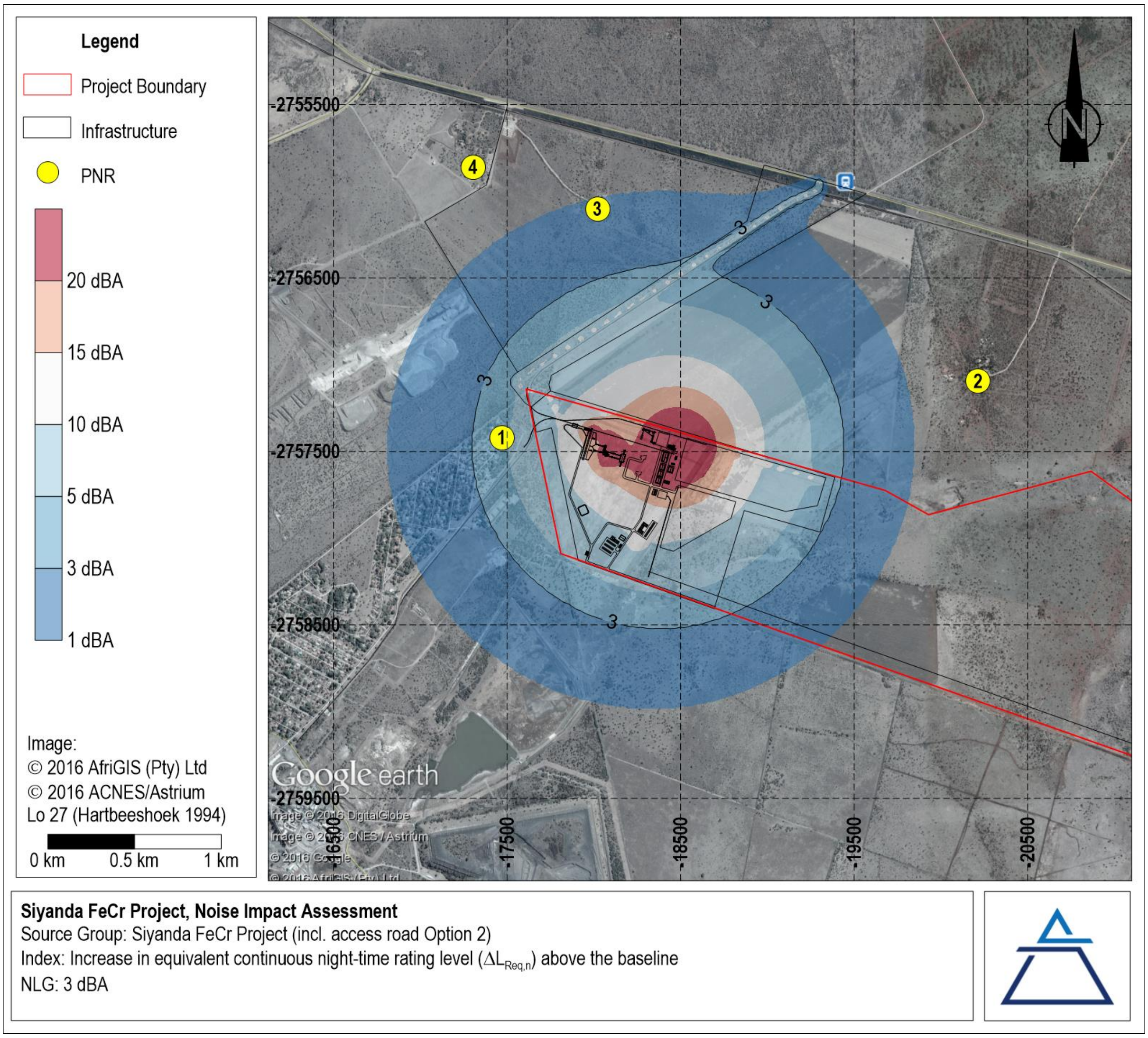

Figure 10: Simulated increase in equivalent continuous night-time rating level ($\Delta L_{Req,n}$) above the baseline

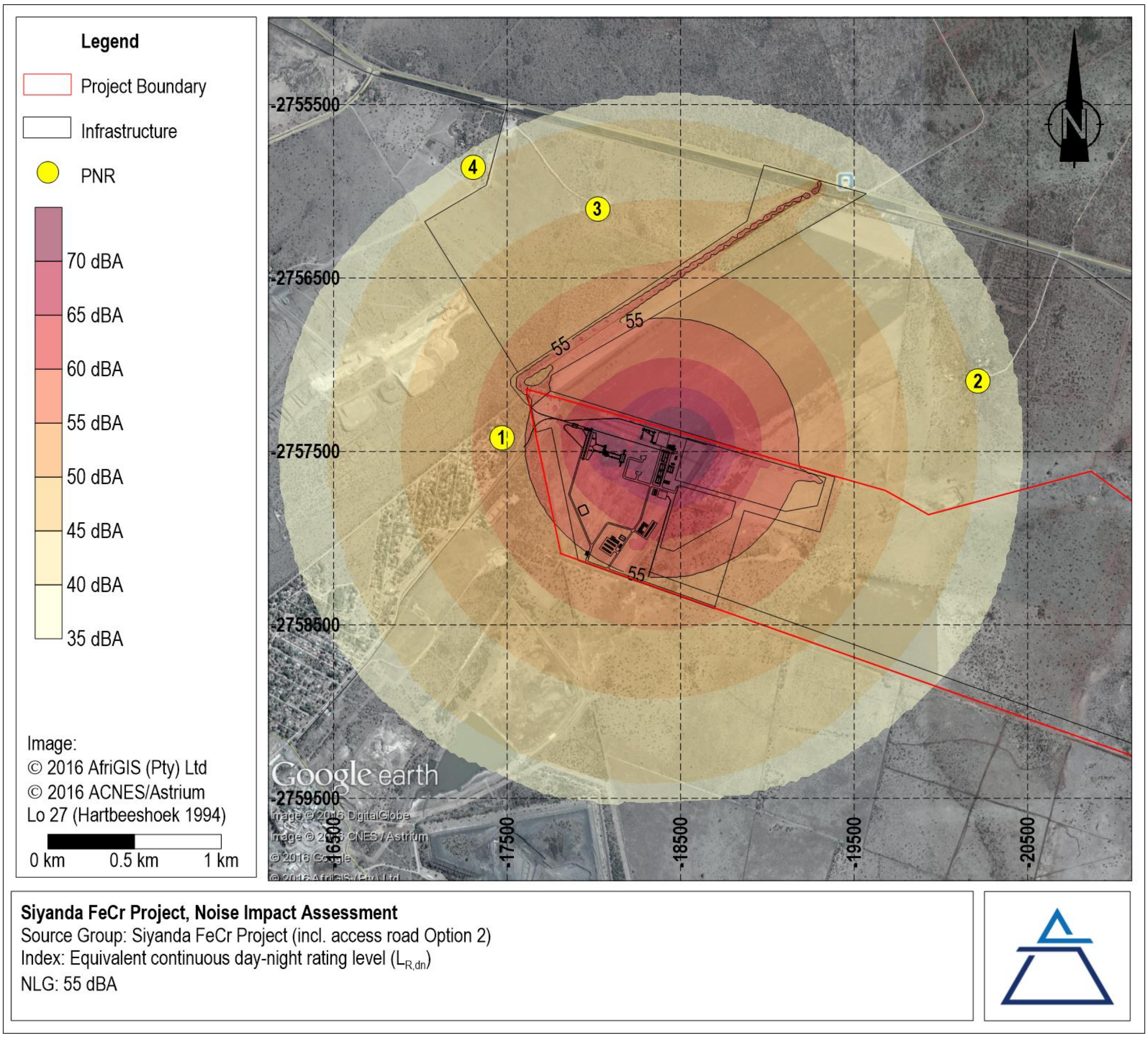

Figure 11: Simulated equivalent continuous day-night rating level ($L_{R,dn}$)

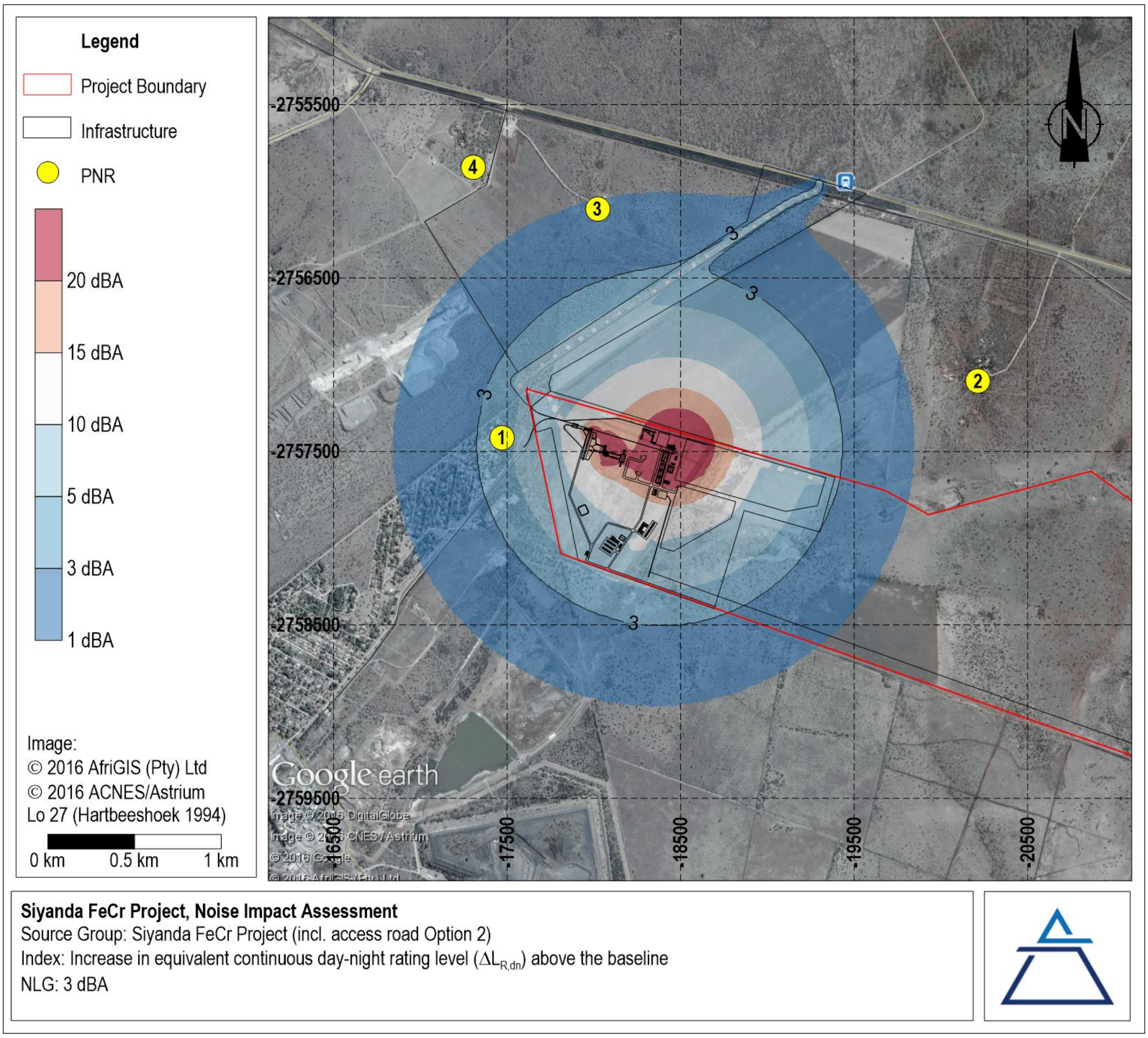

Figure 12: Simulated increase in equivalent continuous day-night rating level ($\Delta L_{R,dn}$) above the baseline

4.3 Impact Significance Rating

The impact assessment is summarised in the subsequent table for the construction, operational and decommissioning phases. The impact significance rating is based on *simulation results* at PNR for the operational phase and a qualitative assessment of potential construction and decommissioning phase impacts. The SLR impact significance rating methodology is included in Appendix B.

4.4 Access Road Options

In terms of the three access road options under consideration, Option 2 is considered most preferable. Option 1 is slightly less preferable given the proximity of the Tiramogo Lodge to the alignment. Option 3 is the least preferred given the location of the Young farmstead to the immediate west of the alignment.

Table 7: Impact significance summary

Scenario	Impact	Severity/Nature of Impact	Duration of Impact	Spatial Scale of Impacts	Consequence	Probability	Significance
Construction phase	noise impact	L	L	M	Low	H	**Medium**
Operational phase	noise impact	L	L	M	Low	H	**Medium**
Decommissioning phase	noise impact	L	L	M	Low	H	**Medium**

Notes:

(a) Severity/nature:

i. L – 0 dB < Δ ≤ 5 dB: There will be 'little' reaction with 'sporadic complaints'

ii. M – 5 dB < Δ ≤ 15 dB: There will be a 'medium' reaction with 'widespread complaints'

iii. H – 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'

(b) Duration:

i. L – Less than the project life. Short term.

ii. M – Project life. Medium term.

(c) Spatial Scale

i. L – Localised, area of exceedance of assessment criteria within the site boundary.

ii. M – Fairly widespread, area of exceedance of assessment criteria beyond the site boundary but local.

(d) Probability of exposure:

i. H – Definite/continuous

5 MANAGEMENT, MITIGATION AND RECOMMENDATIONS

In the quantification of noise emissions and simulation of noise levels as a result of the proposed Siyanda FeCr Project, it was calculated that ambient noise evaluation criteria for human receptors will only be exceeded in close proximity to activities and at the closest downwind NSR. Residents of the Swartklip Mine Village (NSR01) may be exposed to noise level in marginal exceedance of night-time and 24-hour assessment criteria. 'Little' reaction with 'sporadic complaints' can be expected from members of this community.

From a noise perspective the project may proceed provided that the management and mitigation measures are implemented as part of the conditions of environmental authorisation to ensure minimal impacts on the surrounding environment.

5.1 Good Engineering and Operational Practices

For general activities the following good engineering practice should be applied:

- All diesel powered equipment and plant vehicles should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.
- To minimise noise generation, vendors should be required to guarantee optimised equipment design noise levels.
- Vibration isolators should be installed to reduce noise and vibration from crushers and screens.
- A mechanism to monitor noise levels, record and respond to complaints and mitigate impacts should be developed.

5.2 Traffic

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

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

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

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

- Minimizing individual vehicle engine, transmission and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
- Minimize slopes by managing and planning road gradients to avoid the need for excessive acceleration/deceleration.
- Maintain road surface regularly to avoid corrugations, potholes etc.
- Avoid unnecessary idling times.
- Minimizing the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level in the vicinity of the

moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009).

5.3 Operational Hours

As per the project description, crushing and screening activities should be limited to day-time hours. It is also recommended that where possible, noisy activities such as construction and decommissioning be limited to day-time hours.

5.4 Monitoring

In the event that noise related complaints are received short term (24-hour) 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.

It is further recommended that at least one survey be included at the commencement of the construction and operational phases to confirm simulation results. Sampling locations should include all five PNR locations.

The following procedure should be adopted for all noise surveys:

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

6 COMMENTS/ISSUES RAISED

Comments/Issues raised pertaining to potential noise impacts are included in Table 8.

Table 8: Comments/Issues raised

Comment/Issue Raised	Comment by	Response
I am concerned about noise impacts.	Comment raised by Hannes Olckers at scoping meeting, Northam Town Hall, 23 July 2015	The propagation of noise generated by the project was determined as part of this specialist study. It took into account source and operational activities; weather conditions; ground cover, land use and topography; as well as the location of potential noise receptors in relation to project infrastructure. It was found that night-time noise criteria for residential areas may be exceeded at the closest residence of the Swartklip Mine Village. Refer to Section 4.2 for more detail.
We are concerned about the noise related impacts	Comment by Philip Schoeman and Pier De Vries during focused scoping meeting with Union Mine, 13 May 2015	
How far will noise travel from the proposed smelter?	Comment raised by William Segone at scoping meeting, Mmansterre, 21 July 2015	
It is common knowledge that a Ferrochrome Smelter is associated with, amongst others: Noise	Comment raised by Ernst Burger (on behalf of the Schoeman family, the beneficiaries of a Testamentary Trust) – draft scoping report comments, received on 4 May 2016.	
The current noise levels are already a concern and should be monitored. On our farm we can hear the reverse hooters of trucks and the noise from bulldozers.	Comment raised by Sandy McGill, Mr and Mrs Schoeman at the scoping meeting, Swartklip Rec Centre, 21 July 2015	A baseline noise survey was conducted in June 2015. It was found that noise levels within the Swartklip Mine Village are currently similar to what is typical of residential/urban areas. Levels well below the noise level guidelines were recorded on-site and at the Tiramogo Lodge. Refer to Section 3.3 for more detail. High frequency reverse warning signals generated by diesel mobile equipment can be audible over long distances. Although audible, it is highly unlikely in exceedance of noise level guidelines off-site. Minimizing the need for trucks/equipment to reverse will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level in the vicinity of the moving equipment. Refer to Section 5 for recommended mitigation measures.
Noise from trucks is a major concern for us, especially at night time. The reverse alarm of trucks echoes through the veld. Trucks from BCR would also blast their music at night which increases the noise in the area.	Comment by Vernon Koekemoer at focused meeting, on Johan Young's property (Kameelhoek 9), 26 May 2016	

7 REFERENCES

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

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

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

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

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

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

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

8 Annex A – Specialist's Curriculum Vitae

CURRICULUM VITAE

Name	Nicolette von Reiche (nee Krause)
Date of Birth	22 October 1982
Nationality	South African
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Principal Consultant and Project Manager
Profession	Mechanical Engineer employed as a Air Quality and Environmental Noise Assessment Consultant
Years with Firm	9 Years

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- South African Acoustic Institute (SAAI), 2006 to present
- National Association for Clean Air (NACA), 2006 to present
- International Institute for Acoustics and Vibration (IIAV), 2014 to present

EXPERIENCE

Nicolette has over nine years of experience in both air quality and noise impact assessment and management. She is an employee of Airshed Planning Professionals (Pty) Ltd and is involved in the compilation of emission inventories, atmospheric dispersion modelling, air pollution mitigation and management, and air pollution impact work. Airshed Planning Professionals is affiliated with Francois Malherbe Acoustic Consulting cc and in assisting with numerous projects she has gained experience in environmental noise measurement, modelling and assessment as well.

A list of projects competed in various sectors is given below:

Power Generation, Oil and Gas

eni East Africa S.p.A Rovuma Area 4 baseline for offshore gas (Mozambique), Staatsolie Power Company Suriname (Suriname), Benga Coal Fired Power Station (Mozambique), Zuma Energy Project (Nigeria), Anglo Coal Bed Methane Project, Eskom Ash Disposal Projects for Kusile Power Station, Camden Power Station and Kendal Power Station, Hwange Thermal Coal Fired Power Station Project (Zimbabwe), Eskom Ankerlig Gas Power Station.

Industrial Sector

Scantogo Cement Project (Togo), Boland Bricks, Brits Ferrochrome Smelter Project, Samancor Chrome's Ferrometals, Middelburg Ferrochrome and Tubatse Ferrochrome, BHP Billiton Metalloys Ferromanganese Projects and Mamatwan Sinter Plant Projects, Tharisa Minerals Concentrator Plant Project, Obuasi Gold Processing Plant (Ghana), Obuasi Gold Mine Pompora Treatment Plant Project (Ghana), Afrisam Saldanha Project, Scaw Metals Projects, including a Co-generation Plant and Steel Wire Rope Plant Project, Delta EMD Project, Dense Medium Separation (DMS) Powders Project, Transalloys Silica Manganese, Dundee Precious Metals Tsumeb (Namibia), Rӧssing Uranium Desalination Plant (Namibia), Otavi Steel Project (Namibia)

Air Quality and Environmental Noise Management

- Saldanha Industrial Development Zone (IDZ) – Part of an integrated team of specialists that developed the proposed development and management strategies for the IDZ. Air quality guidelines were developed and a method of determining emissions for potential developers. The investigation included the establishment of the current air emissions and air quality impacts (baseline) with the objective to further development in the IDZ and to allow equal opportunity for development without exceeding unacceptable air pollution levels.
- Gauteng Department of Transport air quality and noise management plan - The plan involved the identification of main traffic related sources of noise and air pollution, the identification of intervention strategies to reduce traffic related noise and emissions to air and the theoretical testing of intervention strategies through emission quantification and dispersion modelling of selected case studies.
- Erongo Strategic Environmental Impact Assessment (Namibia) and Air Quality Management Plan

Mining Sector

- **Coal mining:** Elders Colliery, Grootgeluk Colliery, Inyanda Colliery, Boschmanspoort Colliery, Benga Mine (Mozambique), Vangatfontein Colliery Dust Monitoring, T-Project Underground Coal Mine, Lusthof Colliery
- **Metalliferous mines:** Samancor Chrome's Eastern and Western Chrome Mines, Kinsenda Copper Mine (DRC), Bannerman Uranium Mine (Namibia), Sadiola Gold Mine Deep Sulphides Project (Mali), Kolomela Iron Ore Mine Noise Monitoring, Mamatwan Manganese Mine, Ntsimbintle Manganese Mine, Tharisa Minerals Chrome and Platinum Group Metals Open-pit Mine Project, Obuasi Gold Mine (Ghana), Omitiomire Copper Mine (Namibia), Perkoa Zinc Project (Burkina Faso), Tschudi Copper Mine (Namibia), Rössing Uranium Mine (Namibia), WCL Iron Ore Mines (Liberia), Fekola Gold Project (Mali), Esaase Gold Project (Ghana), Xstrata Paardekop and Amersfoort Underground Coal Mines, Mampon Gold Mine (Ghana), Husab Uranium Mine (Namibia), Mkuju River Uranium Project (Tanzania), Impala Platinum Mine, Angola Exploration Mining Resources Project (Angola), Kanyika Niobium Mine (Malawi)
- **Quarries:** Scantogo Limestone Quarry, Lion Park Quarries Dustfall Monitoring

Waste Disposal and Treatment Sector

Aloes Hazardous Waste Disposal Site, Holfontein Hazardous Waste Disposal Site, Shongweni Hazardous Waste Disposal Site, Coega General and Hazardous Waste Disposal Site, Umdloti Waste Water Treatment Works, Waltloo Medical Waste Incinerator

Transport and Logistics Sector

Saldanha Iron Ore Port Projects and Railway Line, Gautrain Environmental Noise Monitoring Project, Guinea Port and Railway Project (Guinea), Kenneth Kaunda International Airport Expansion (Zambia), Zambia Dry Port Project in Walvis Bay (Namibia)

Ambient Air Quality and Noise Sampling

- Gravimetric Particulate Matter (PM) and dustfall sampling
- Passive diffusive gaseous pollutant sampling
- Environmental noise sampling
- Source noise measurements

SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, ISC, CALPUFF, ADMS (United Kingdom), CALINE, GASSIM, TANKS
- Noise Propagation Modeling: Integrated Noise Model (for airport noise), CONCAWE, South African National Standards (SANS 10210) for Calculating and Predicting Road Traffic Noise
- Graphical Processing: Surfer, ArcGIS (basic proficiency)
- Other: MS Word, MS Excel, MS Outlook

EDUCATION

- BEng: (Mechanical Engineering), 2005, *University of Pretoria*
- BEng (Hons): (Mechanical Engineering) 2010, *University of Pretoria*; specializing in:
    - Advance Heat and Mass Transfer
    - Advanced Fluid Mechanics
    - Numerical Thermo-flow
    - Tribology

COURSES COMPLETED AND CONFERENCES ATTENDED

- Course: Air Quality Management. Presented by the University of Johannesburg (March 2006)
- Course: AERMET/AERMAP/AERMOD Dispersion Model. Presented by the University of Johannesburg (March 2010)
- Conference: NACA (October 2007), Attended and presented a paper
- Conference: NACA (October 2008), Attended and presented a paper
- Conference: NACA (October 2011), Attended and presented a poster
- Conference: NACA (October 2012), Attended and presented a paper
- Conference: IUAPPA (October 2013), Attended and presented a paper

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Zimbabwe, Zambia, Namibia, the Democratic Republic of the Congo, Botswana, Ghana, Liberia, Togo, Mali, Burkina Faso, Tanzania, Malawi, Angola, Nigeria and Suriname

LANGUAGES

	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Excellent	Excellent	Excellent

REFERENCES

Name	Position	Contact Number
Dr. Gerrit Kornelius	Associate of Airshed Planning Professionals	+27 (82) 925 9569 gerrit@airshed.co.za
François Malherbe	Owner of François Malherbe Acoustic Consulting	+27 (82) 469 8063 malherf@mweb.co.za
Dr. Hanlie Liebenberg Enslin	Managing Director at Airshed Planning Professionals	+27 (83) 416 1955 hanlie@airshed.co.za

CERTIFICATION

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

28/03/2015

9 ANNEX B – SLR IMPACT SIGNIFICANCE RATING METHODOLOGY

Table 9: Criteria for assessment of impacts

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

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

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

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

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