NOISE STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

Development of the proposed Greater Soutpansberg Mopane Project, Limpopo

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EXECUTIVE SUMMARY

The Gudani Consulting were contracted by Coal of Africa Limited to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the development of the proposed Greater Soutpansberg Mopane Project. Gudani undertook the noise impact study in consortium with Enviro-Acoustic Research (EARES). This project forms part of the Greater Soutpansberg Project (GSP) situated to the north of the Soutpansberg in the Limpopo Province.

The mining footprint covers an area of 1 572 ha for mining, divided into the Voorburg and Jutland Sections. Coal will be mined to a depth of up to 200 m using opencast methods using a fleet of Cat 793F and 789C trucks and appropriately sized excavators.

Current planning is that construction and mining will commence at the Voorburg Section in 2019, followed by the Jutland Section after 2030. The coal product will be transported to the markets using Transnet's railway infrastructure. The total life of the Mopane Project is in excess of 50 years.

Although the mining operation will start at Voorburg, the processing plant is located centrally between the Voorburg and Jutland pits close to the Mopane railway station. The Voorburg mine will however be provided with a workshop and other necessary infrastructure required for the mining operation. This includes a material tip and crusher at the conveyor feed to the coal beneficiation plant.

The centrally located infrastructure (at Jutland) will comprise a coal washing plant, personnel support structures, vehicle support structures, water management structures and management and monitoring systems. A conveyor will be utilised to transport the run of mine (ROM) from Voorland to the processing plant at Jutland.

Ambient sound levels were measured at 7 locations during a site visit 2 – 5 July 2013 using equipment and methodologies as defined in SANS 10103:2008. Measurements indicated significant variation in equivalent sound levels from location to location, with all locations experiencing noisy single events at times that impacted on the sound levels. L_{A90} levels however indicate an area with significant potential to be quiet at times.

Equivalent daytime ambient sound levels were measured around between 43 – 64 dBA, ranging between 22 and 75 dBA (10-minute measurements) with equivalent night-time ambient sound levels were measured around between 33 – 64 dBA, ranging between 19 and 75 dBA (10-minute measurements).

The Mopane community and the NSD30 (Mr. Meintjies) currently experience slightly elevated ambient sound levels due to the Limestone Plant in the area. There are however little indication of any significant noise impacts from external sources of anthropogenic origin at other monitoring locations. While the gravel roads in the area does increase noise levels due to single events, the main source of noise appears to be originating from local dwellings. The source in most cases relates to faunal activity around the dwellings. This is specifically clear at measurement location MAS03 where chickens raised the noise levels to those similar of a commercial district.

Due to the significant variance in ambient sound measurements it is recommended that the project use the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas.

With the input data as used, this assessment indicated that there is a potential noise impact of moderate (daytime) to high (night-time) significance during the construction phase. The layout as evaluated however provides a number of berms and stockpiles that will assist in the attenuation of noises from the mining activities during the operational phase. Subsequently, the potential noise impact would be of a moderate significance during the night-time period during the operational phase.

Mitigation measures were proposed that could further reduce the noise levels as experienced by the closest noise-sensitive developments (the magnitude of the reduction depending on the selection of the mitigation measures).

Because there still exist a risk of a noise impact, noise monitoring is recommended. As there exists scope for further mitigation measures such a noise monitoring program can only be designed after all mitigation measures are designed and known. Once designed it should be implemented on a quarterly basis for a period of one year before the construction activities start to define pre-mining ambient sound levels.

Quarterly noise monitoring is also recommended to be conducted during the first year of operation, and, depending on the findings of the monitoring report, to be extended, reduced or stopped. Noise measurements should be conducted over a period of 24 hours as per the methodology employed in this report.

Measurements should be collected in 10-minute bins over the measurement period. Variables recommended to be analysed include L_{AMin}, L_{AIeq}, $L_{Aeq,f}$, L_{Aeq}, L_{Ceq}, L_{AMax}, L_{A10}, L_{A90} and spectral analysis. If all potential noise-sensitive receptors living within the 40 dBA contour are relocated before the mining project starts noise measurements can be dispensed with.

Additional measurements should be collected at the location of any receptors that have complained to the mine regarding noise originating from the operation. Feedback regarding noise measurements should be presented to all stakeholders and other interested and affected parties in the area.

This report should also be made available to all potentially sensitive receptors in the area, or the contents explained to them to ensure that they understand all the potential noise risks that the mining operation may have on them and their families.

Due to economic advantages, coal mining does provide valuable employment, local taxes and foreign currency. However, when mining projects are near to potential noise-sensitive receptors, consideration must be given to ensuring a compatible co-existence. The potential sensitive receptors should not be adversely affected and yet, at the same time mining need to reach an optimal scale in terms of layout and production.

It should be noted that this does not suggest that the sound from the mining activities should not be audible under all circumstances - this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source – but rather that the sound due to the mining activities should be at a reasonable level in relation to the ambient sound levels.

Title:

Noise Study for Environmental Impact Assessment: Development of the proposed Greater Soutpansberg Mopane Project, Limpopo

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Report no:

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GLOSSARY OF ABBREVIATIONS

AZSL	Acceptable Zone Sound Level (Rating Level)
bcm/h	Bank cubic meters per hours
DEADP	Department of Environmental Affairs and Development Planning
DEDEA	Department of Economic Development and Environmental Affairs
DEA	Department of Environmental Affairs
EARES	Enviro-Acoustic Research cc
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act (Act 78 of 1989)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
FEL	Front End Loader
IAPs	Interested and Affected Parties
i.e.	that is
IEM	Integrated Environmental Management
km	kilometres
LHD	Load haul dumper
m	Meters (measurement of distance)
m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
NGO	Non-government Organisation
PPE	Personal Protective Equipment
PPP	Public Participation Process
SABS	South African Bureau of Standards
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
TLB	Tip Load Bucket
UTM	Universal Transverse Mercator
WHO	World Health Organisation

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

The Gudani Consulting were contracted by Coal of Africa Limited to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the development of the proposed Greater Soutpansberg Mopane Project. Gudani undertook the noise impact study in consortium with Enviro-Acoustic Research (EARES).

1.2 BRIEF PROJECT DESCRIPTION

1.2.1 Project Background

The Mopane Project forms part of the Greater Soutpansberg Project (GSP) situated to the north of the Soutpansberg in the Limpopo Province. The Mopane Project footprint covers an area of 1 572 ha for mining and a further 1 964 ha for infrastructure development. The mining and infrastructure layouts are shown in **Figure 1-1**.

It is estimated that in most instances it is mineable to a depth of 200 m through open cast methods. Due to the flat dipping nature of the coal resource a normal truck and shovel strip open cast mining method is likely to prove the most cost effective.

Current planning is that construction and mining will commence at the Voorburg Section first (see also mining schedule **Figure 1-2**), followed by the Jutland Section as capacity in infrastructure is developed (see also mining schedule **Figure 1-3**). Production at the Voorburg Section will commence in late 2019 and build up to 4 Mtpa Run-of-Mine (RoM) (2.5 Mtpa product) by 2020. Due to rail logistics constraints, mining at the Voorburg Section continues for ± 33 years to exhaustion of the resource.

It is expected that additional rail capacity will become available after 2030, allowing for an increase in coal production. Mine development at the Jutland Section will therefore commence in 2030 with first production in 2032. To cater for the additional production from 2033 onward, a further coal beneficiation plant will be required at the Jutland Section and a new Rapid Load-out Terminal (RLT) will be built at the rail loop. The total life of the Mopane Project is in excess of 50 years.

1.2.2 Support Infrastructure

Although the mining operation will start at Voorburg, the processing plant is located centrally between the Voorburg and Jutland pits close to the Mopane railway station. The Voorburg mine will however be provided with a workshop and other necessary infrastructure required for the mining operation. This includes a material tip and crusher at the conveyor feed to the coal beneficiation plant.

The centrally located infrastructure (at Jutland) will comprise a coal washing plant, personnel support structures, vehicle support structures, water management structures and management and monitoring systems. A conveyor will be utilised to transport the run of mine (ROM) from Voorland to the processing plant at Jutland. The following sections discuss the mining infrastructure in more detail.

1.2.3 Plant Infrastructure

The coal beneficiation plant will produce two products namely a middlings product with an ash content of 30% and a coking product with an ash content of 10%. The processing plant will therefore use the following technologies:

- Two-stage DMS for coarse coal beneficiation using cyclone separators to produce a coking and middlings product;
- Two-stage of up-flow classification for recovery of fine coal using reflux classifiers to produce a coking and middlings product; and
- Two-stage flotation using micro-bubble and conventional mechanical technologies for the recovery of ultra-fine coking coal product.

Fine tails will be dewatered using a thickener followed by tailings filtration before being discharged on a common discard conveyor feeding the discards stockpile. The development of the discards stockpile will be done in phases.

1.2.4 Mining Equipment

Coal units are modelled to be mined by excavators with a capacity of 1 400 bcm/h, using slightly larger units for inter- and overburden units. A fleet of Cat 793F trucks at 220 tonne payload have been allocated for waste movement. Coal mining and reject haulage has been modelled with a fleet of Cat 789C trucks at 150 tonne payload. The scheduled waste demand to meet a 2.5 Mtpa coal product production rate is such that 1 coal excavators is required with 3 interburden and 2 overburden excavators.

1.2.5 Product Transport

The coal product will be transported to the available markets using the existing Transnet railway infrastructure passing the Jutland section. The Mopane Rapid Load-out Terminal has been designed to meet this operational plan and allow flexibility for future increases in train lengths up to a maximum of 100 appropriate freight wagons.

1.3 STUDY AREA

The study area (also refer to **Figure 1-1**) concerns a number of farms and potential noise-sensitive receptors in the vicinity of the proposed development. The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

1.3.1 Topography

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

1.3.2 Surrounding Land Use

The surrounding land use is mainly commercial game farming with cultivation and cattle agriculture taking place at certain farms.

1.3.3 Roads and Railways

Access to the Mopane Project Infrastructure Hub is by way of the N1 towards Musina, turning west onto the D525 approximately 7 km to Mopane Railway Station.

The main entrance to the Jutland Section is approximately 3 km south from Mopane Railway Station adjacent to the gravel road along the railway line. The D525 Provincial Road is a surfaced road which will be upgraded should it be necessary to carry the required future traffic loads. The existing access road to the mine infrastructure from Mopane Railway Station is gravel but will be surfaced during the mining development.

The access to Voorburg Section is along the R525 (gravel) approximately 7 km north-west of Mopane Railway Station. The site assessment revealed low traffic volumes on these roads.

The Musina – Makhado Railway Line runs just south-east of the proposed Jutland section. The railway line is aligned in a north-south direction and reported to carry 4 trains per day.

1.3.4 Residential areas

Residential areas and potential noise-sensitive developments/receptors were identified using GoogleEarth® with the areas up to a distance of 2,000 meters from closest mining infrastructure in **Figure 1-4**.

1.3.5 Other industrial and commercial activities

Most of the site is rural with a small limestone quarry just south of the Mopane railway station. This quarry is likely to impact on noise levels in the direct vicinity of the operation.

1.3.6 Ground conditions and vegetation

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

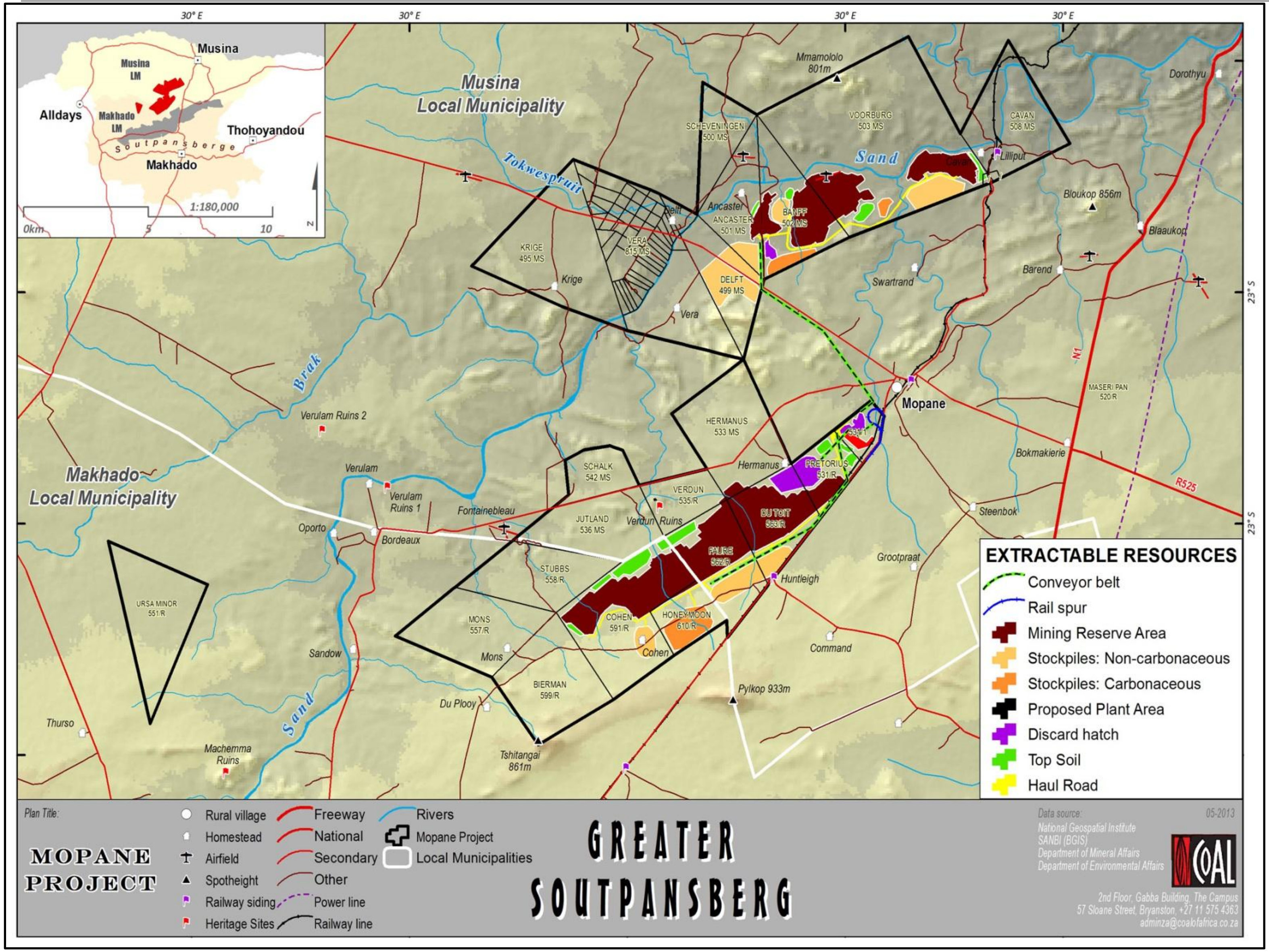

Figure 1-1: Site map indicating the location of the proposed mining development

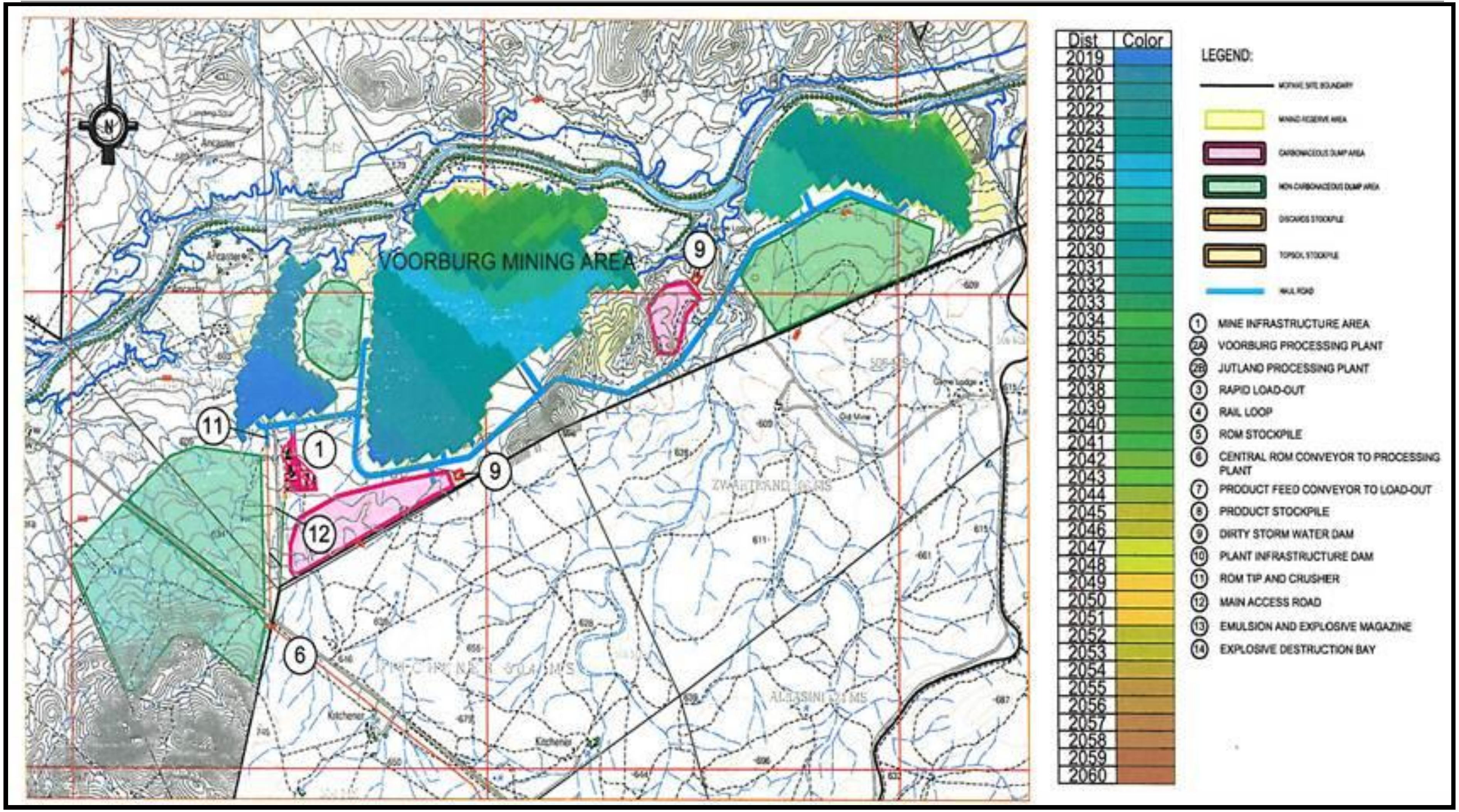

Figure 1-2: Mining layout and schedule for the Voorburg Section

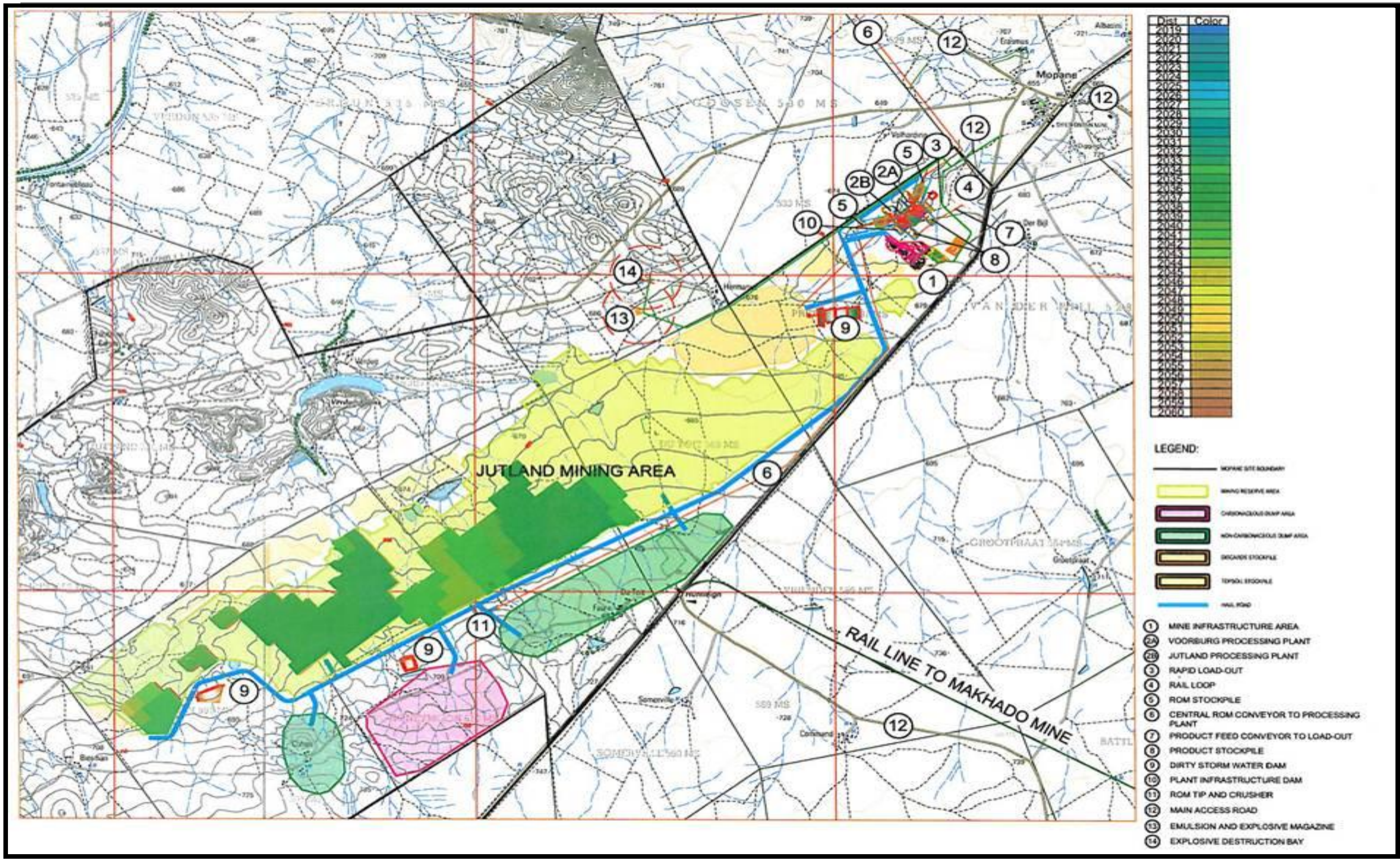

Figure 1-3: Mining layout and schedule for the Jutland Section

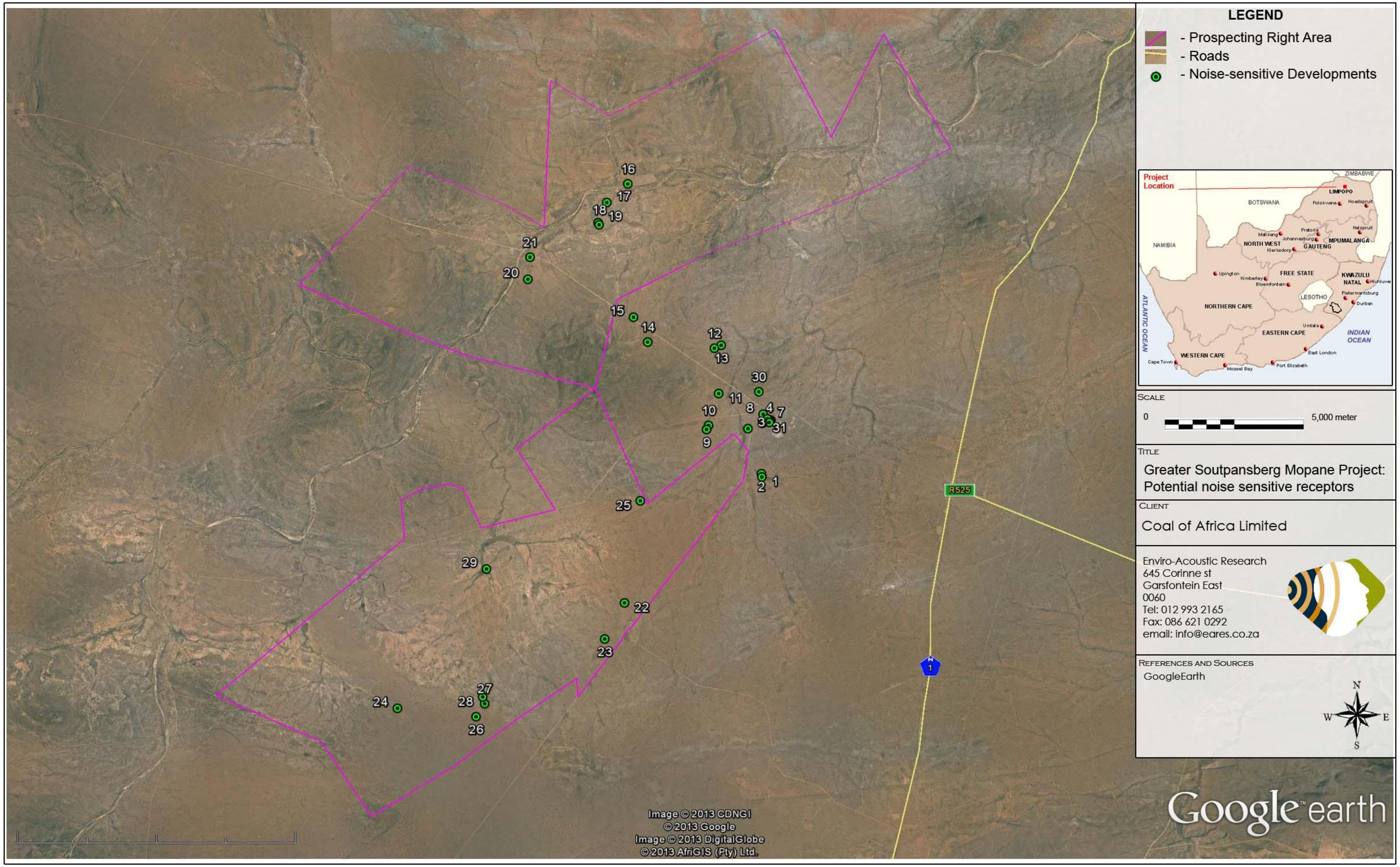

Figure 1-4: Study area potential noise-sensitive developments / receptors

1.4 TERMS OF REFERENCE

SANS 10328:2008 (Edition 3) specifies the methods to be used to assess the noise impacts on the environment as result of a proposed *or* existing activity. The standard also stipulates the minimum requirements to be assessed for an EIA. These minimum requirements are:

1. the purpose of the investigation;
2. a brief description of the planned *or* existing development or the changes that are being considered;
3. a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements;
4. the identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics;
5. the identified noise sources that were not taken into account and the reasons as to why they were not assessed;
6. the identified noise-sensitive developments and the noise impact on them;
7. where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;
8. an explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations;
9. an explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question;
10. the location of measuring or calculating points in a sketch or on a map;
11. quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;
12. alternatives that were considered and the results of those that were assessed;
13. a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
14. a detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them;
15. conclusions that were reached;

16. proposed recommendations;
17. whether remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority; and
18. any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

2 LEGAL CONTEXT, POLICIES AND GUIDELINES

2.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION ACT ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see **Section 2.6**).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

2.2 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. See also **section 2.2.1**.

2.2.1 National Noise Control Regulations (GN R154 of 1992)

In terms of section 25 of the ECA, the national Noise Control Regulations (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Gauteng and Western Cape provinces with no provincial regulations for the Limpopo province.

In terms of Regulation 2 -

"A local authority may –

(c): if a noise emanating from a building, premises, vehicle, recreational vehicle or street is a disturbing noise or noise nuisance, or may in the opinion of the local authority concerned be a disturbing noise or noise nuisance, instruct in writing the person causing

such noise or who is responsible therefor, or the owner or occupant of such building or premises from which or from where such noise emanates or may emanate, or all such persons, to discontinue or cause to be discontinued such noise, or to take steps to lower the lever of the noise to a level conforming to the requirements of these Regulations within the period stipulated in the instruction: Provided that the provisions of this paragraph shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles;

Regulation 3 states-

"No person shall –

(d): build a road or change an existing road, or alter the speed limit on a road, if it shall in the opinion of the local authority concerned cause an increase in noise in or near residential areas, or office, church, hospital or educational buildings, unless noise control measures have been taken in consultation with the local authority concerned to ensure that the land in the vicinity of such road shall not be designated as a controlled area.

Regulation 4 prohibit the generation of a disturbing noise (see also definitions Appendix A) with Regulation 5 prohibits activities that can result in a noise nuisance.

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include the following measures:

1. to investigate, assess and evaluate the impact on the environment
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed to avoid causing significant pollution or degradation of the environment
3. to cease, modify or control any act, activity or process causing the pollution or degradation
4. to contain or prevent the movement of the pollution or degradation
5. to eliminate any source of the pollution or degradation
6. to remedy the effects of the pollution or degradation

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT ("AQA" – ACT 39 OF 2004)

Section 34 of the National Environmental Management: Air Quality Act (Act 39 of 2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise

(ii) the maximum levels of noise

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

This section of the Act is in force, but no such standards have yet been promulgated. Draft regulations have however, been promulgated for adoption by Local Authorities.

An atmospheric emission licence issued in terms of section 22 may contain conditions in respect of noise.

2.4.1 Model Air Quality Management By-law for adoption and adaptation by Municipalities (GN 579 of 2010)

Model Air Quality Management By-Laws for adoption and adaptation by municipalities was published by the Department of Water and Environmental Affairs in the Government Gazette of 2 July 2010 as Government Notice 579 of 2010.

The main aim of the model air quality management by-law is to assist municipalities in the development of their air quality management by-law within their jurisdictions. It is also the aim of the model by-law to ensure uniformity across the country when dealing with air quality management challenges. Therefore, the model by-law is developed to be generic to deal with most of the air quality management challenges. With Noise Control being covered under the Air Quality Act (Act 39 of 2004), noise is also managed in a separate section under this Government Notice.

- **IT IS NOT** the aim of the model by-law to have legal force and effect on municipalities when published in the Gazette; and
- **IT IS NOT** the aim of the model by-law to impose the by-law on municipalities.

Therefore, a municipality will have to follow the legal process set out in the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000) when adopting and adapting the model by-law to its local jurisdictions.

2.5 ROAD TRAFFIC ACT, 1996 (ACT NO 93 OF 1996)

The Road Traffic Act of 1996 provides, *inter alia*, that *no person shall operate or permit to be operated on a public road and vehicle causing noise in excess of the prescribed noise level.* The Act, however, does not prescribe noise levels, but empowers the Minister of Transport to issue regulations prescribing them. The consolidated Road Traffic Regulations in terms of the Act do not prescribe any such noise levels, although the noise levels specified in the South African National Standard SANS 10181 (SABS 0181) have been specified as control standards.

2.6 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from mines, industry and roads. They are:

- SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
- SANS 10210:2004. 'Calculating and predicting road traffic noise'.
- SANS 10328:2008. 'Methods for environmental noise impact assessments'.
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method'.
- SANS 10181:2003. 'The Measurement of Noise Emitted by Road Vehicles when Stationary'.
- SANS 10205:2003. 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se.*

2.7 NATIONAL TRANSPORT POLICY (SEPTEMBER 1996)

The White Paper sets the vision for transport in South Africa that provides for *safe, reliable, effective, efficient and fully integrated transport operations and infrastructure which….. are environmentally and economically sustainable*. The White Paper further states that "*the provision of transportation infrastructure and the operation of the transportation system have the potential for causing damage to the physical and social environment, inter alia, through atmospheric and noise pollution, ecological damage and severance. … The Department of Transport is committed to an integrated environmental management approach in the provision of transport*". It is also stated that "*As part of the overall long-term vision for the South African transport system, transport infrastructure will, inter alia, be structured to ensure environmental sustainability and internationally accepted standards*". One of the strategic objectives for transport infrastructure to achieve this vision is to promote environmental protection and resource conservation.

2.8 INTERNATIONAL GUIDELINES

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

2.8.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments. It discusses the specific effects of noise on communities including:

- interference with communication
- noise-induced hearing impairment
- sleep disturbance effects
- cardiovascular and psychophysiological effect
- mental health effects
- effects on performance
- annoyance responses and

- effects on social behavior.

It further discusses how noise can impact (and propose guideline noise levels) on specific environments such as:

- residential dwellings
- schools and preschools
- hospitals
- ceremonies, festivals and entertainment events
- sounds through headphones
- impulsive sounds from toys, fireworks and firearms; and
- parklands and conservation areas.

To protect the majority of people from being affected by noise during the daytime, it propose that sound levels at outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB LAeq. At night, equivalent sound levels at the outside façades of the living spaces should not exceed 45 dBA and 60 dBA LAmax so that people may sleep with bedroom windows open.

It is critical to note that this guideline requires the sound level measuring instrument to be set on the "fast" detection setting.

2.8.2 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the World Health Organization has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30 dB inside at night (which equals 45-50 dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40 db to avoid sleep disturbance and its related health effects. The report notes that only below 30 dB (outside annual average) are "*no significant biological effects observed*," and that between 30 and 40 dB, several effects are observed, with the chronically ill and children being more susceptible; however, "*even in the worst cases the effects seem modest*." Elsewhere, the report states more definitively, "*There is no sufficient evidence that the biological effects observed at the level below 40 dB (night, outside) are harmful to health*." At levels over 40 dB, "*Adverse health effects are observed*" and "*many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected*."

The 184-page report offers a comprehensive overview of research into the various effects of noise on sleep quality and health (including the health effects of non-waking sleep arousal), and is recommended reading for anyone working with noise issues. The use of an outdoor noise standard is in part designed to acknowledge that people do prefer to leave windows open when sleeping, though the year-long average may be difficult to obtain (it would require longer-term sound monitoring than is usually budgeted for by either industry or neighbourhood groups).

While recommending the use of the average level, the report notes that some instantaneous effects occur in relation to specific maximum noise levels, but that the health effects of these "cannot be easily established."

2.8.3 Equator Principles

The **Equator Principles** (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. Equator Principles Financial Institutions (EPFIs) commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs.

The Equator Principles were developed by private sector banks and were launched in June 2003. The banks chose to model the Equator Principles on the environmental standards of the World Bank (1999) and the social policies of the International Finance Corporation (IFC). Sixty-seven financial institutions (October 2009) have adopted the Equator Principles, which have become the de facto standard for banks and investors on how to assess major development projects around the world. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

2.8.4 IFC: General EHS Guidelines – Environmental Noise Management

These guidelines are applicable to noise created beyond the property boundaries of a development that conforms to the Equator Principle.

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from project facilities/operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling noise from stationary sources is to implement noise control measures at source.

It goes as far as to proposed methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas ;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 2-1**) as well as highlighting the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development. It is therefore the considered opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

Table 2-1: IFC Table .7.1-Noise Level Guidelines

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

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

3 CURRENT ENVIRONMENTAL SOUND CHARACTER

3.1 MEASUREMENT PROCEDURE

Ambient (background) noise levels were measured at appropriate times in accordance with the South African National Standard SANS 10103:2008 "***The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication***". The standard specifies the acceptable techniques for sound measurements including:

- type of equipment (Class 1);
- minimum duration of measurement;
- microphone positions and height above ground level;
- calibration procedures and instrument checks; and
- supplementary weather measurements and observations.

3.2 LIMITATIONS: ACOUSTICAL MEASUREMENTS AND ASSESSMENTS

Limitations due to environmental acoustical measurements include the following:

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. A high measurement may not necessarily mean that noise levels in the area are always high. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced one 10-minute measurement using the reading result at the end of the measurement;
- Defining ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above. The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined (at that location). The more complex the sound environment, the longer the required measurement (especially when at a community or house);
- Determination of existing road traffic and other noise sources of significance are important (traffic counts etc);
- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises;
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high due to faunal activity which can dominate the sound levels around the measurement point. This generally is still considered naturally quiet and

understood and accepted as features of the natural soundscape, and various cases sought after and pleasing;

- Considering one sound descriptor is not sufficient for and acoustical assessment. Parameters such as L_{AMin}, L_{AIeq}, L_{Aeq}, L_{Ceq}, L_{AMax}, L_{A10}, L_{A90} and spectral analysis forms part of the many variables to be considered;
- It is technically difficult to correctly measure the spectral distribution of a large equipment in an industrial setting due to the other noise sources active in the area;
- Exact location of a sound level meter in an area in relation to structures, vegetation and external noise sources will impact on the measurements; and
- As a residential area develops the presence of people will result in increased sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV's and Radios). The result is that ambient sound levels will increase as an area matures.

3.3 AMBIENT SOUND MEASUREMENTS

3.4 EXISTING MEASURED SOUNDSCAPE

The location of the day/night ambient sound measurement locations are presented in **Table 3-1** below and is also illustrated in **Figure 3-1** as **blue** squares. Measurements were conducted from the morning of 2 July to the afternoon of 5 July 2013. Sound level meter settings and measurement methodology conform to specifications listed in SANS 10103:2008.

Appendix B presents photos taken of the measurement locations. Measurement locations were numbered as **MAS01** to **MAS07** in this report. These measurements were conducted over a period of approximately 20 – 24 hours.

Table 3-1: Day/night-time measurement locations (Datum type: WGS 84)

Point name	Latitude	Longitude
MAS01	-22.616632°	29.855353°
MAS02	-22.608796°	29.852377°
MAS03	-22.608797°	29.838052°
MAS04	-22.653268°	29.759507°
MAS05	-22.561271°	29.741831°
MAS06	-22.643518°	29.810733°
MAS07	-22.592321°	29.813782°

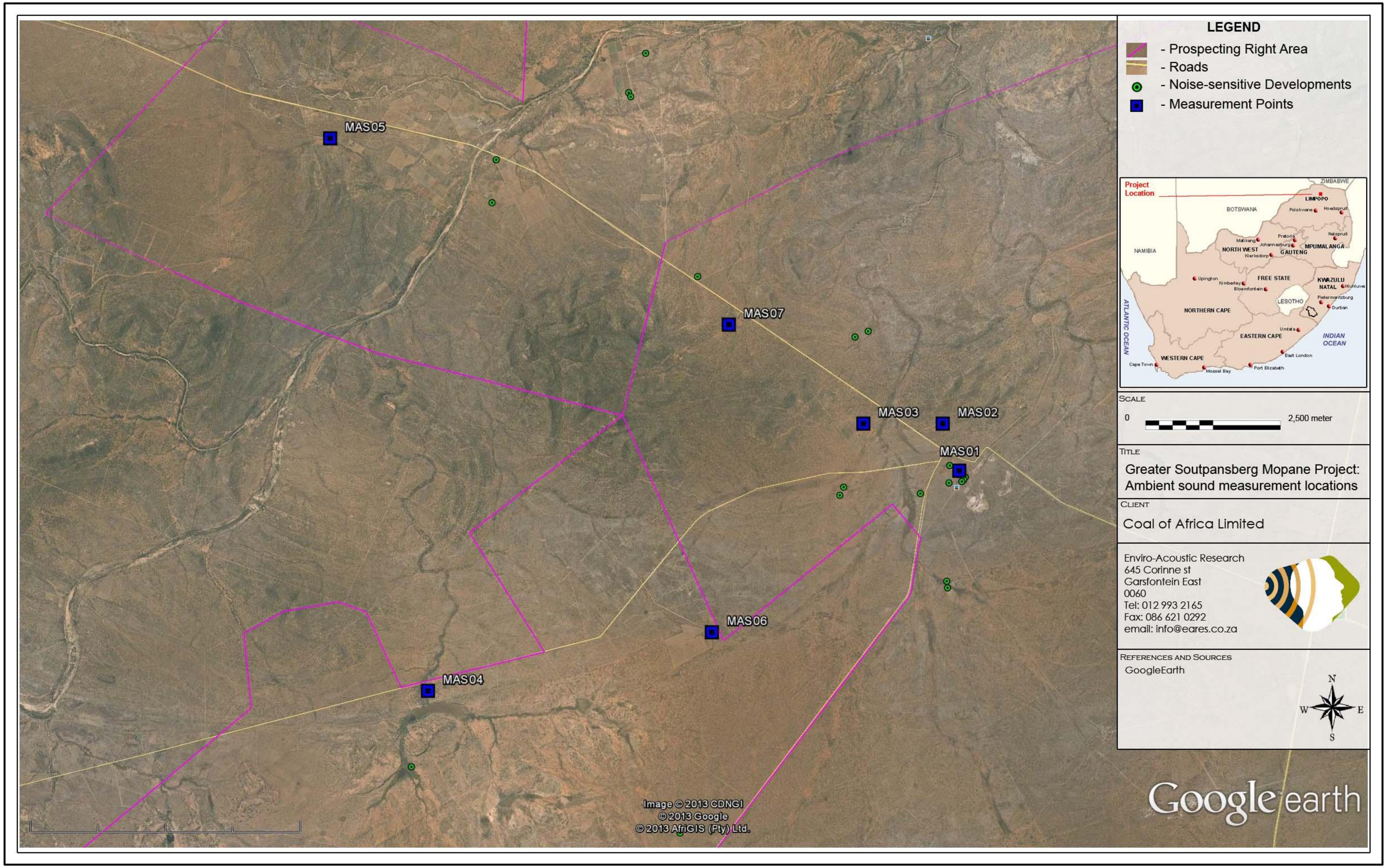

Figure 3-1: Localities of ambient sound level measurements

3.4.1 Measurement Point MAS01: Assembly area, Mopane School

A number of 10 minute measurements were taken over a day/night period on 2 July 2013. The equipment defined in **Table 3-2** was used for gathering data. Measured sound levels are presented in **Figure 3-2**.

Table 3-2: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Rion NA-28	00901489	24 May 2013
Microphone*	Rion UC-59	02087	24 May 2013
Calibrator	Rion NC-74	34494286	23 January 2013

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

The measurement location was selected as it was a safe location for the equipment to be left overnight. There were no identifiable noise sources close to the measurement location and the location should provide a very overview of the sound character in the Mopane area. The limestone plant was clearly audible even though the school building broke the line of sight. The microphone was located in an open area further than 5 meters from any vegetation or reflective surfaces (excluding the ground itself). Refer to **Appendix B** for a photo of this measurement location.

Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes): Refer to **Table 3-3** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-3: Noises/sounds heard during site visits at receptor MAS01

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural** Slight wind induced-noises (at times during gusts). Insects. Birds.
	Residential and other Anthropogenic Nothing audible
	Industries, Commercial and Road Traffic During single events (Vehicles passing on the gravel road). The limestone plant.

Impulse equivalent sound levels: During the daytime L_{AIeq} values ranged between 30.6 to 62.8 dBA. The night-time L_{AIeq} values ranged between 30.8 to 55.2 dBA. The average value of the 91 10-minute equivalent daytime measurements was calculated at 41.7 dBA, while the average for the 48 night-time measurements were calculated at 37.9

dBA. Equivalent (average) sound levels for the day- and night-time periods are shown on **Figure 3-2**.

Statistical sound levels ($L_{A90,f}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-2**. **$L_{A90,f}$** daytime values ranged from 24.4 to 42.3 dBA90. The night-time **$L_{A90,f}$** values ranged from 29.0 to 35.1 dBA90. Measured **$L_{A90,f}$** data indicated an area where there is a constant noise that is impacting on the ambient sound levels. Comparing this site with data collected at a quiet location L_{A90} levels could be less than 20 dBA90 at night.

Maximum noise levels: Settings on the instrument recorded the third-octave sound level at which a certain frequency band measured the highest noise level and not the RMS maximum sound level. The data is mainly used to identify the potential origin of a noise source and not in the description of average ambient sound levels. Maximum noise levels will not be discussed for this location.

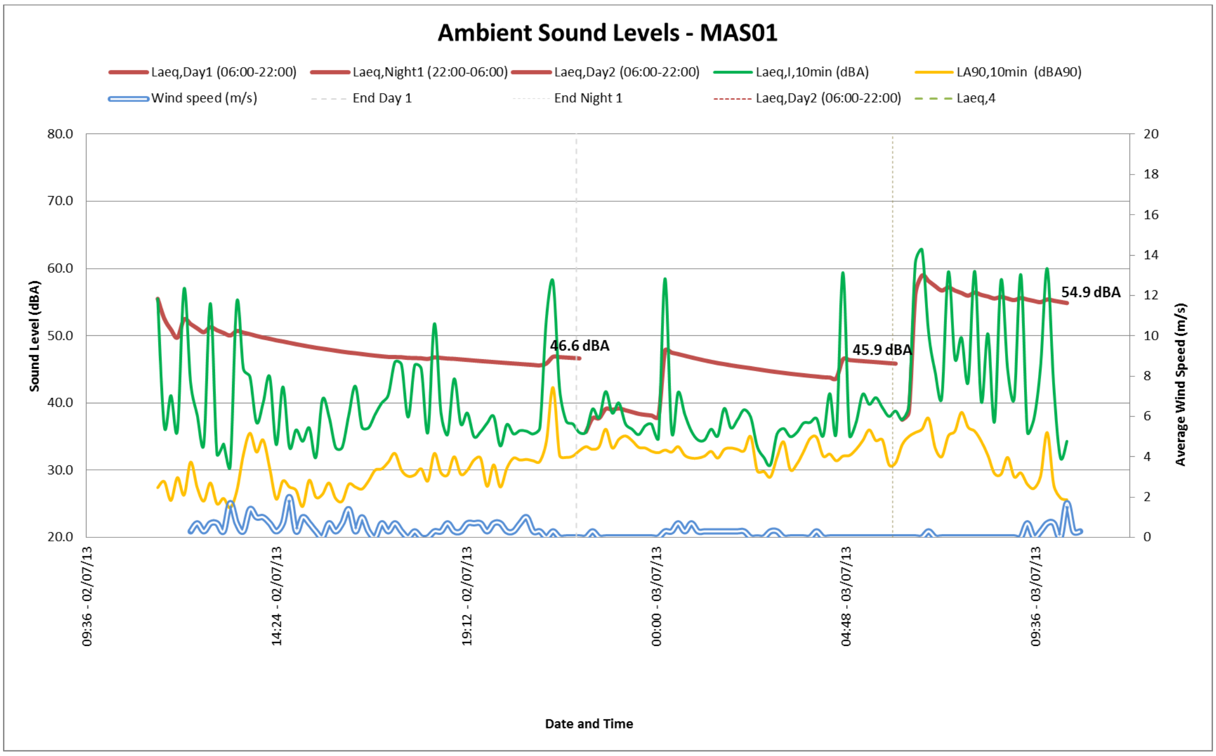

Figure 3-2: Ambient Sound Levels at MAS01

Minimum noise levels: As with the maximum noise levels minimum noise levels will not be discussed for this location.

Third octave spectral analysis

Lower frequency (20 – 250 Hz): This frequency band is generally dominated by noises originating from anthropogenic activities (vehicles idling and driving, pumps and motors, etc) as well as certain natural phenomena (wind and ocean surf). Motor vehicle engine revs per minute (rpm) convert to this range of frequency (not considering other motor car acoustical sources e.g. tyre to road interaction pumping and "horn effect")[1]. Daytime measurements (see **Figure 3-3**) illustrate the spectral character of a number of different noise sources with no particular distinctive character. Quieter measurements reflect a peak in the 31.5 and 80 – 100 Hz frequency bands with the source unknown. This is more visible in the night-time measurements (see **Figure 3-4**).

Third octave surrounding 1000 Hz: This range contains energy mostly associated with human speech (mostly 350 Hz – 2,000 Hz, could be between 20 – 16,000 Hz), dwelling related sounds and road to tyre interaction from road traffic. This frequency band did not show any particular (consistent) peaks in this region.

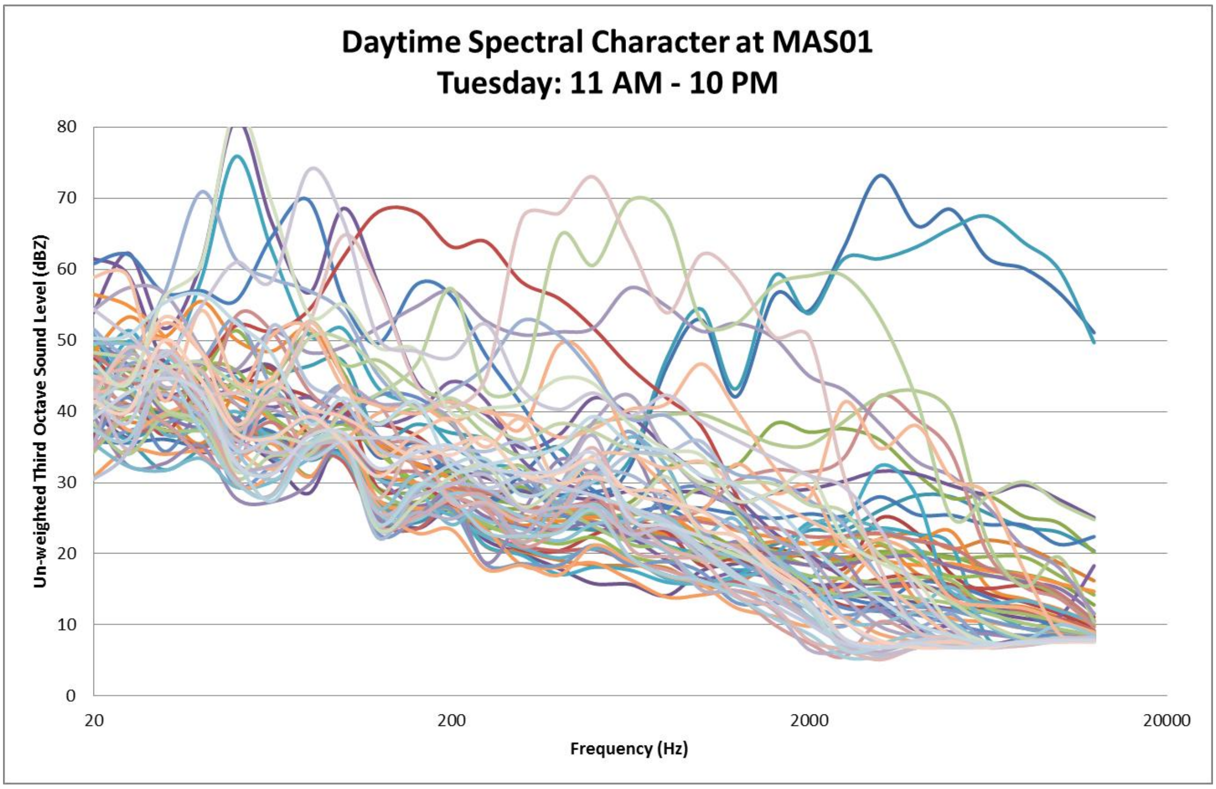

Figure 3-3: Daytime spectral frequency distribution at MAS01, day one

[1] Mechanical Engineering Conversion Factors, Dr. K. Clark Midkiff

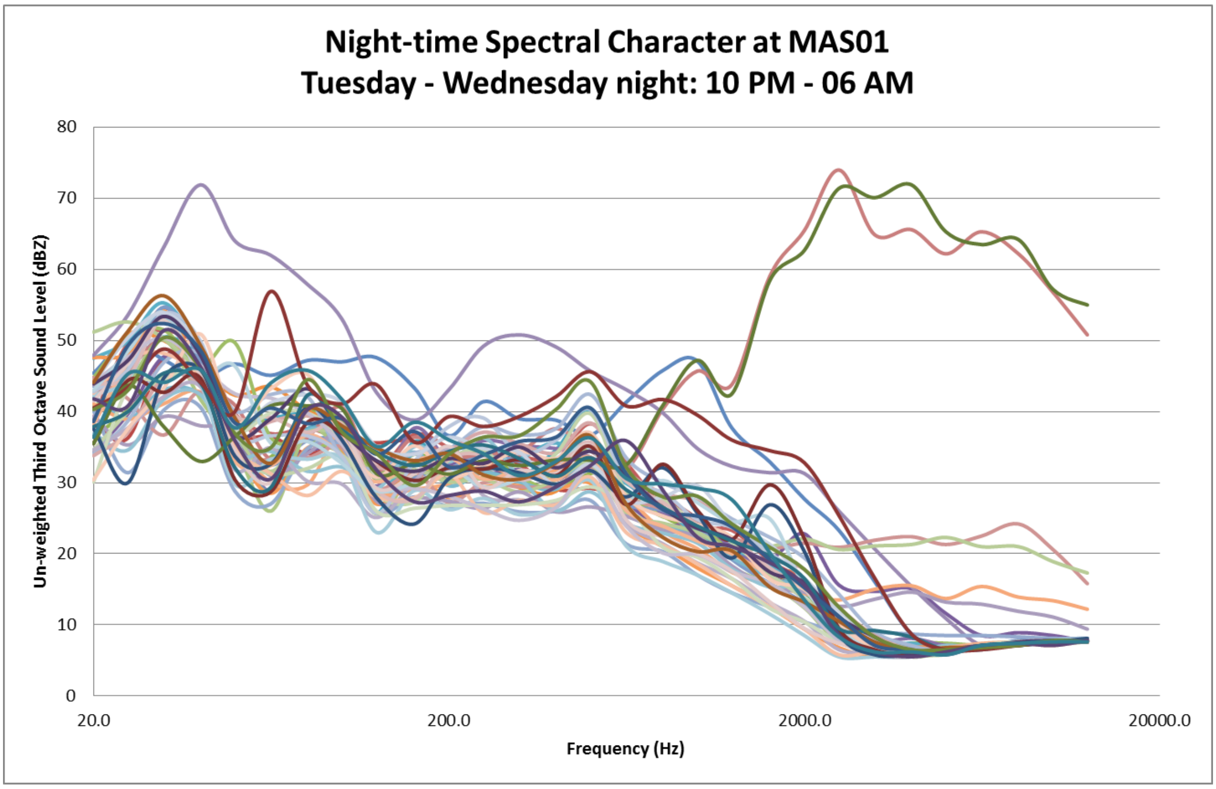

Figure 3-4: Night-time spectral frequency distribution at MAS01, first night

Higher frequency (2,000 Hz upwards): Most faunal species, including larger animals, birds, frogs, crickets and cicada would use this range to communicate and hunt etc.[2] This frequency band however is particularly void of the characteristic peaks indicating insect and especially frog and bat communication. This is likely due to the dry ground and surroundings providing little habitat for these species.

SANS 10103:2008 Rating Level: Daytime measured data indicate sound levels typical of an area with a rural district character. Night-time levels however are far higher than expected for a rural area, conforming more to an urban district zone sound level, confirmed by the 54.9 dBA $L_{Aeq,I}$ level measured the following day. Considering the L_{A90} and the developmental character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable. The constant noise from the limestone plant currently does have a slight noise impact on the location, but, combined with the cumulative effect of single events it raises the noises levels at the location (and surrounding area) from the expected rural to that of an urban area. The measured $L_{Aeq,f}$ levels during the day and night however conforms to the recommendation of 55 and 45 dBA respectively by the World Health Organization (**section 2.8.1**), World Bank (see

[2] A Paradoxical Problem. Can bush crickets discriminate frequency?, J.C Hartley, University of Nottingham. An Automatic Monitoring System for Recording Bat Activity, Colin O' Donnel and JAnd Sedgeley.Short Communication. The Scaling of song Frequency in Cicadas, H.C Bennet-Clark (1994).

section 2.8.3) and International Finance Corporation (see **section 2.8.4**) for residential areas.

3.4.2 Measurement point MAS02: Farm Erasmus (Mr. Meintjies)

The measurement location was chosen as it was a safe location for the equipment to be left for this period (people at the dwelling most of the time). The instrument was deployed 2 July but failed during the third measurement. After resetting the instrument (removing batteries for more than 30 minutes) it was redeployed.

The measurement point was located away from the receptors dwelling close to the entrance gate. Buildings activities were taking place on the farms but were more than 50 meters away from the microphone. Refer to **Appendix B** for photos of this measurement point.

The equipment defined in **Table 3-4** was used for gathering data. Measured data is presented in **Figure 3-5**.

Table 3-4: Equipment used to gather data

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

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

Sounds heard during measurements dates: Refer to **Table 3-5** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-5: Noises/sounds heard during site visits at MAS02

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural** Wind sheer, rustling of tree leaves. Insects. Birds.
	Residential and other Anthropogenic Activities at the receptors dwelling, voices. Quadbike during passing and driving around on property.
	Industries, Commercial and Road Traffic Limestone plant.

Impulse equivalent sound levels: During the daytime L_{AIeq} values ranged between 28.8 to 73.4 dBA. The night-time L_{AIeq} values ranged between 28.3 to 52.6 dBA. The average value of the 85 10-minute equivalent daytime measurements was calculated at 45.86 dBA, while the average for the 48 night-time measurements calculated at 37.2 dBA. A number of single events with loud noises however impacted on the day and night-time equivalent sound levels as shown on **Figure 3-5**.

Statistical sound levels ($L_{A90,f}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average and equivalent sound levels. It is illustrated on **Figure 3-5** and **Figure 3-6**. $L_{A90,f}$ daytime values ranged from 20.8 to 38.6 dBA90. The night-time $L_{A90,f}$ values ranged from 22.3 to 33.4 dBA90. Measured $L_{A90,f}$ data indicated an area that is generally very quiet, typical of a rural area with little industrial and commercial activities although there are a slight background noise that does impact on this measurement location (likely the barely audible limestone plant).

Maximum noise levels: Maximum noise levels are illustrated on **Figure 3-6**. The equivalent sound level graph has a shape similar to the maximum noise level graph, indicating that maximum noise levels did influence the equivalent sound level readings. There is an average difference of more than 17 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 6 and 32 dB. Considering the L_{A90} and L_{AIeq} graphs maximum noises were of sufficient duration to impact on the equivalent and even at statistical readings. The source of the maximum noises is undefined.

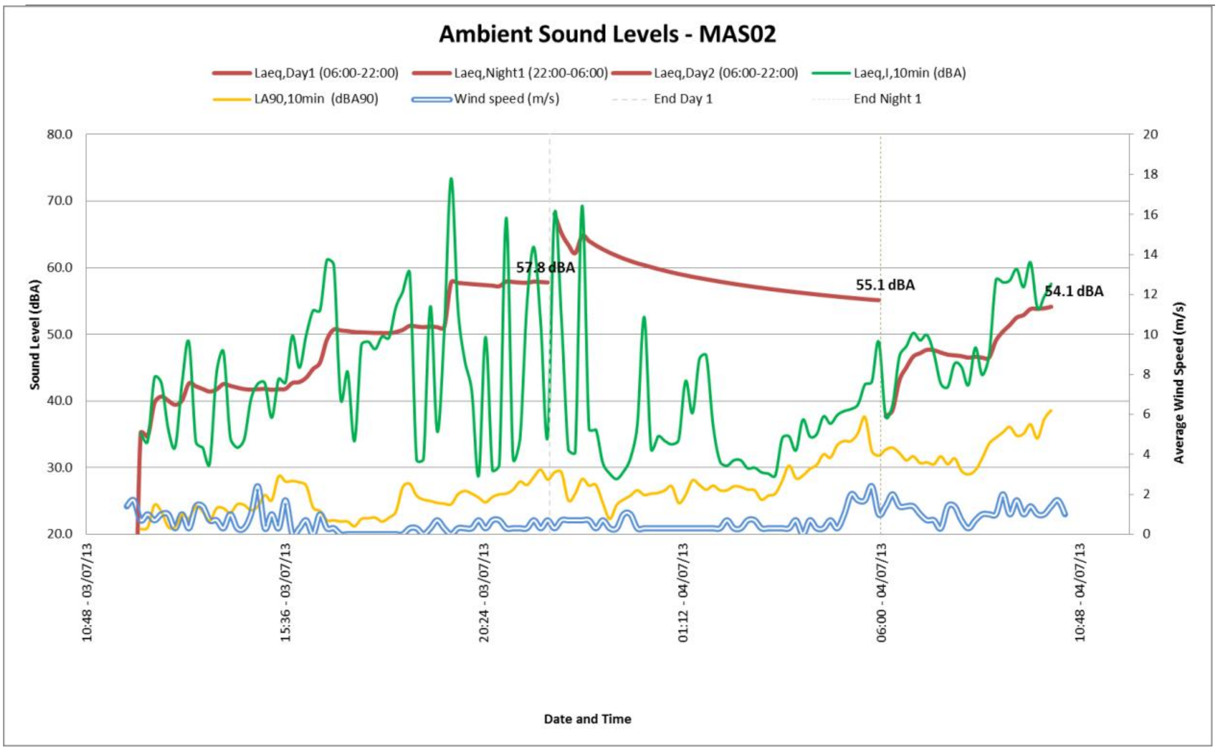

Figure 3-5: Ambient Sound Levels at MAS02

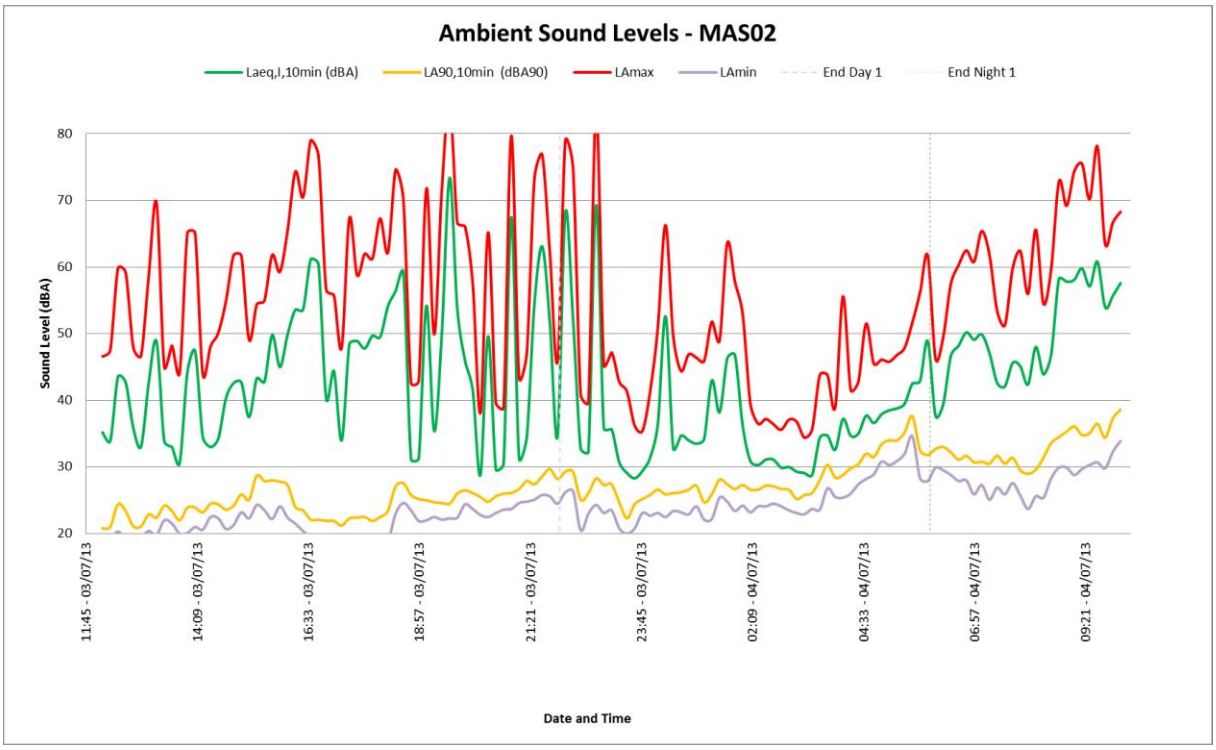

Figure 3-6: Maximum, Minimum and Statistical sound levels at MAS02

Minimum noise levels: Minimum noise levels are illustrated on **Figure 3-6**. Considering both the L_{A90} and $L_{A,min}$ graphs shows an area that is quiet most of the times with single noisy events impacting on the sound levels (equivalent, statistical, minimum). This is typical of an area where natural noises (bird song, insects, animal sounds) with a transient character (like the chirping of a bird) dominates with few constant noises (such as a TV/radio playing, the hum of a motor).

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

SANS 10103:2008 Rating Level: Measured data indicate sound levels typical of an Urban district. Based on the measured levels (statistical) and the development character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable for this location as the average L_{A90} indicates that the ambient noise level could have been lower in the absence of noisy single events. The measured $L_{Aeq,f}$ levels during the day and night conforms to the recommended of 55 daytime sound level but not with the 45 dBA night-time sound levels of the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for a residential areas.

3.4.3 Measurement Point MAS03: Farm Sonskyn, house of worker

A number of 10 minute measurements were taken over a day/night period on 2 July 2013. The equipment defined in **Table 3-6** was used for gathering data. Measured sound levels are presented in **Figure 3-7** and **Figure 3-8**.

Table 3-6: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Svan 977	34160	17 May 2013
Microphone*	ACO 7052E	54645	17 May 2013
Calibrator	Rion NC-74	34494286	23 January 2013

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

The measurement location was selected as it was a safe location for the equipment to be left overnight, slightly further from the area where the residents spend their time (there were also kids playing in the area, although they were asked to stay away from the instrument). There was a chicken pen with chickens close to the microphone that would influence the measurements. There was no vegetation that can rustle in the wind within 10 meters of the microphone. Refer to **Appendix B** for a photo of this measurement location.

Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes): Refer to **Table 3-7** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-7: Noises/sounds heard during site visits at receptor MAS03

Ambient Sound Character -Sounds of Significance

Magnitude Scale Code: Barely Audible, Audible, Dominating

Faunal and Natural

Slight wind induced-noises (at times during gusts). Insects. Birds at times.

Residential and other Anthropogenic

Children playing. Voices. Chickens at times.

Industries, Commercial and Road Traffic

During single events (Vehicles passing on the gravel road).

Impulse equivalent sound levels: During the daytime $\mathbf{L_{AIeq}}$ values ranged between 24.4 to 75.1 dBA. The night-time $\mathbf{L_{AIeq}}$ values ranged between 23.1 to 72.7 dBA. The average value of the 91 10-minute equivalent daytime measurements was calculated at 46.8 dBA, while the average for the 48 night-time measurements were calculated at 41.2 dBA. A significant number of single events with loud noises however impacted on the day and night-time equivalent sound levels as shown on **Figure 3-7**.

Statistical sound levels ($\mathbf{L_{A90,f}}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-7** and **Figure 3-8**. $\mathbf{L_{A90,f}}$ daytime values ranged from 19.4 to 42.5 dBA90. The night-time $\mathbf{L_{A90,f}}$ values ranged from 19.5 to 27.7 dBA90. Measured $\mathbf{L_{A90,f}}$ data indicated an area that can be very quiet at periods but that single noisy events are of sufficient duration to impact on this statistical level.

Maximum noise levels: Maximum noise levels are illustrated on **Figure 3-8**. The equivalent sound level graph has a shape similar to the maximum noise level graph, indicating that maximum noise levels did influence the equivalent sound level readings. There is an average difference of more than 20 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 8 and 32 dB. Considering the L_{A90} and L_{AIeq} graphs maximum noises were of sufficient duration to impact on the equivalent and statistical readings. The source of the maximum noises is undefined but likely relates to the chickens in the closely located pen.

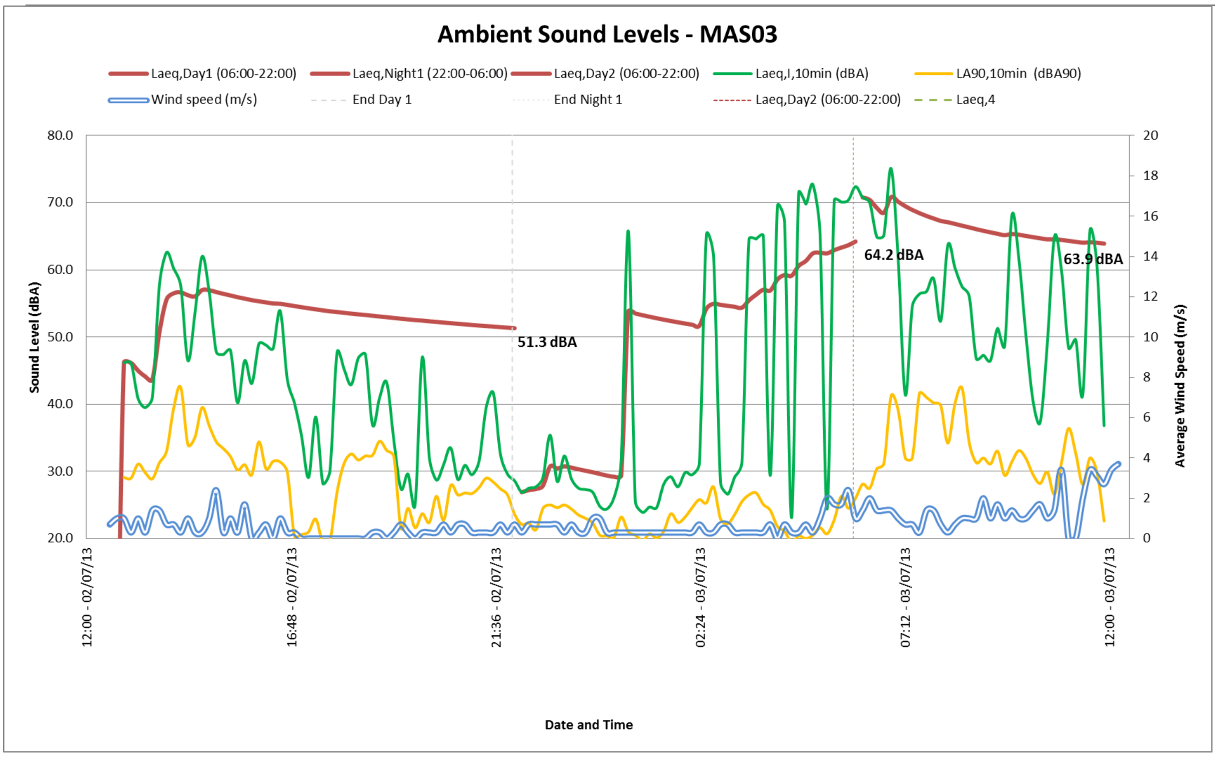

Figure 3-7: Ambient Sound Levels at MAS03

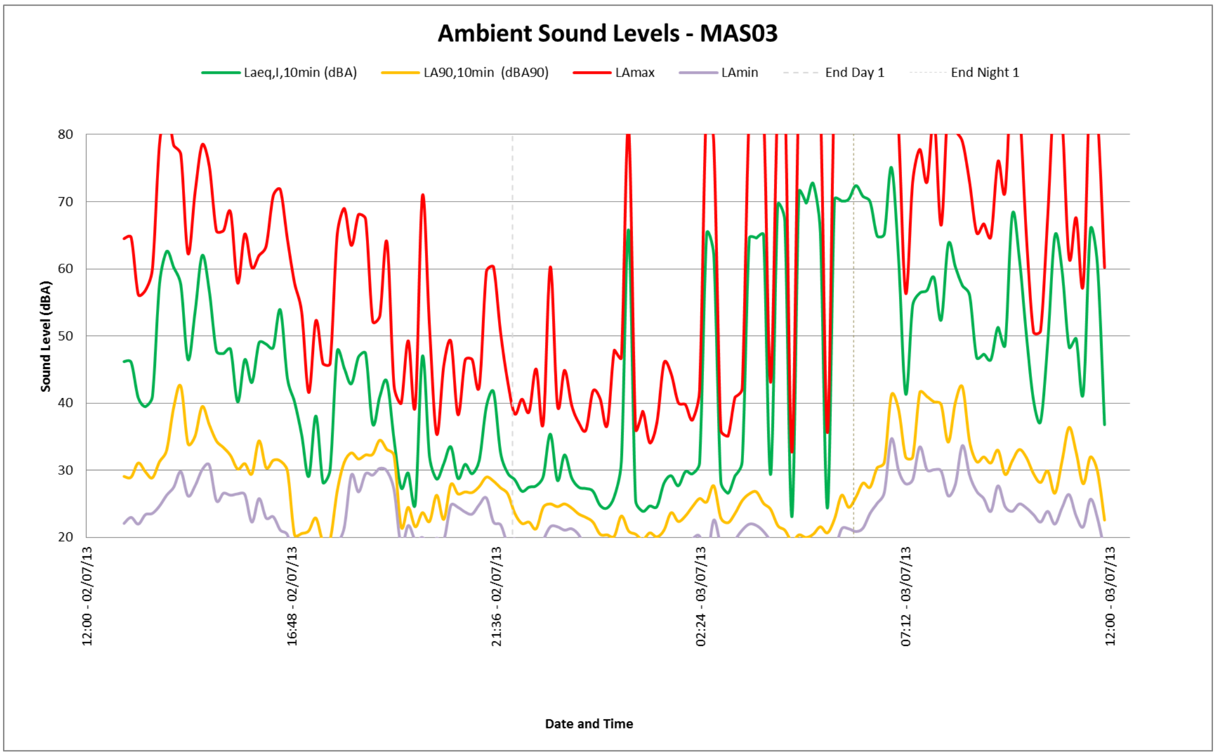

Figure 3-8: Maximum, Statistical and Minimum Sound Levels at MAS03

Minimum noise levels: Minimum noise levels are illustrated on **Figure 3-8**. Considering both the L_{A90} and $L_{A,min}$ graphs shows an area that is very quiet at times with single noisy events impacting on the sound levels (equivalent, statistical, minimum). This is typical of an area where natural noises (bird song, insects, animal sounds) with a transient character (like the chirping of a bird) dominates.

Third octave spectral analysis

Lower frequency (20 – 250 Hz): Daytime measurements (see **Figure 3-9** and **Figure 3-11**) illustrate the spectral character of a number of different noise sources with no particular distinctive character. Quieter measurements reflect a peak in the 25, 40 and 80 Hz frequency bands with the source unknown, likely a diesel or petrol engine (based on spectral signature) situated far from the microphone. This is more visible in the night-time measurements (see **Figure 3-10**).

Third octave surrounding 1000 Hz: This range contains energy mostly associated with human speech (mostly 350 Hz – 2,000 Hz, could be between 20 – 16,000 Hz), dwelling related sounds and road to tyre interaction from road traffic. There is quite a distinctive peak at 500 Hz with the source unknown. It is reflected in all the night-time (and early evening) measurements but being less than 30 dBZ in most cases, originating from a very quiet noise source (see **Figure 3-10**). More visible are very high noises measured during the night-time period (see **Figure 3-10**) with peaks in the 800, 1 600, 3 150 and 5 000 Hz frequency bands. Being harmonics of the 1 600 Hz frequency band it is likely from the same noise source, likely the chickens in the area.

Higher frequency (2,000 Hz upwards): Most faunal species, including larger animals, birds, frogs, crickets and cicada would use this range to communicate and hunt etc. Excluding the signature discussed the previous paragraph, this frequency band is void of the characteristic peaks indicating insect and frog communication. The afternoon sample however shows some high frequency peaks (see **Figure 3-9**) likely relating to bat communication (between 19:00 and 20:00).

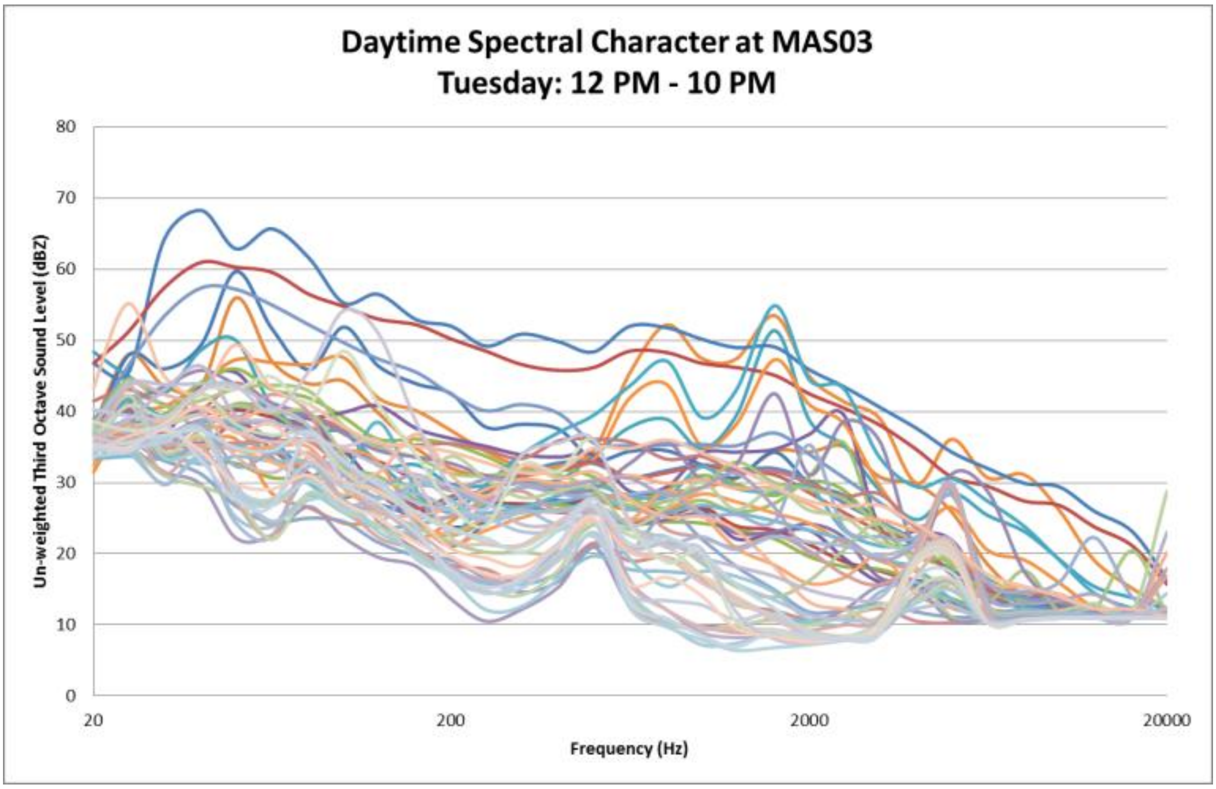

Figure 3-9: Daytime spectral frequency distribution at MAS03, day one

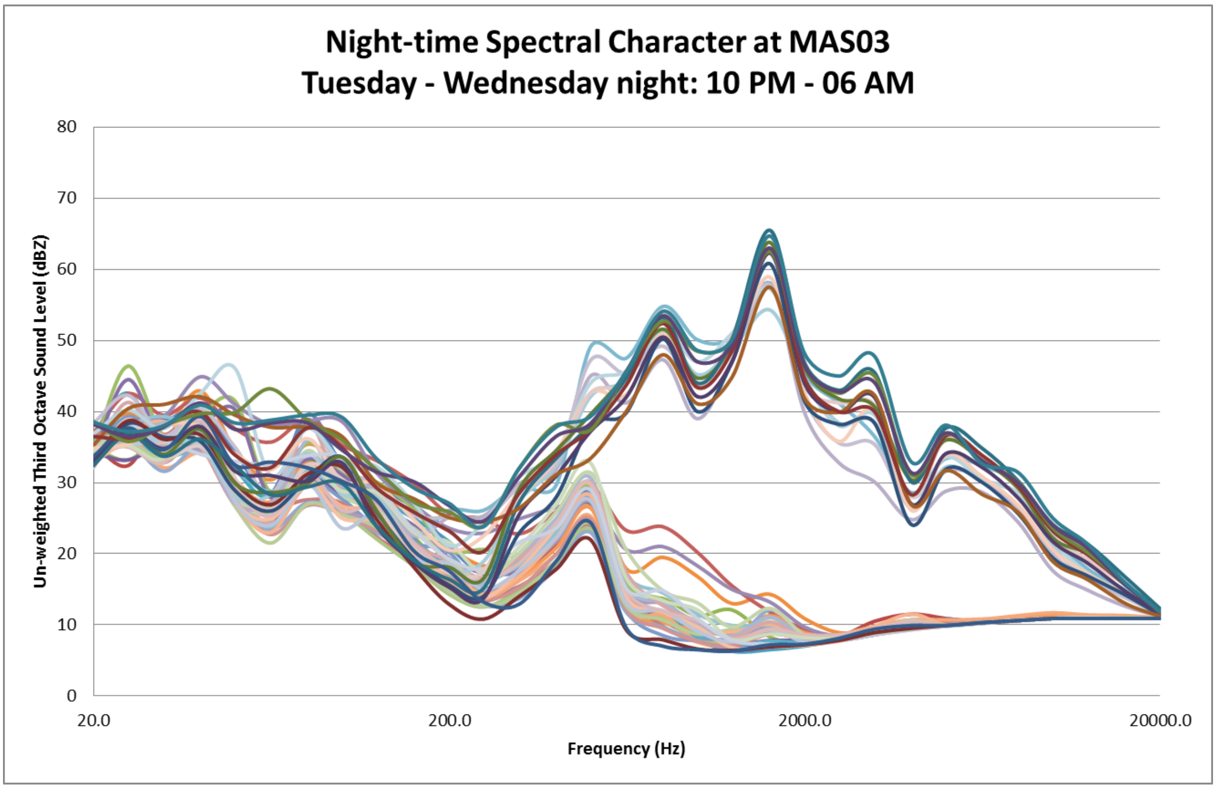

Figure 3-10: Night-time spectral frequency distribution at MAS03, first night

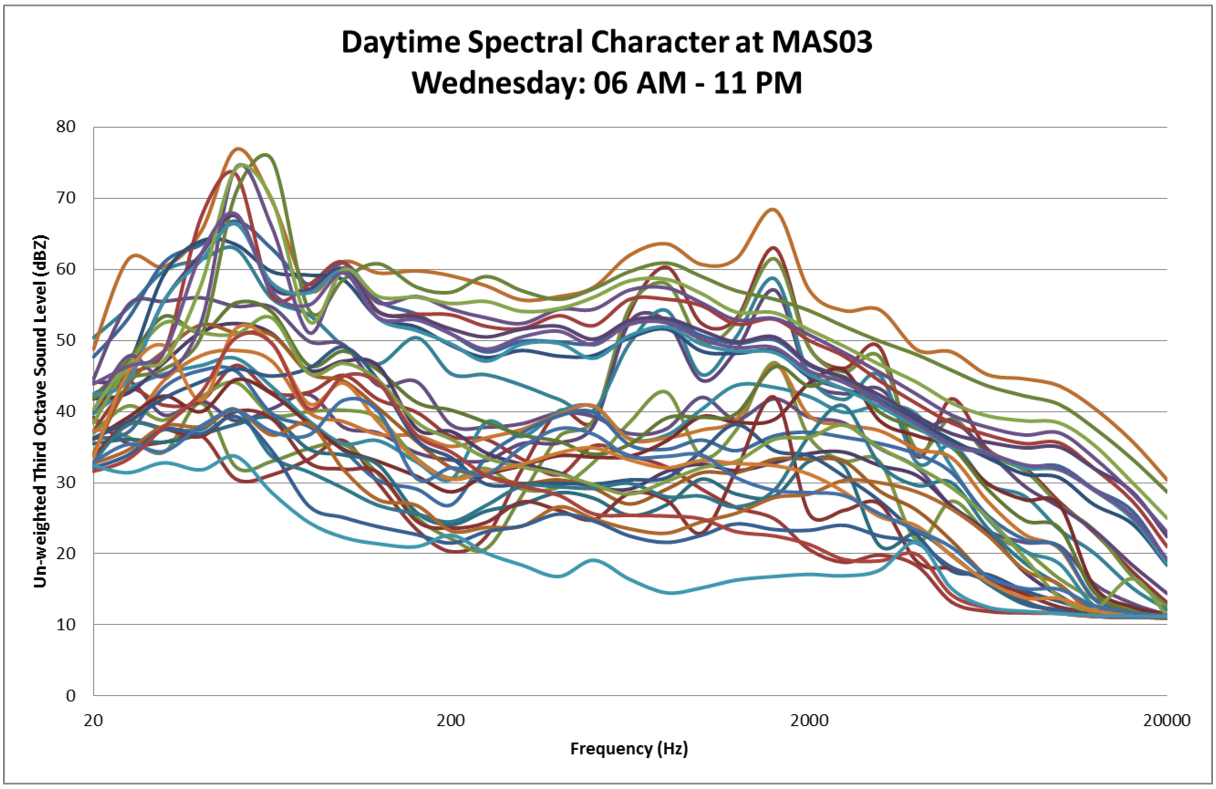

Figure 3-11: Daytime spectral frequency distribution at MAS03, second day (morning)

SANS 10103:2008 Rating Level: Daytime measured data indicate sound levels typical of an area with a urban district noise character. Night-time levels however are very high for a rural area, conforming more to a commercial district zone sound level. Considering the L_{A90} and the developmental character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable. The measured $L_{Aeq,f}$ levels during the day and night however does not conform to the recommendation of 55 and 45 dBA respectively by the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for residential areas. It should be noted that the increased noise levels are directly related to the animals in the vicinity of the dwelling.

3.4.4 Measurement Point MAS04: Close to dwelling of Mr. Osners

A number of 10 minute measurements were taken over a day/night period on 3 July 2013. The equipment defined in **Table 3-8** was used for gathering data. Measured sound levels are presented in **Figure 3-12**.

Table 3-8: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Rion NA-28	00901489	24 May 2013
Microphone*	Rion UC-59	02087	24 May 2013
Calibrator	Rion NC-74	34494286	23 January 2013

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

The measurement location was at a quiet spot in the garden next to the fence away from the main dwelling. There were dogs on the property but they never barked during the site visits. There was a pump operating in the background filling a dam. The microphone was located in a relatively open area further than 5 meters from any vegetation or reflective surfaces (excluding the ground itself). Refer to **Appendix B** for a photo of this measurement location.

Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes): Refer to **Table 3-9** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-9: Noises/sounds heard during site visits at receptor MAS04

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural** Insects and Birds.
	Residential and other Anthropogenic Water pump.
	Industries, Commercial and Road Traffic Nothing audible.

Impulse equivalent sound levels: During the daytime L_{AIeq} values ranged between 31.7 to 54.9 dBA. The night-time L_{AIeq} values ranged between 26.9 to 37.6 dBA. The average value of the 94 10-minute equivalent daytime measurements was calculated at 41.8 dBA, while the average for the 48 night-time measurements were calculated at 31.0 dBA. Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-12**.

Statistical sound levels ($L_{A90,f}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-12**. $L_{A90,f}$ daytime values ranged from 27.3 to 40.3 dBA90. The night-time $\mathbf{L_{A90,f}}$ values ranged from 25.7 to 31.8 dBA90. Measured $\mathbf{L_{A90,f}}$ data indicated an area where there is a constant soft noise that is impacting on the ambient sound levels. Comparing this site with data collected at a quiet location L_{A90} levels could be less than 20 dBA90 at night.

Maximum noise levels: Settings on the instrument recorded the third-octave sound level at which a certain frequency band measured the highest noise level and not the RMS maximum sound level. The data is mainly used to identify the potential origin of a noise source and not in the description of average ambient sound levels. Maximum noise levels will not be discussed for this location.

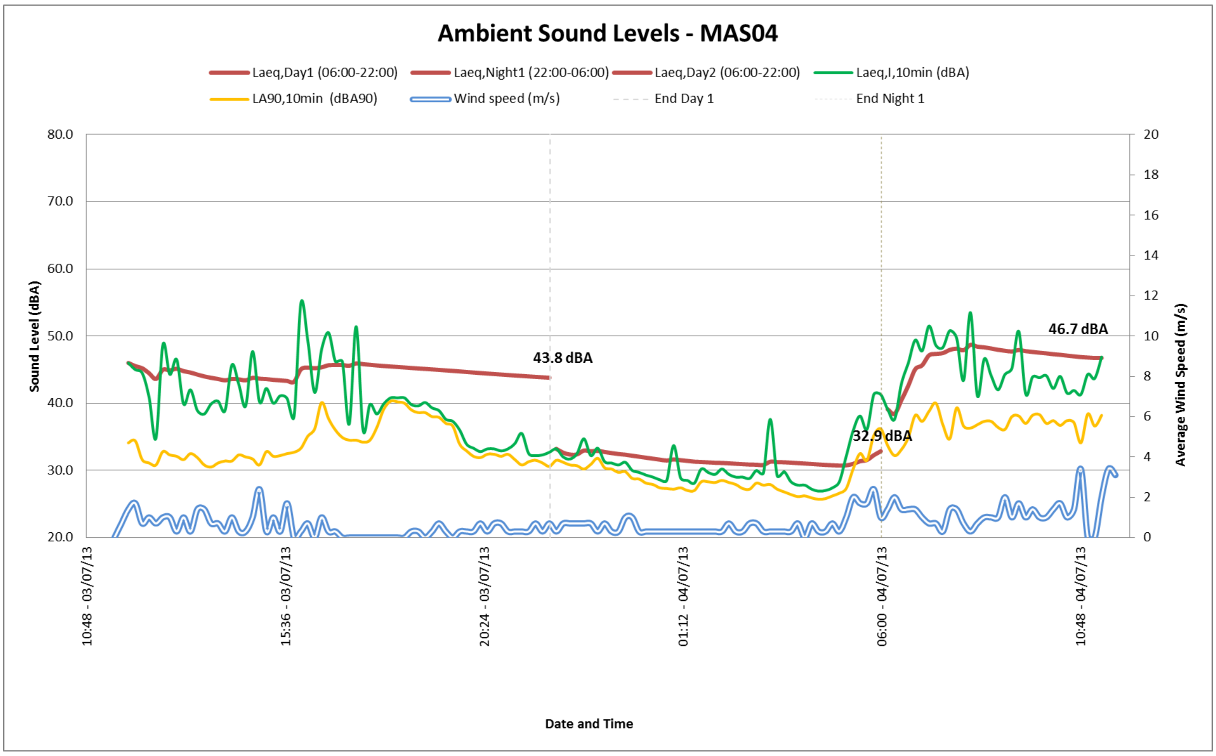

Figure 3-12: Ambient Sound Levels at MAS04

Minimum noise levels: As with the maximum noise levels minimum noise levels will not be discussed for this location.

Third octave spectral analysis

Lower frequency (20 – 250 Hz): Daytime measurements (see **Figure 3-13** and **Figure 3-15**) illustrate the spectral character of a number of different noise sources with quieter samples showing a distinct peak at 25, 50 and 10 – 125 Hz (likely the water pump). This is more visible in the night-time measurements (see **Figure 3-14**). Early morning (just before 06:00) and the following day (see **Figure 3-14** and **Figure 3-15**) shows a typical shape (straight line) where wind induced noise due to increased winds starts impacting on measurements (generally only observable in very quiet areas).

Third octave surrounding 1000 Hz: This range contains energy mostly associated with human speech (mostly 350 Hz – 2,000 Hz, could be between 20 – 16,000 Hz), dwelling related sounds and road to tyre interaction from road traffic. This frequency band did not show any particular (consistent) peaks in this region, with a few peaks at the 400, 500 and 630 Hz frequency bands.

Higher frequency (2,000 Hz upwards): A significant number of the day-and night-time measurements shows peaks in the 2 000 (day) and 3 150 – 5 000 Hz frequency bands. The 3 150 – 5 000 Hz frequency band is used by crickets and numerous frog species.

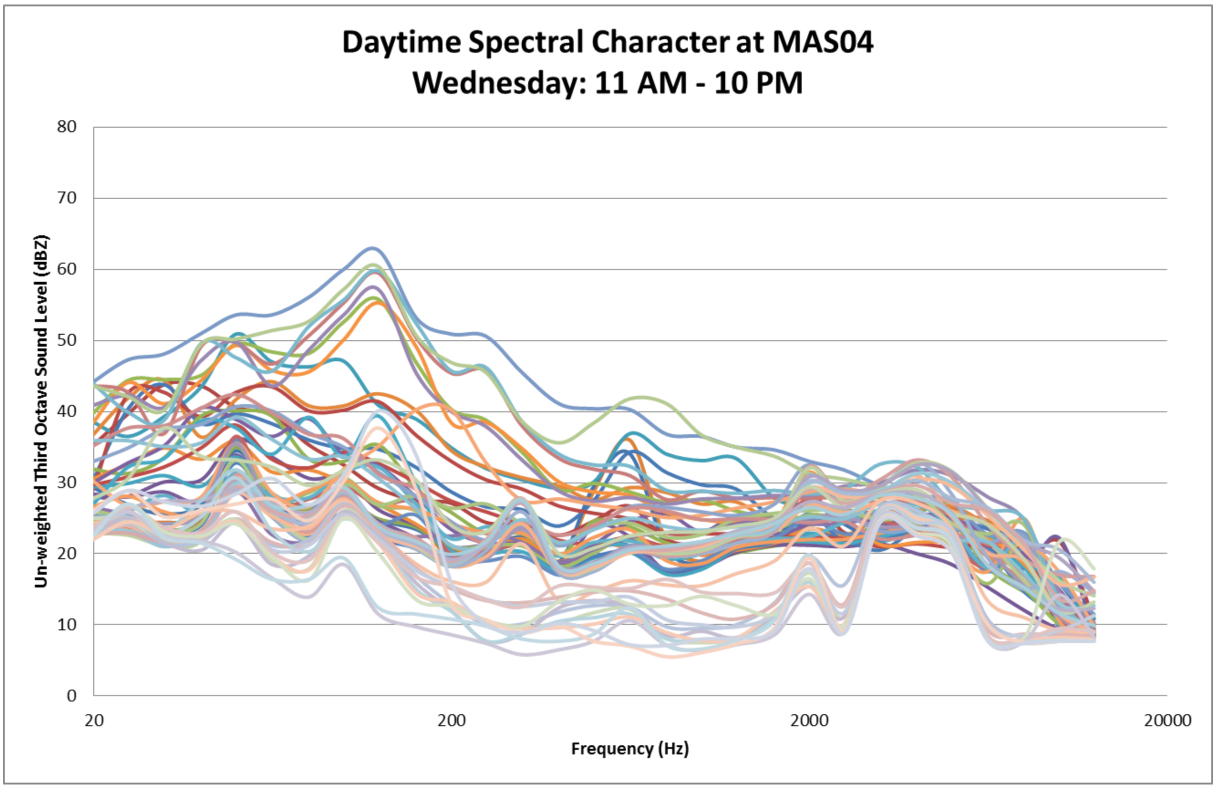

Figure 3-13: Daytime spectral frequency distribution at MAS04, day one

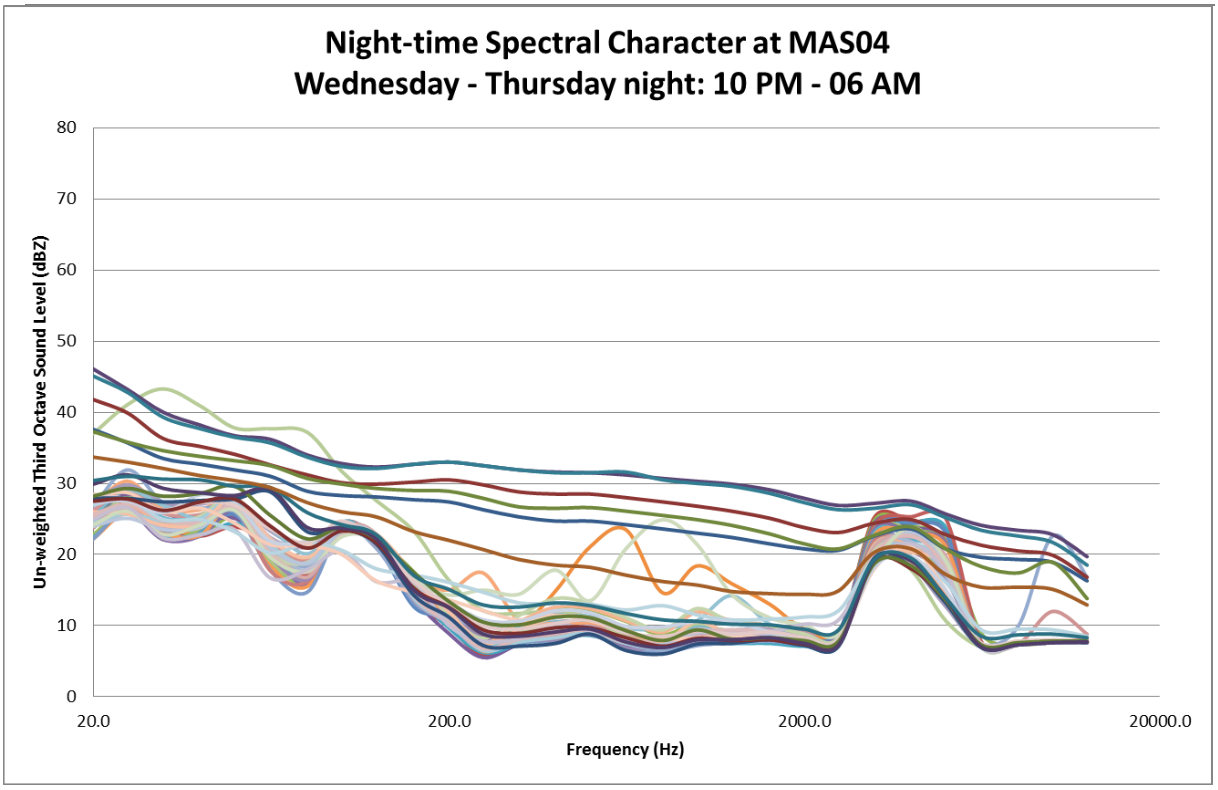

Figure 3-14: Night-time spectral frequency distribution at MAS04, first night

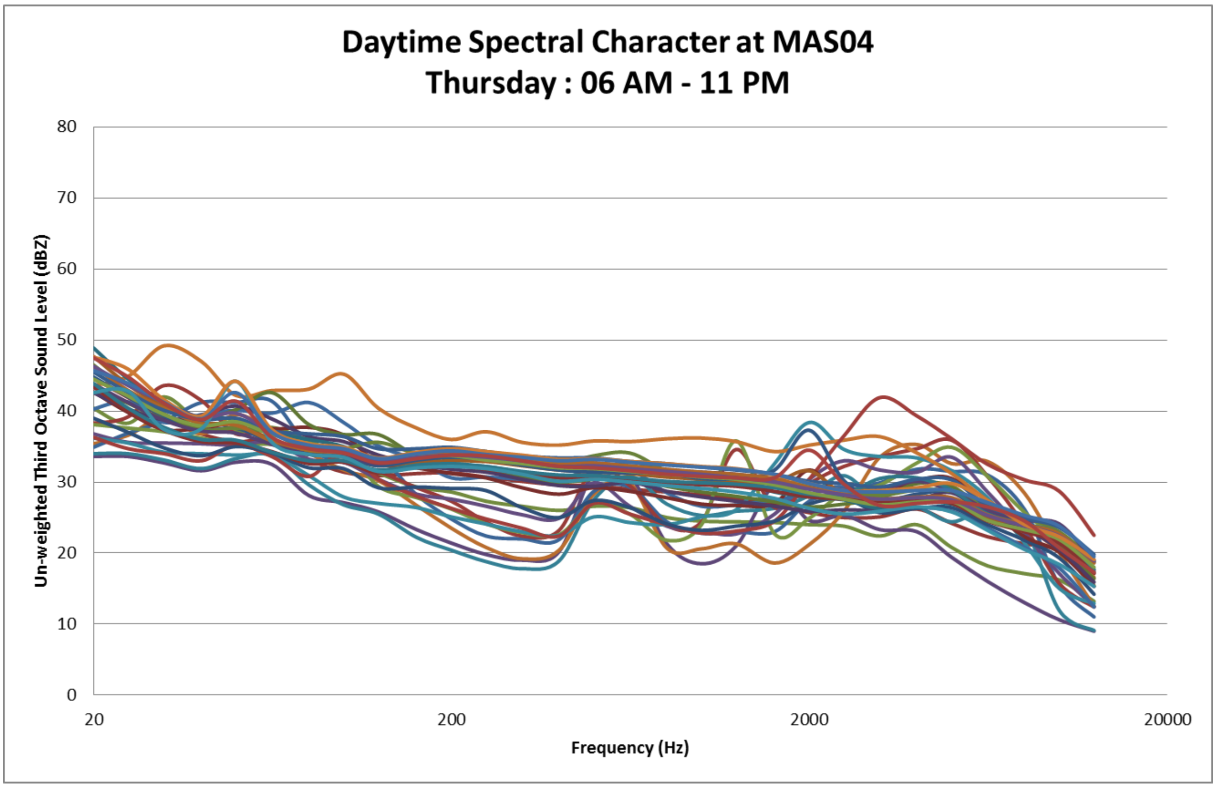

Figure 3-15: Daytime spectral frequency distribution at MAS04, morning second day

SANS 10103:2008 Rating Level: Measured data indicate sound levels typical of an area with a rural district sound character. The measured $L_{Aeq,f}$ levels conforms to the recommended 55 and 45 dBA (day and night respectively) by the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for residential areas.

3.4.5 Measurement Point MAS05: Dwelling of Mr. Hanekom

A number of 10 minute measurements were taken over a day/night period on 2 July 2013. The equipment defined in **Table 3-10** was used for gathering data. Measured sound levels are presented in **Figure 3-16** and **Figure 3-17**.

Table 3-10: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Svan 977	34160	17 May 2013
Microphone*	ACO 7052E	54645	17 May 2013
Calibrator	Rion NC-74	34494286	23 January 2013

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

The instruments were deployed at the fence between the house and the animal holding areas. There were goats roaming the property and it was reported that cattle is kept in the kraal at night. There was no vegetation that can rustle in the wind within 10 meters of the microphone. Refer to **Appendix B** for a photo of this measurement location.

Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes): Refer to **Table 3-11** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-11: Noises/sounds heard during site visits at receptor MAS05

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural** Insects. Birds and goats at times.
	Residential and other Anthropogenic Voices and sounds from house.
	Industries, Commercial and Road Traffic Nothing.

Impulse equivalent sound levels: During the daytime L_{AIeq} values ranged between 22.4 to 69.1 dBA. The night-time L_{AIeq} values ranged between 19.1 to 45.2 dBA. The average value of the 91 10-minute equivalent daytime measurements was calculated at 46.8 dBA, while the average for the 48 night-time measurements were calculated at 30.6

dBA. A significant number of single events with loud noises however impacted on the day and night-time equivalent sound levels as shown on **Figure 3-16**. Considering the difference between the $\mathbf{L_{AIeq}}$ and $\mathbf{L_{Aeq,f}}$ values the single noise events had a highly impulsive character, likely due to sounds from natural sources.

Statistical sound levels ($\mathbf{L_{A90,f}}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-16**. $\mathbf{L_{A90,f}}$ daytime values ranged from less than 20 to 42.8 dBA90. The night-time $\mathbf{L_{A90,f}}$ values ranged from less than 20 to 21.6 dBA90. Measured $\mathbf{L_{A90,f}}$ data indicated an area that can be very quiet at periods (very quiet at night). Single noisy events are of sufficient duration during the day to impact on this statistical level.

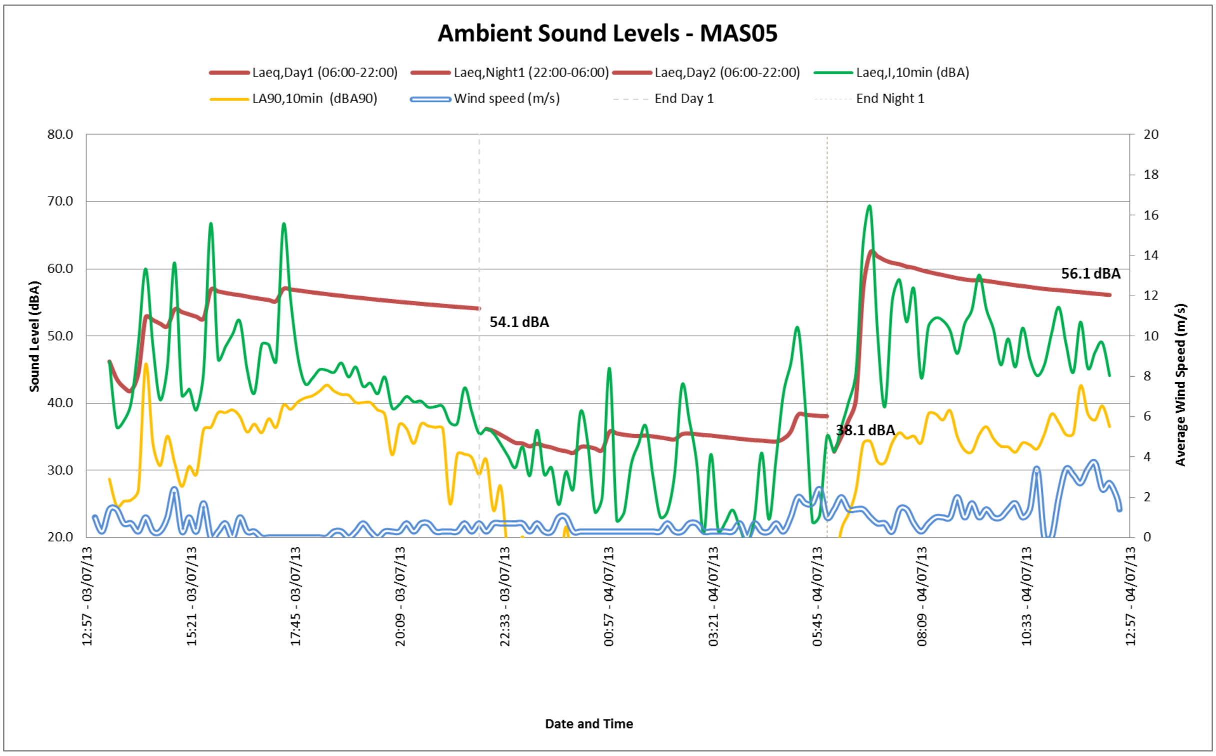

Figure 3-16: Ambient Sound Levels at MAS05

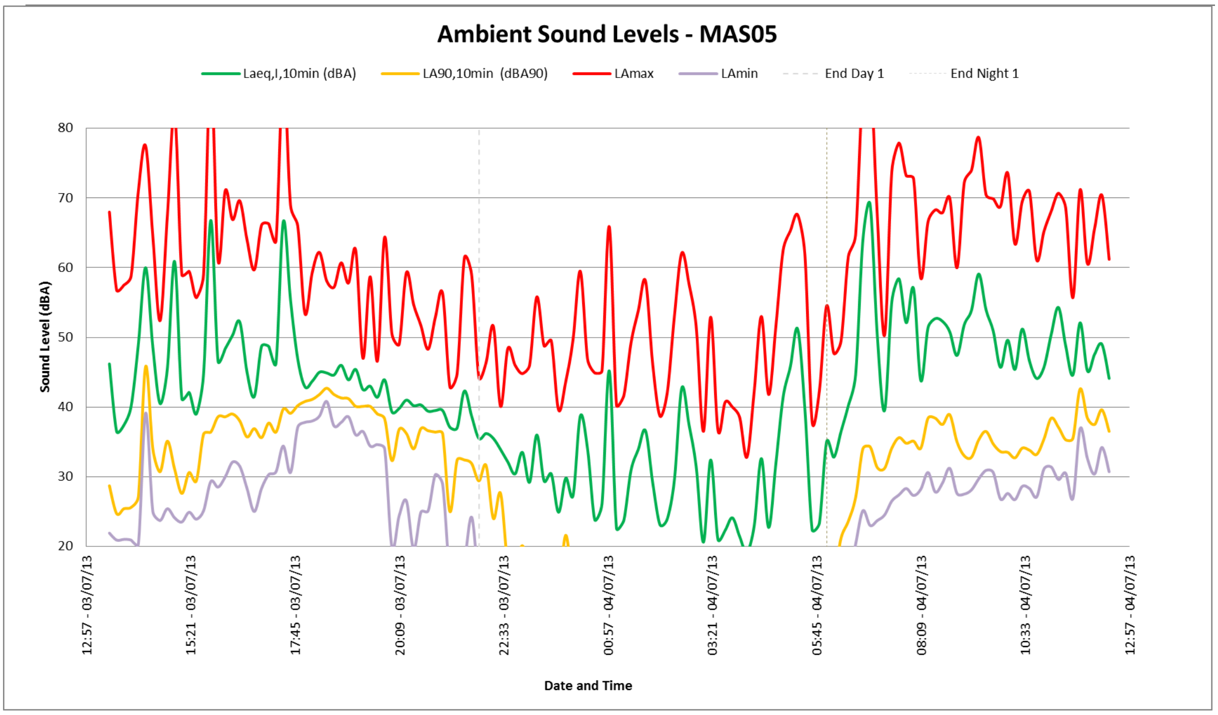

Figure 3-17: Maximum, Statistical and Minimum Sound Levels at MAS05

Maximum noise levels: Maximum noise levels are illustrated on **Figure 3-17**. The equivalent sound level graph has a shape similar to the maximum noise level graph, indicating that maximum noise levels did influence the equivalent sound level readings at times. There is an average difference of more than 23 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 10 and 34 dB. Considering the L_{A90} and L_{AIeq} graphs maximum noises were of sufficient duration to impact on the equivalent and statistical readings at times. The source of the maximum noises is undefined but likely natural because there was a number of very short duration, especially at night.

Minimum noise levels: Minimum noise levels are illustrated on **Figure 3-17**. Considering both the L_{A90} and $L_{A,min}$ graphs shows an area that is very quiet at night-time with various noisy events impacting on the sound levels (equivalent, statistical, minimum). This is typical of an area where there are constant daytime noises impacting on the soundscape at night.

Third octave spectral analysis

Lower frequency (20 – 250 Hz): All measurements (see **Figure 3-18**, **Figure 3-19** and **Figure 3-20**) illustrate the spectral character of a number of different noise sources with no particular distinctive character.

Third octave surrounding 1000 Hz: As with the 20 – 250 Hz frequency band all measurements illustrate the spectral character of a number of different noise sources with no particular distinctive character.

Higher frequency (2,000 Hz upwards): As with the 20 – 250 Hz frequency band all measurements illustrate the spectral character of a number of different noise sources with no particular distinctive character. The afternoon and night-time period does shows some high frequency peaks (see **Figure 3-9**) likely relating to bat communication (between 19:00 and 20:00) as well in the 3 150 Hz band (likely crickets).

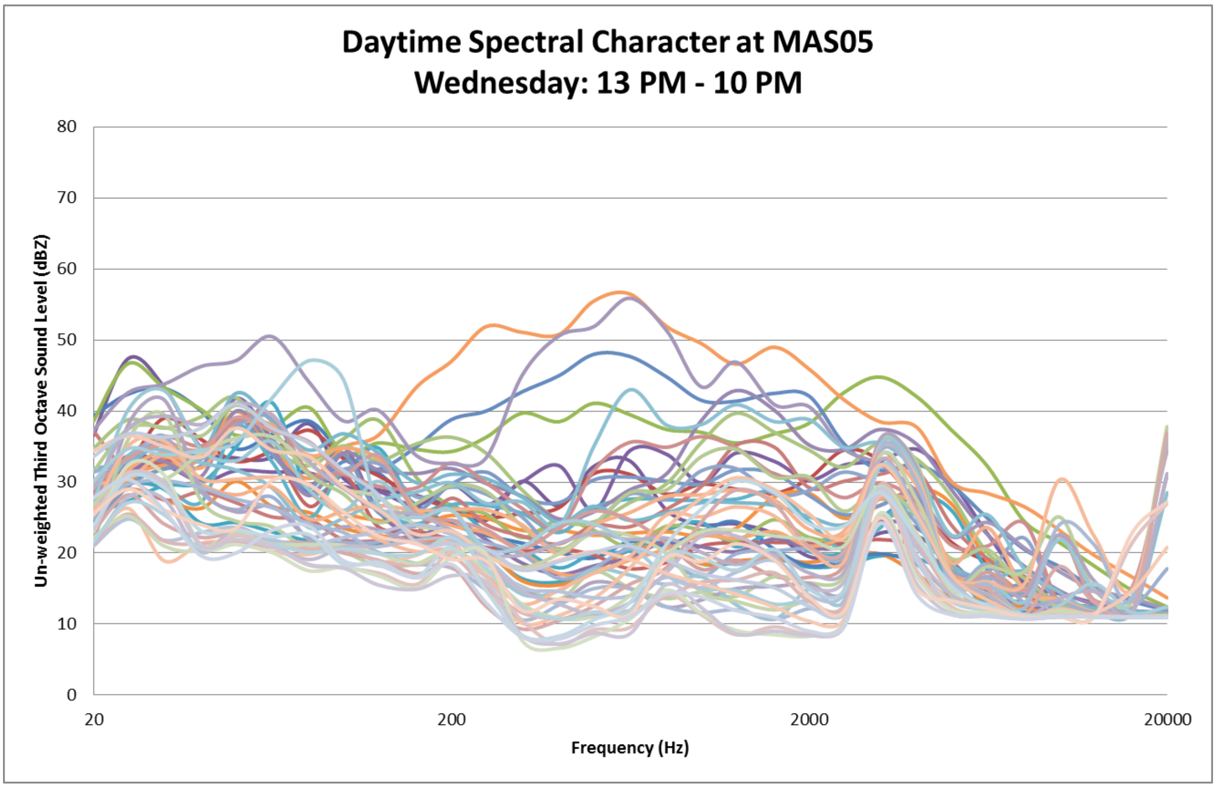

Figure 3-18: Daytime spectral frequency distribution at MAS05, day one

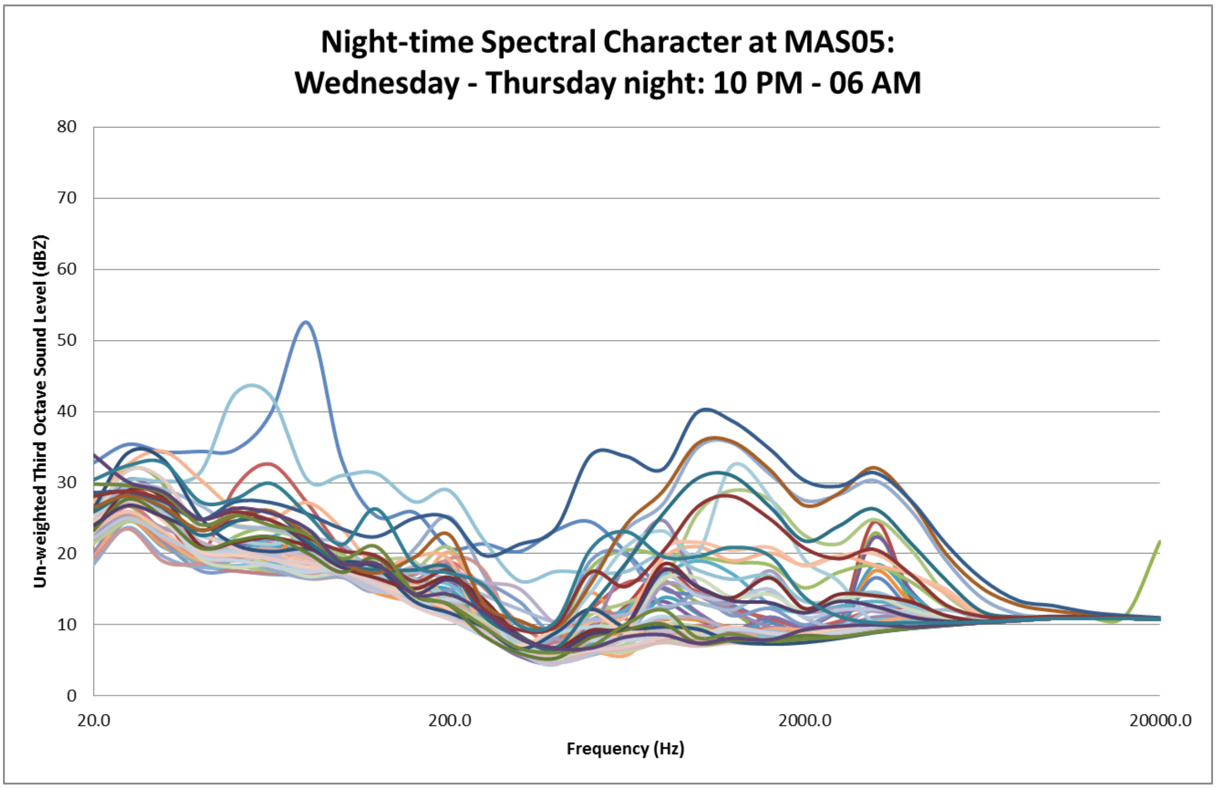

Figure 3-19: Night-time spectral frequency distribution at MAS05, first night

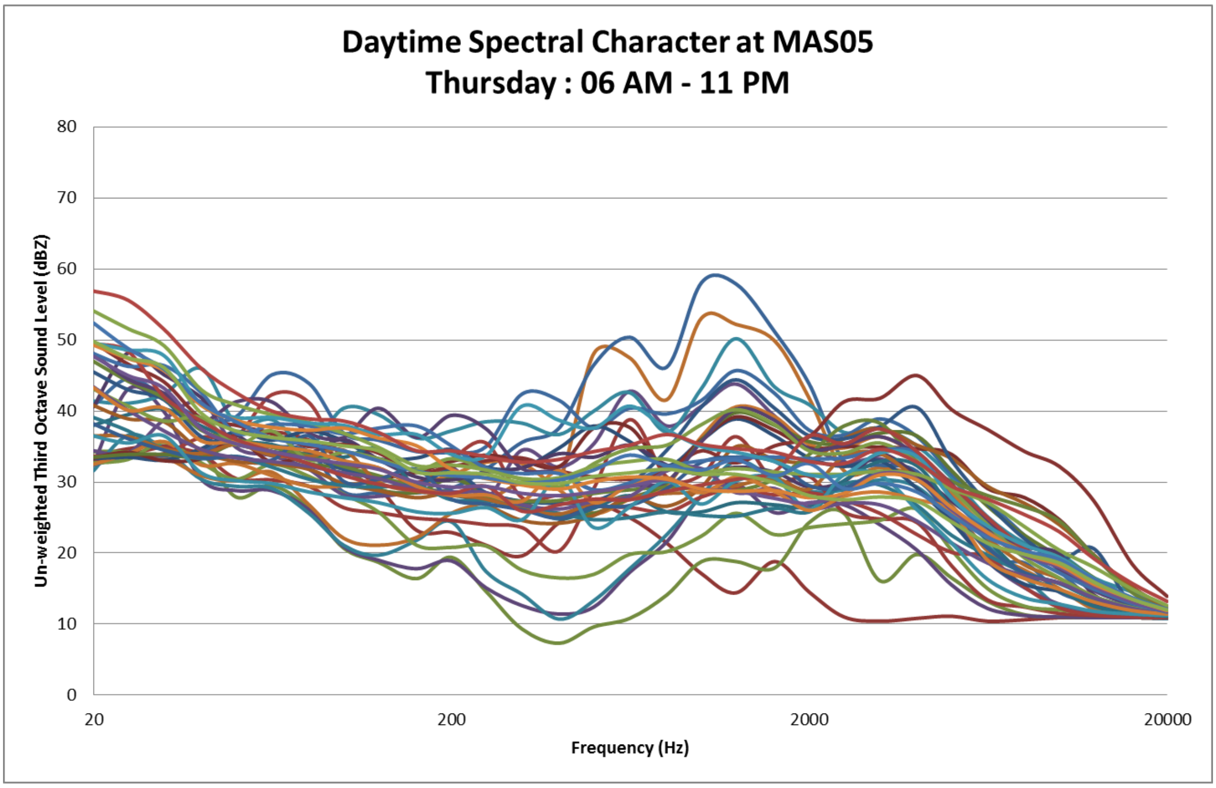

Figure 3-20: Daytime spectral frequency distribution at MAS05, morning second day

SANS 10103:2008 Rating Level: Daytime measured data indicate sound levels typical of an area with a urban district noise character although night-time levels are more typical of a rural area. Considering the L_{A90} and the developmental character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable. The measured $L_{Aeq,f}$ levels during the day and night does conform to the recommendation of 55 and 45 dBA respectively by the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for residential areas.

3.4.6 Measurement point MAS06: Unused vegetable garden - Mr. van der Merwe

The instrument was deployed 4 July 2013 with the measurement location inside a closed off area in a disused vegetable garden away from the receptors dwelling. Refer to **Appendix B** for photos of this measurement point.

The equipment defined in **Table 3-12** was used for gathering data. Measured data is presented in **Figure 3-21** and **Figure 3-22**.

Table 3-12: Equipment used to gather data

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

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

Sounds heard during measurements dates: Refer to **Table 3-13** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-13: Noises/sounds heard during site visits at MAS06

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural** Wind induced - rustling of tree leaves. Insects. Birds.
	Residential and other Anthropogenic Quiet - dogs never barked during the site visit.
	Industries, Commercial and Road Traffic Nothing.

Impulse equivalent sound levels: During the daytime $\mathbf{L_{AIeq}}$ values ranged between 27.6 to 60.8 dBA. The night-time $\mathbf{L_{AIeq}}$ values ranged between 27.8 to 44.5 dBA. The average value of the 92 10-minute equivalent daytime measurements was calculated at 41.6 dBA, while the average for the 48 night-time measurements calculated at 36.5 dBA.

A number of single events with loud noises did impact on the day and night-time equivalent sound levels as shown on **Figure 3-22**.

Statistical sound levels ($L_{A90,f}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average and equivalent sound levels. It is illustrated on **Figure 3-21** and **Figure 3-22**. **$L_{A90,f}$** daytime values ranged from 18.1 to 42.1 dBA90. The night-time **$L_{A90,f}$** values ranged from 21.9 to 36.5 dBA90. Measured **$L_{A90,f}$** data indicated an area that is generally very quiet, typical of a rural area with little industrial and commercial activities although there are a slight background noise that does impact on this measurement location (likely the barely audible limestone plant).

Maximum noise levels: Maximum noise levels are illustrated on **Figure 3-22**. The equivalent sound level graph has a shape similar to the maximum noise level graph, indicating that maximum noise levels did influence the equivalent sound level readings. There is an average difference of more than 15 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 6 and 32 dB. Considering the L_{A90} and L_{AIeq} graphs maximum noises were of sufficient duration to impact on the equivalent and even at statistical readings. The source of the maximum noises is undefined but may relate to wind gusts (based on the shape of the wind speed and L_{A90} graphs).

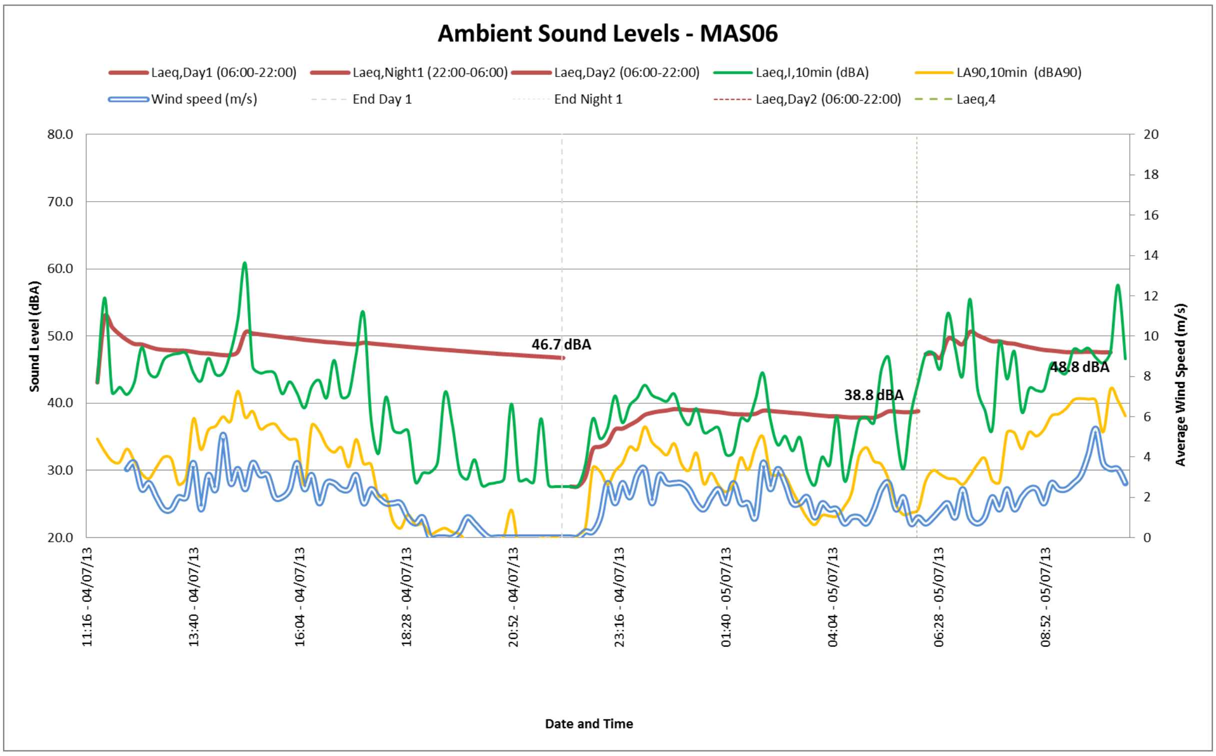

Figure 3-21: Ambient Sound Levels at MAS06

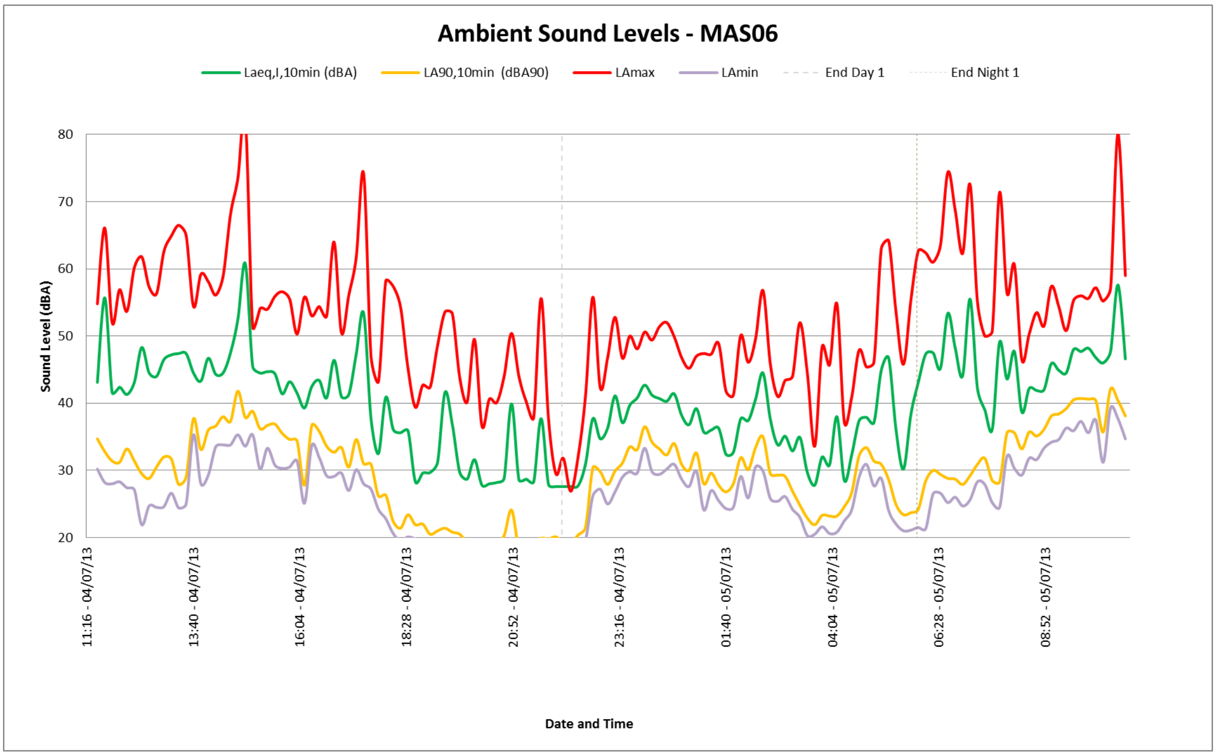

Figure 3-22: Maximum, Minimum and Statistical sound levels at MAS06

Minimum noise levels: Minimum noise levels are illustrated on **Figure 3-6**. Considering both the L_{A90} and $L_{A,min}$ graphs shows an area that can be very quiet at times. Increased wind speeds likely did impact on the readings considering the shape of the wind speed graph in relation to the $L_{A,min}$ graph.

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

SANS 10103:2008 Rating Level: Measured data indicate sound levels typical of an rural district. Based on the measured levels (statistical) and the development character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable for this location. The measured $L_{Aeq,f}$ levels during the day and night conforms to the recommended of 55 and 45 sound level set by the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for a residential area.

3.4.7 Measurement Point MAS07: Farm Sonskyn – Foreman's dwelling

A number of 10 minute measurements were taken over a day/night period on 4 July 2013. The equipment defined in **Table 3-14** was used for gathering data. Measured sound levels are presented in **Figure 3-23**.

Table 3-14: Equipment used to gather data

Equipment	Model	Serial no	Calibration Date
SLM	Rion NA-28	00901489	24 May 2013
Microphone*	Rion UC-59	02087	24 May 2013
Calibrator	Rion NC-74	34494286	23 January 2013

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

The measurement location was at a quiet spot in the garden next to the fence close to the main dwelling. The location was very quiet and mainly birds were audible. The microphone was located in a relatively open area further than 5 meters from any vegetation or reflective surfaces (excluding the ground itself). Refer to **Appendix B** for a photo of this measurement location.

Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes): Refer to **Table 3-15** indicating sounds heard at the measurement point by the acoustical consultant.

Table 3-15: Noises/sounds heard during site visits at receptor MAS07

Ambient Sound Character -Sounds of Significance	
Magnitude Scale Code: Barely Audible / Audible / Dominating	**Faunal and Natural** Birds.
	Residential and other Anthropogenic Quiet.
	Industries, Commercial and Road Traffic Single events from traffic on the gravel road.

Impulse equivalent sound levels: During the daytime L_{AIeq} values ranged between 26.6 to 72.4 dBA. The night-time L_{AIeq} values ranged between 24.0 to 39.1 dBA. The average value of the 84 10-minute equivalent daytime measurements was calculated at 42.1 dBA, while the average for the 48 night-time measurements were calculated at 32.5 dBA. Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-23**.

Statistical sound levels ($L_{A90,f}$): The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-23**. $L_{A90,f}$ daytime values ranged from 22.7 to 43.5 dBA90. The night-time $L_{A90,f}$ values ranged from 22.3 to 31.3 dBA90.

Measured **$L_{A90,f}$** data indicated an area where there is a constant soft noise that is impacting on the ambient sound levels although increased wind speeds could have impacted on the sound levels measured.

Maximum noise levels: Settings on the instrument recorded the third-octave sound level at which a certain frequency band measured the highest noise level and not the RMS maximum sound level. The data is mainly used to identify the potential origin of a noise source and not in the description of average ambient sound levels. Maximum noise levels will not be discussed for this location.

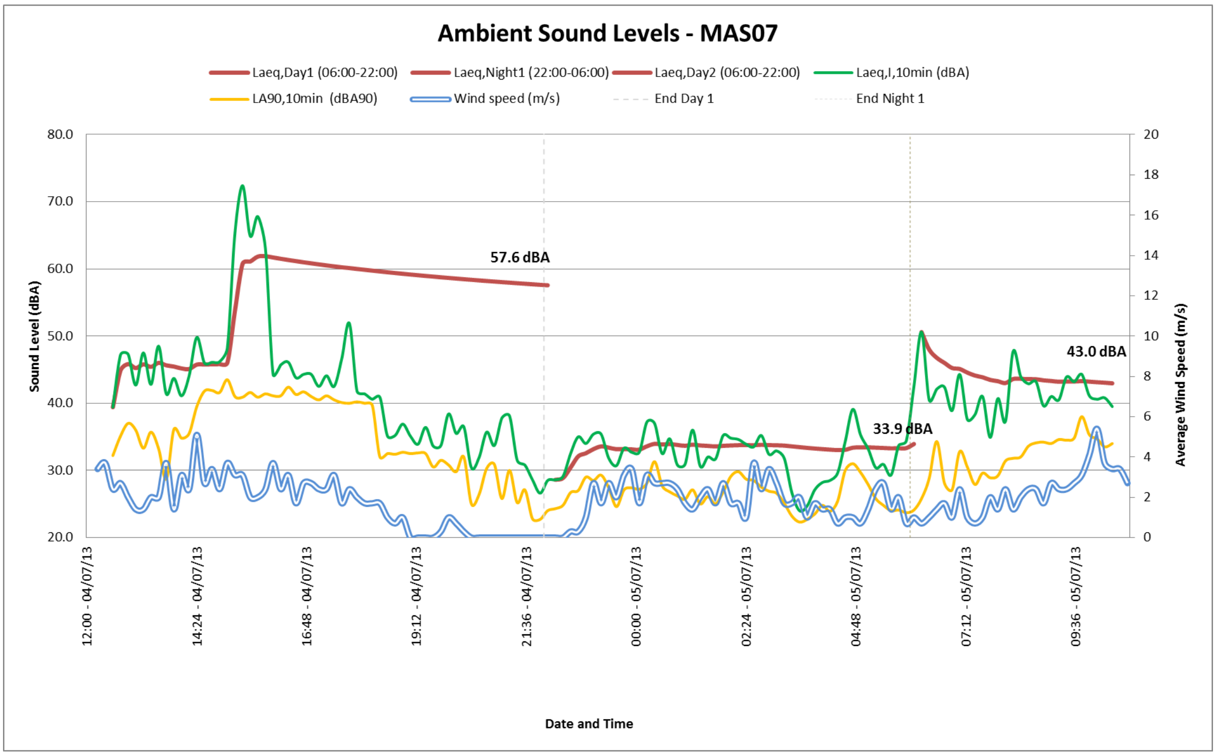

Figure 3-23: Ambient Sound Levels at MAS07

Minimum noise levels: As with the maximum noise levels minimum noise levels will not be discussed for this location.

Third octave spectral analysis

Lower frequency (20 – 250 Hz): Daytime measurements (see **Figure 3-24** and **Figure 3-26**) illustrate the spectral character of a number of different noise sources, including wind induced noises. A number of measurements shows a peak at 50 Hz (undefined) with very quiets measurements showing slight bumps at 40 and 80 Hz. The source of these noises is unknown. Sounds at night were mainly due to wind-induced noises. (see **Figure 3-25**).

Third octave surrounding 1000 Hz: This range contains energy mostly associated with human speech (mostly 350 Hz – 2,000 Hz, could be between 20 – 16,000 Hz), dwelling related sounds and road to tyre interaction from road traffic. This frequency band did not show any particular (consistent) peaks in this region, with a few measurements showing slight peaks at the 500 Hz frequency band.

Higher frequency (2,000 Hz upwards): A significant number of the daytime measurements shows peaks in the 5 000, 12 500 and 20 000 Hz frequency bands. These frequency bands are used by frogs, cicada and bats.

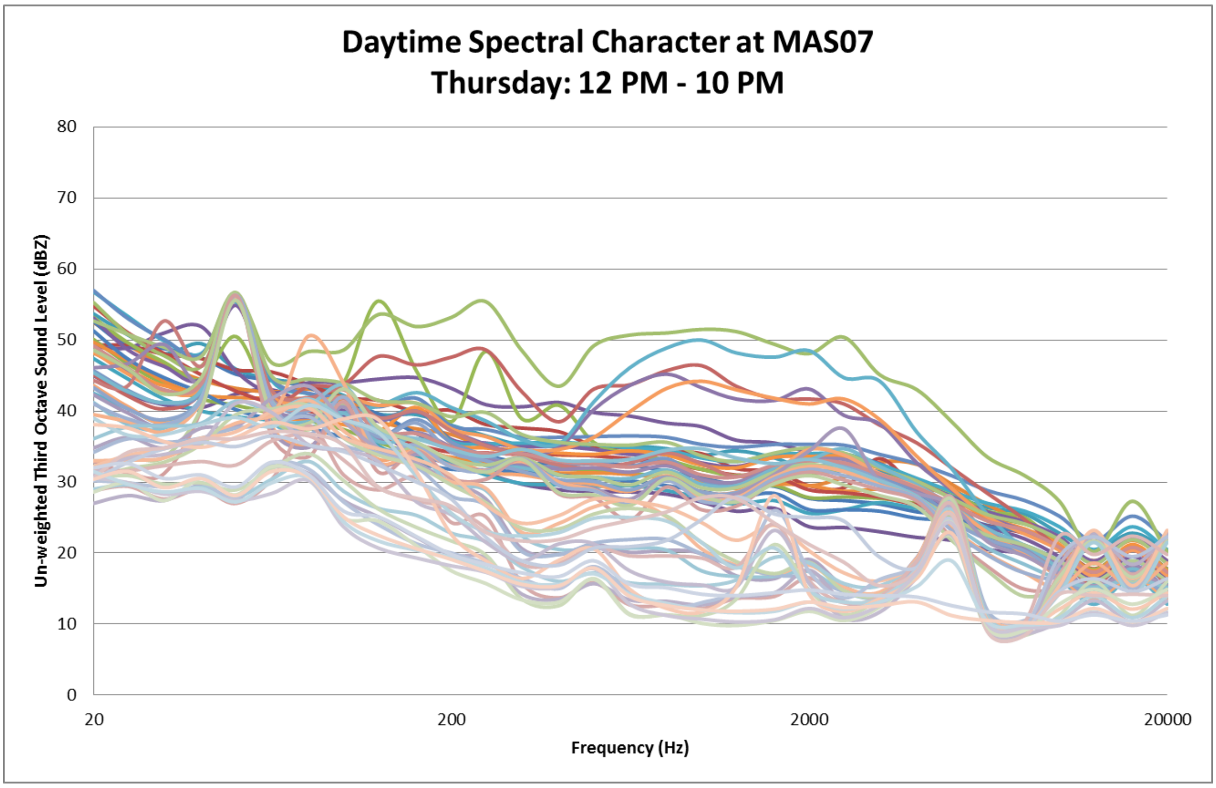

Figure 3-24: Daytime spectral frequency distribution at MAS07, day one

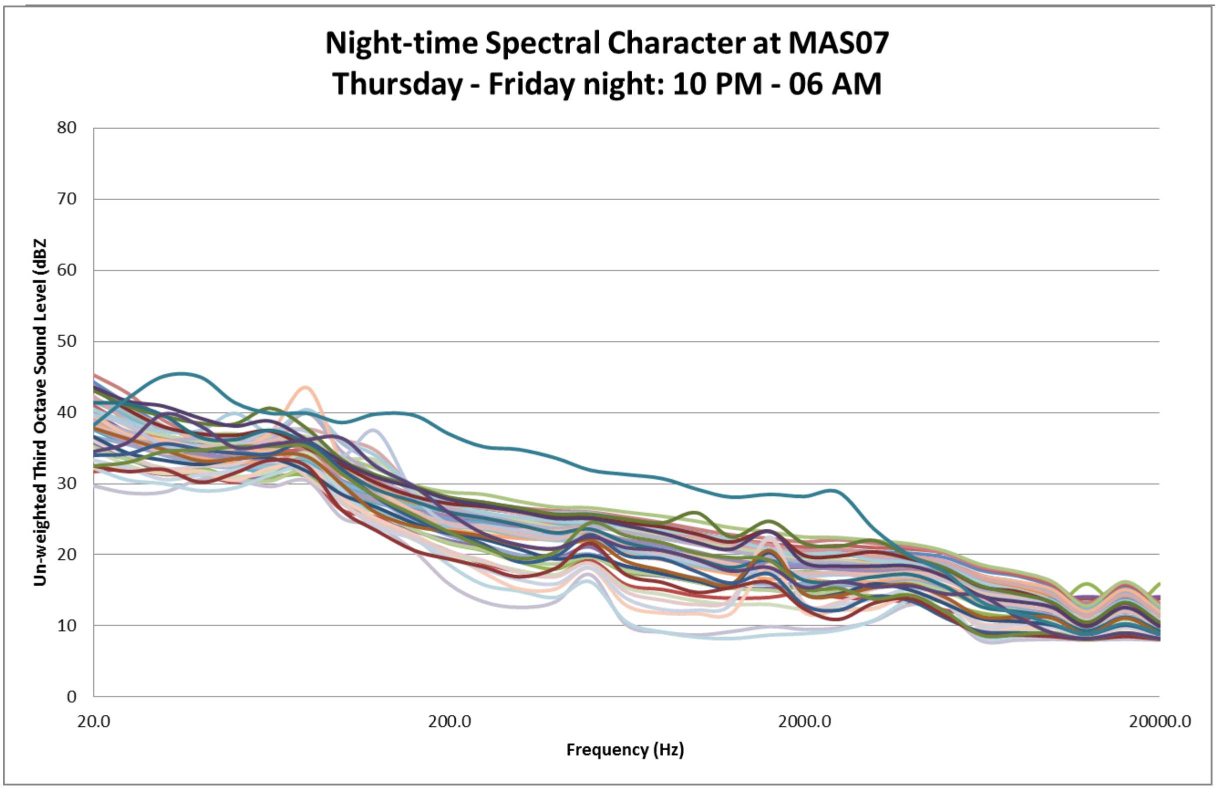

Figure 3-25: Night-time spectral frequency distribution at MAS07, first night

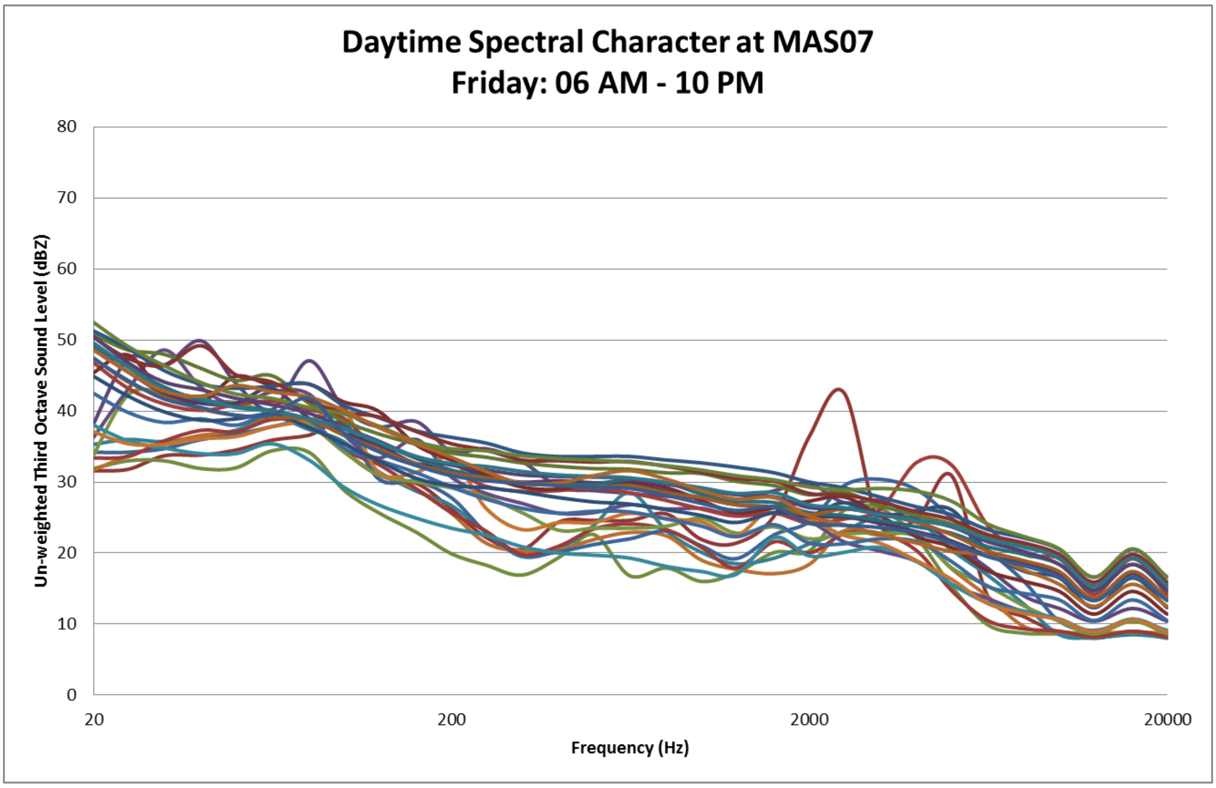

Figure 3-26: Daytime spectral frequency distribution at MAS07, morning second day

SANS 10103:2008 Rating Level: Measured data indicate sound levels typical of an area with a rural district sound character even the first day recorded an equivalent sound level of 57.6 dBA. The measured $L_{Aeq,f}$ levels conforms to the recommended 55 and 45 dBA (day and night respectively) by the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for residential areas.

3.5 AMBIENT SOUND LEVELS – SUMMARY

Equivalent sound levels varied significantly from location to location, with all locations experiencing noisy single events at times that impact on the sound levels (both L_{Aeq} and L_{A90}). L_{A90} levels however indicate an area with significant potential to be quiet at times. Equivalent daytime ambient sound levels were measured around between 43 – 64 dBA, ranging between 22 and 75 dBA (10-minute measurements) with equivalent night-time ambient sound levels were measured around between 33 – 64 dBA, ranging between 19 and 75 dBA (10-minute measurements).

The Mopane community and the NSD30 (Mr. Meintjies) currently experience slightly elevated ambient sound levels due to the Limestone Plant in the area. There are however little indication of any significant noise impacts from external sources of anthropogenic origin at other monitoring locations. While the gravel roads in the area does increase noise levels due to single events, the main source of noise appears to be originating from local dwellings. The source in most cases relates to faunal activity around the dwellings. This is specifically clear at measurement location MAS03 where chickens raised the noise levels to those similar of a commercial district.

A summary of the SANS 10103:2008 noise districts are provided in **Table 3-16**.

Table 3-16: Summary of noise district rating levels

Point name	Noise district rating based on L_{Aeq} measurement data (Day / Night)	Noise district rating based on all data and character of area	Existing ambient sound levels conforming to international recommended levels?
MAS01	Rural / Urban	Sub-urban	Yes
MAS02	Urban / Urban	Sub-urban	Yes
MAS03	Urban / Commercial	Sub-urban	No
MAS04	Rural / Rural	Rural	Yes
MAS05	Urban / Rural	Sub-urban	Yes
MAS06	Rural / Rural	Sub-urban	Yes
MAS07	Rural / Rural	Rural	Yes

Due to the significant variance in ambient sound measurements it is recommended that the project use the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas (see **Table 2-1**).

4 INVESTIGATED NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction of the proposed mine and related infrastructure, as well as the operational phase of the activity.

4.1 POTENTIAL NOISE SOURCES: PRE-CONSTRUCTION PHASE

Noises generated during the preconstruction phase are of a very low significance.

4.2 POTENTIAL NOISE SOURCES: CONSTRUCTION PHASE

4.2.1 Construction Activities

The following are possible to be the main construction related sources of noise for a mine and its infrastructure:

i. Vegetation removal and the stripping of topsoil;
ii. Development of the topsoil berms (around mining pits – 3 meters high) and stockpiles;
iii. Construction camp establishment;
iv. Development of the internal and access roads;
v. Activities related to the deployment and implementation of services (power lines, communication infrastructure, pipelines, conveyor systems);
vi. Excavation of building foundations and service trenches. Blasting may be required but in general pneumatic breakers will be used where rock is encountered;
vii. Development of initial box cuts (excavation of soft overburden, drilling and blasting of hard interburden/overburden, loading of blasted hard interburden/overburden as well as material transport);
viii. Piling operations for large buildings and structures;
ix. Construction of offices and other structures;
x. Installation of crushing, screening and beneficiation plant;
xi. General movement of heavy vehicles around the site; and,
xii. Construction material and equipment delivery vehicles coming/going.

The level and character of the construction noise will be highly variable as different activities with different equipment take place at different times, for different periods of time (operating cycles), in different combinations, in different sequences and on different parts of the construction site. Potential maximum noise levels generated by construction equipment as well as the potential extent are presented in **Table 4-1**. The potential extent depends on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral character of the noise as well as the ambient surroundings.

Average or equivalent sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the receptor can experience. Typical sound power levels associated with various activities that may be found at a construction site is presented in **Table 4-2**.

4.2.2 Blasting

Blasting may be required as part of the civil works to clear obstacles or to prepare foundations. However, blasting will not be considered during the Scoping or EIA phase for the following reasons:

- Blasting is highly regulated and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner.
- Blasting is a highly specialised field, and various management options are available to the blasting specialist. Options available to minimise the risk to equipment, people and infrastructure includes:
    - The use of different explosives that have a lower detonation speed, which reduces vibration, sound pressure levels as well as air blasts.
    - Blasting techniques such as blast direction and/or blast timings (both blasting intervals and sequence).
    - Reducing the total size of the blast.
    - Damping materials used to cover the explosives.
- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. This is normally associated with close proximity mining/quarrying.
- Blasts will be an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast result in a higher acceptance of the noise.

4.2.3 Traffic

A significant source of noise during the construction phase is additional traffic to and from the site, as well as traffic on the site. This will include trucks transporting equipment and machinery, as well as contractors. Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary during the construction period.

Table 4-1: Potential maximum noise levels generated by construction equipment

Equipment Description[3]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential **maximum** noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Auger Drill Rig	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Backhoe	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Chain Saw	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Compactor (ground)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	No	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Concrete Saw	No	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6
Crane	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dozer	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Generator (<25KVA, VMS Signs)	No	104.7	79.7	73.7	67.6	59.7	53.7	50.1	47.6	44.1	39.7	36.2	33.7	27.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Jackhammer	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Man Lift	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Mounted Impact Hammer	Yes	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6

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

Paver	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Pickup Truck	No	89.7	64.7	58.7	52.6	44.7	38.7	35.1	32.6	29.1	24.7	21.2	18.7	12.6
Pumps	No	111.7	86.7	80.7	74.6	66.7	60.7	57.1	54.6	51.1	46.7	43.2	40.7	34.6
Rivit Buster/Chipping Gun	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Rock Drill	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Roller	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sand Blasting (single nozzle)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Scraper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sheers (on backhoe)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Slurry Plant	No	112.7	87.7	81.7	75.6	67.7	61.7	58.1	55.6	52.1	47.7	44.2	41.7	35.6
Slurry Trenching Machine	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Soil Mix Drill Rig	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Tractor	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Vacuum Excavator (Vac-Truck)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vacuum Street Sweeper	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Ventilation Fan	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibrating Hopper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibratory Concrete Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Vibratory Pile Driver	No	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Warning Horn	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Welder/Torch	No	107.7	82.7	76.7	70.6	62.7	56.7	53.1	50.6	47.1	42.7	39.2	36.7	30.6

4.3 POTENTIAL NOISE SOURCES: OPERATIONAL PHASE

4.3.1 Operational Activities: Mining

Because the night-time period is the more critical time for the surrounding receptors, modelling will only focus on typical activities that take place at night. Mining activities such as rehabilitation behind the active mining pit as well as site preparation ahead of the opencast pit generally does not take place at night and will not be considered in this report[4]. It will be assumed that all activities are taking place simultaneously with all equipment operating at full load, representing a worse-case scenario.

The following noise generation activities will be modelled for the operational phase at the mine:

- Opencast activities;
    - Drilling of hard interburden (surface level to illustrate a potential worst case scenario),
    - Excavation and loading-hauling-dumping of interburden (30 meters below surface),
    - The dumping of the interburden on surface level,
    - Drilling of hard overburden (30 meters below surface),
    - Excavation and loading-hauling-dumping of overburden (60 meters below surface),
    - Ore excavation and load-haul-dumping (at the material tip),
    - Material handling, primary crushing (rotary crusher) and belt-drive unit at material tip,
- Conveying of ROM via a conveyor belt system overland to the beneficiation plant,
- Plant activities;
    - Ore receipt (stockpiling);
    - High Gravity Dense Medium Separation;
    - Low Gravity Dense Medium Separation;
    - Discard management (material handling);
    - Flotation and fines management;
    - Tailings thickening and tailing disposal;
    - Product handling.

Of these activities significant noise are associated with the opencast, material tip and plant activities. Typical sound power levels associated with various activities that may be found at an opencast mine is presented in **Table 4-2**. It is important to note that the list

[4] This will be considered during the construction phase as this is a typical daytime activity.

and number of equipment was not defined at the time this report was compiled. As can be seen from this table there are a range of equipment, frequently with different sound power emission levels and spectral characteristics. If the developer selected different equipment than used for modelling in this report, modelling results will be different.

4.3.2 Blasting

Blasting is an integral part of mining activities but will not be considered further during the operational phase for the following reasons:

- Blasting is highly regulated, and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner.
- Blasting is a highly specialised field, and various management options are available to the blasting specialist. Options available to minimise the risk to equipment, people and infrastructure includes:
    - The use of different explosives that have a lower detonation speed, which reduces vibration, sound pressure levels as well as air blasts.
    - Blasting techniques such as blast direction and/or blast timings (both blasting intervals and sequence).
    - Reducing the total size of the blast.
    - Correct tamping of the blasting holes.
- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. However, these are normally associated with close proximity mining/quarrying. Current policies require that people within a radius of 500 meters be moved (permanent or temporary during blasting) due to the risk that blasting pose to them. Noise created during blasting is therefore the least of any concerns.
- Blasts are an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast result in a higher acceptance of the noise.

Table 4-2: Potential equivalent noise levels generated by various equipment

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Bulldozer CAT D10	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D11	113.3	88.4	82.3	76.3	68.4	62.3	58.8	56.3	52.8	48.4	44.8	42.3	36.3
Bulldozer CAT D9	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D6	108.2	83.3	77.3	71.2	63.3	57.3	53.7	51.2	47.7	43.3	39.8	37.3	31.2
Bulldozer CAT D5	107.4	82.4	76.4	70.4	62.4	56.4	52.9	50.4	46.9	42.4	38.9	36.4	30.4
Bulldozer Komatsu 375	114.0	89.0	83.0	77.0	69.0	63.0	59.5	57.0	53.4	49.0	45.5	43.0	37.0
Crusher/Screen (MTC Mobile)	109.6	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.0	44.6	41.1	38.6	32.6
Coal crushing plant (50 tons/h)	114.5	89.5	83.5	77.5	69.5	63.5	60.0	57.5	54.0	49.5	46.0	43.5	37.5
Coal beneficiation plant	107.5	82.5	76.5	70.5	62.5	56.5	53.0	50.5	46.9	42.5	39.0	36.5	30.5
Coal silo (Material Transfer)	103.2	78.3	72.2	66.2	58.3	52.2	48.7	46.2	42.7	38.3	34.7	32.2	26.2
Coal Yard Equipment	106.8	81.8	75.8	69.8	61.8	55.8	52.3	49.8	46.3	41.8	38.3	35.8	29.8
Coal Screen	105.1	80.1	74.1	68.1	60.1	54.1	50.6	48.1	44.6	40.1	36.6	34.1	28.1
Diesel loco moving	108.7	83.7	77.7	71.7	63.7	57.7	54.2	51.7	48.2	43.7	40.2	37.7	31.7
Diesel loco idling	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7
Drilling Machine	109.6	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.1	44.6	41.1	38.6	32.6
Dumper/Haul truck - CAT 700	115.9	91.0	85.0	78.9	71.0	65.0	61.4	58.9	55.4	51.0	47.5	45.0	38.9
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.2	57.7	55.2	51.7	47.2	43.7	41.2	35.2
Excavator - Hitachi EX1200	113.1	88.1	82.1	76.1	68.1	62.1	58.6	56.1	52.6	48.1	44.6	42.1	36.1
Excavator - Hitachi 870 (80 t)	108.1	83.1	77.1	71.1	63.1	57.1	53.6	51.1	47.5	43.1	39.6	37.1	31.1
FEL - Bell L1806C	102.7	77.7	71.7	65.7	57.7	51.7	48.2	45.7	42.1	37.7	34.2	31.7	25.7
FEL - CAT 950G	102.1	77.2	71.2	65.1	57.2	51.2	47.6	45.1	41.6	37.2	33.7	31.2	25.1
FEL - Komatsu WA380	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7
General noise	108.8	83.8	77.8	71.8	63.8	57.8	54.2	51.8	48.2	43.8	40.3	37.8	31.8
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.9	54.4	51.9	48.4	43.9	40.4	37.9	31.9
Grader	110.9	85.9	79.9	73.9	65.9	59.9	56.4	53.9	50.3	45.9	42.4	39.9	33.9
Screening plant	105.5	80.6	74.6	68.5	60.6	54.6	51.0	48.5	45.0	40.6	37.0	34.6	28.5
Water Dozer, CAT	113.8	88.8	82.8	76.8	68.8	62.8	59.3	56.8	53.3	48.8	45.3	42.8	36.8

4.3.3 Traffic

The main source of traffic noise during the operational phase relates to traffic around the plant and mining area as well as the movement of employees/contractors at shift changes.

Noise levels associated with traffic inside the plant and mining area would have a minor impact considering other operational noises in the area and will not be considered in this report. Noise levels due to traffic entering and leaving the operational area via the road through the community will be estimated using the methodology stipulated in SANS 10210:2004 (Calculating and predicting road traffic noise).

With the railway line being an existing facility and a commercial activity managed by Transnet (), noise from the railway facility will not be considered. Due to the low speeds involved in the rail loop, noise levels from the loading processes will be low compared to the activities at the Rapid Load out Terminal and this will not be considered.

4.4 POTENTIAL NOISE SOURCES: CLOSURE PHASE

Closure activities will not be considered in this report. In general, closure activities have a significant lower noise impact than both the operational and closure phases. The closure phase will therefore not be considered during this document for the following reasons:

- Closure activities are generally less intense than construction and operational activities. Noise levels are lower and frequently limited to daylight hours. This reduces the significance of the noise impact.
- Most rehabilitation takes place con-currently with mining. It is therefore just another activity generating noise that could be considered as part of the operational phase,
- A closure EMP must be developed by the mining operation at the end of the mining operation, which is more specific and accurate. If required, noise could be addressed in this document.

5 METHODS: NOISE IMPACT ASSESSMENT

5.1 WHY NOISE CONCERNS COMMUNITIES[5]

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping); and
- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases, annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered “disturbing”. One can refer to a dripping tap in the quiet of the night, or the irritating “thump-thump” of the music from a neighbouring house at night when one would prefer to sleep.

Severity of the annoyance depends on factors such as:

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

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

5.1.1 Annoyance associated with Industrial Activities[6]

Annoyance is the most widely acknowledged effect of environmental noise exposure, and is considered to be the most widespread. It is estimated that less than a third of the individual noise annoyance is accounted for by acoustic parameters, and that the non-acoustic factors plays a major role. Non-acoustic factors that have been identified include age, economic dependence on the noise source, attitude towards the noise source and self-reported noise sensitivity.

On the basis of a number of studies into noise annoyance, exposure-response relationships were derived for high annoyance from different noise sources. These relationships, illustrated in **Figure 5-1**, are recommended in a European Union position paper published in 2002, stipulating policy regarding the quantification of annoyance. This can be used in Environmental Health Impact Assessment and cost-benefit analysis to translate noise maps into overviews of the numbers of persons that may be annoyed, thereby giving insight into the situation expected in the long term. It is not applicable to local complaint-type situations or to an assessment of the short-term effects of a change in noise climate.

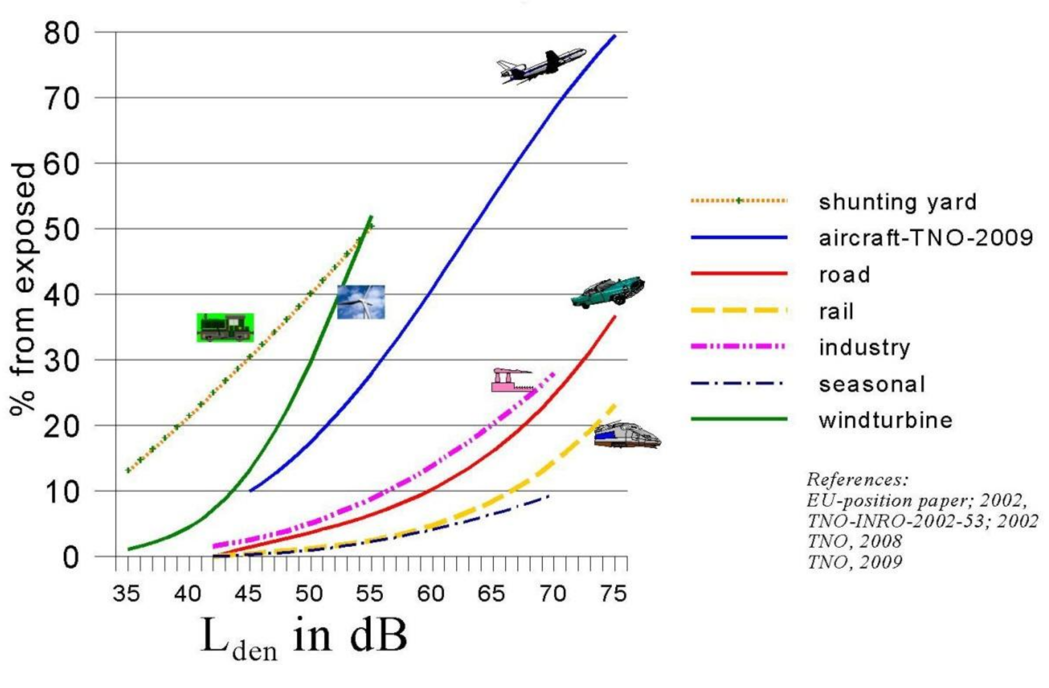

Figure 5-1: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling

[6] Van den Berg, 2011; Milieu, 2010.

As shown in **Figure 5-1**, there is significant potential of annoyance associated with noise from shunting operations, mainly due to the highly impulsive character of the noises created.

5.2 IMPACT ASSESSMENT CRITERIA

5.2.1 Overview: The common characteristics

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are:

- Intensity;
- Loudness;
- Annoyance; and
- Offensiveness.

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated, but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

5.2.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Regulations, published by the Department of Environmental Affairs (June 2006) in terms of the NEMA, SANS 10103:2008 as well as guidelines from the World Health Organization.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations, an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 5-2**.

- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 5-1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

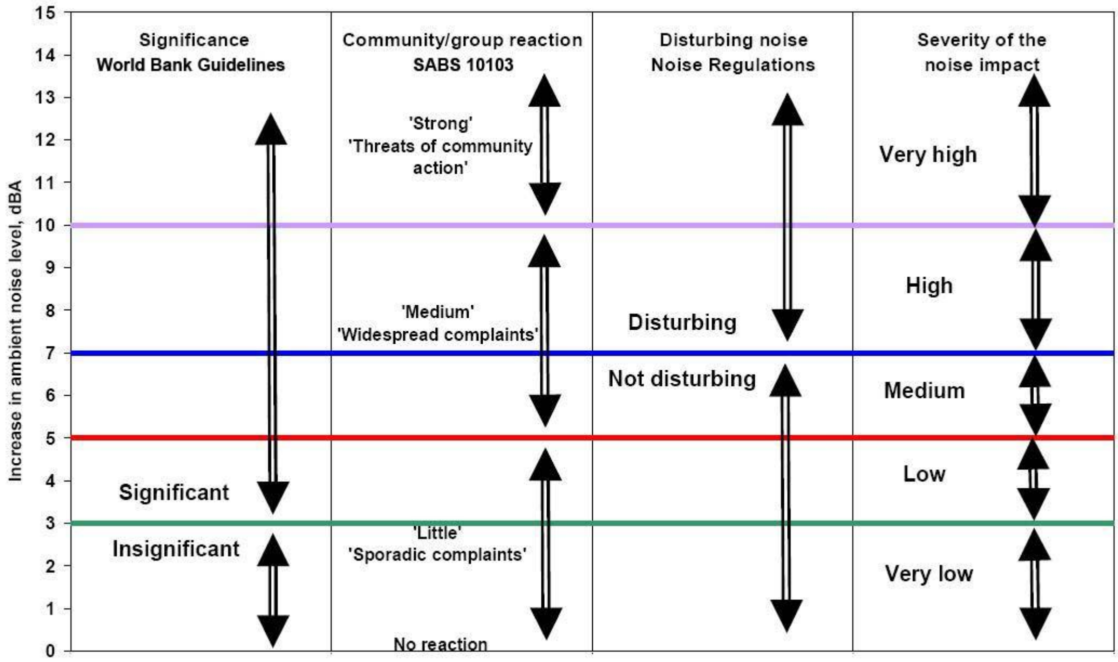

Figure 5-2: Criteria to assess the significance of impacts stemming from noise

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 5-1**). It provides the equivalent ambient noise levels (referred to as Rating Levels), $L_{Req,D}$ and $L_{Req,N}$, during the day and night respectively to which different types of developments may be exposed. The following rating levels (zone sound levels) are desired:

- “Sub-urban Districts” (50 and 40 dBA day/night-time Rating)

SANS 10103:2008 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in sound level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.
- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit ‘little’ community response with ‘sporadic complaints’. People will just be able to notice a change in the sound character in the area.

- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

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

Table 5-1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)

1	2	3	4	5	6	7
Type of district	Equivalent continuous rating level ($L_{Req.T}$) for noise dBA					
	Outdoors			Indoors, with open windows		
	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

5.2.3 Other noise sources of significance

In addition, other noise sources that may be present should also be considered. During the day, people are generally bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc). This excludes activities that may generate additional noise associated with normal work.

At night, sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from a variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

Figure 5-3 illustrates the sound levels associated with some equipment or in certain rooms. This is however more for illustrative purposes, as there are many manufacturers with different equipment, each with a different noise emission character.

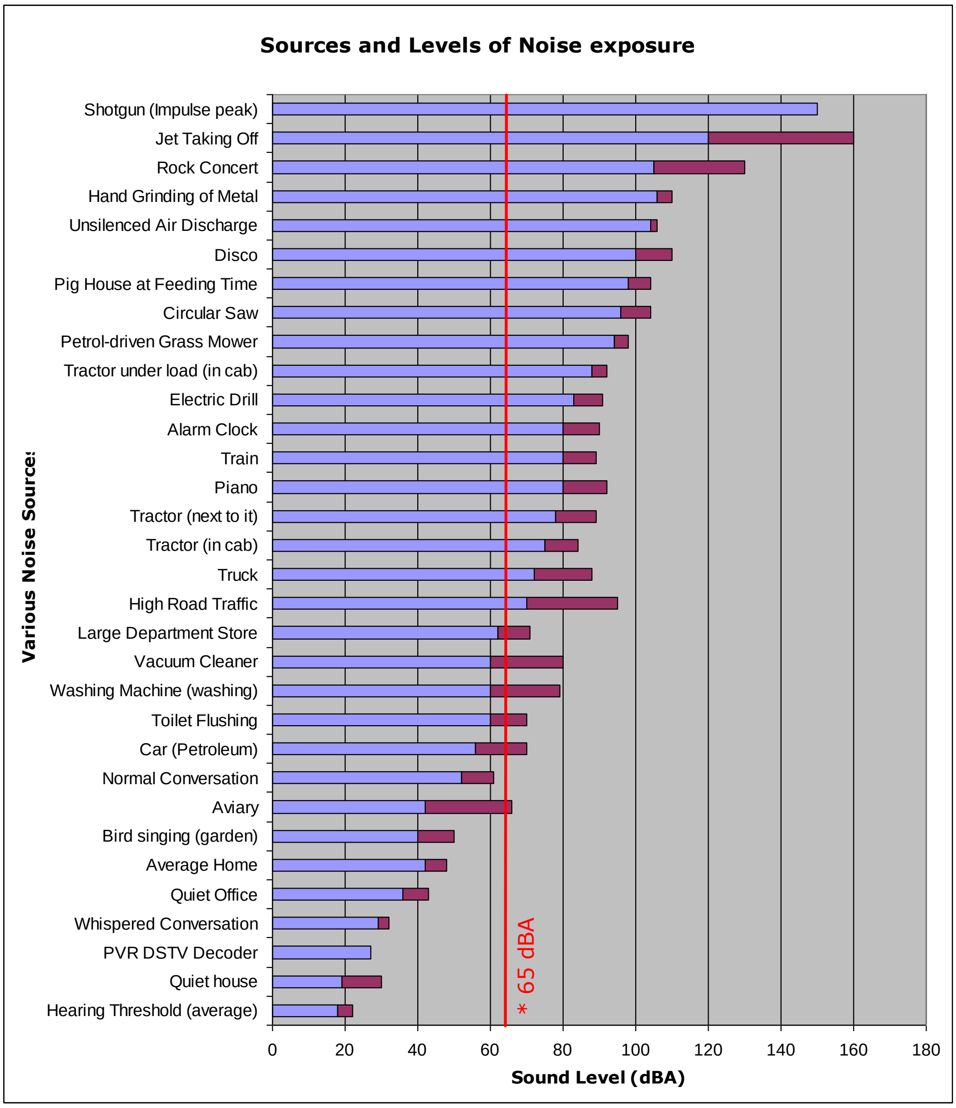

Figure 5-3: Typical Noise Sources and associated Sound Pressure Level

5.2.4 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value as defined in the third column in the tables below.

The impact consequence is determined by the summing the scores of Magnitude **Table 5-2**), Duration (**Table 5-3**) and Spatial Extent (**Table 5-4**). The impact significance (see **Sections 5.2.5** and **Section 5.2.6**) is determined by multiplying the Consequence result with the Probability score (**Table 5-5**).

An explanation of the impact assessment criteria is defined in the following tables.

Table 5-2: Impact Assessment Criteria - Magnitude

This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species.		
Rating	**Description**	**Score**
Low	Total projected noise level is less than the Zone Sound Level in wind-still conditions.	2
Low Medium	Sound levels between 3 and 5 above the acceptable zone sound level (wind-less conditions).	4
Medium	Sound levels between 5 and 7 above the acceptable zone sound level (wind less conditions). Sporadic complaints expected.	6
High	Increase in sound pressure levels between 7 and 10 dBA above the acceptable zone sound level (wind-less conditions). Medium to widespread complaints expected.	8
Very High	Increases in sound pressure levels higher than 10 dB above the acceptable zone sound level (wind less-conditions). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action. Any point where instantaneous noise levels exceed 65 dBA at any receptor.	10

Table 5-3: Impact Assessment Criteria - Duration

The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently.		
Rating	**Description**	**Score**
Temporary	Impacts are predicted to be of short duration (portion of construction period) and intermittent/occasional.	1
Short term	Impacts that are predicted to last only for the duration of the construction period.	2
Long term	Impacts that will continue for the life of the Project, but ceases when the Project stops operating.	4
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.	5

Table 5-4: Impact Assessment Criteria – Spatial extent

Classification of the physical and spatial scale of the impact		
Rating	**Description**	**Score**
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1
Local	The impact could affect the local area (within 1,000 m from site).	2
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.	3
National	The impact could have an effect that expands throughout the country (South Africa).	4
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.	5

Table 5-5: Impact Assessment Criteria - Probability

This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:		
Rating	**Description**	**Score**

Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).	1
Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25 %.	2
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50 %.	3
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined between 50 % to 75 %.	4
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100 %.	5

In order to assess each of these factors for each impact, the following ranking scales as contained in **Table 5-6** will be used.

Table 5-6: Assessment Criteria: Ranking Scales

PROBABILITY		MAGNITUDE	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
Definite/don't know	5	Very high/don't know	10
Highly likely	4	High	8
Likely	3	Medium	6
Possible	2	Low Medium	4
Improbable	1	Low	2
DURATION		**SPATIAL SCALE**	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
		International	5
Permanent	5	National	4
Long Term	4	Regional	3
Short term	2	Local	2
Temporary	1	Footprint	1

5.2.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a Significance Rating (SR) value for each impact (prior to the implementation of mitigation measures).

Significance without mitigation is rated on the following scale:

SR<30	Low (L)	Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required.
30<**SR** <60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR>60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk.

		Resulting impact could influence the decision depending on the possible mitigation. An impact which could influence the decision about whether or not to proceed with the project.

5.2.6 Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale:

SR<30	Low (L)	The impact is mitigated to the point where it is of limited importance.
30<**SR** <60	Medium (M)	Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
SR>60	High (H)	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded of high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

6 METHODS: CALCULATION OF NOISE CLIMATE

6.1 NOISE EMISSIONS INTO THE SURROUNDING ENVIRONMENT

The noise emissions into the environment from the various sources as defined were calculated for the construction and operational phase in detail, using the sound propagation model described in SANS 10357:2004.

The following was considered:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receivers from the noise sources;
- The impact of atmospheric absorption;
- The meteorological conditions in terms of Pasquill stability;
- The operational details of the proposed project, such as projected areas where activities will be taking place;
- A barrier where berms, highwalls, spoil or discard dumps are expected;
- Topographical layout; and
- Acoustical characteristics of the ground. 50% soft ground conditions were modelled, as the area where the mining activity would be taking place is well vegetated and sufficiently uneven to allow the consideration of soft ground conditions. This is because the use of hard ground conditions could represent a too precautionary situation.

The noise emission into the environment due to additional traffic will be calculated using the sound propagation model described in SANS 10210:2004. Corrections such as the following will be considered:

- Distance of receptor from the road;
- Road construction material;
- Average speeds of travel;
- Types of vehicles used; and
- Ground acoustical conditions.

Noise from the conveyor belt between the Voorburg mining area and Jutland mining area (where plant is situated) will be treated as a linear noise source and the sound propagation estimated using the SANS 10210:2004 model considering the following;

- Basic noise level;
- Distance of receptor from the conveyor belt; and
- Ground acoustical conditions.

6.2 SOUND PROPAGATION: CALCULATION AND IMPACT ASSESSMENT LIMITATIONS

Limitations due to the calculations of the noise emissions into the environment include the following:

- Most sound propagation models do not consider refraction through the various temperature layers (specifically relevant during the night-times);
- Most sound propagation models do not consider the very low frequency range (third octave 16 – 31.5 Hz). This would be relevant to facilities with a potentially low frequency issues;
- Many environmental models consider sound to propagate in hemi-spherical way. Certain noise sources (e.g. a speakers, exhausts, fans) emit sound power levels in a directional manner;
- The octave sound power levels selected for processes and equipment accurately represents the sound character and power levels of processes/equipment. The determination of these levels in itself is subject to errors, limitations and assumptions with any potential errors carried over to any model making use of these results;
- Sound power emission levels from processes and equipment change depending on the load the process and equipment is subject too. While the octave sound power level is the average (equivalent) result of a number of measurements, this measurement relates to a period that the process or equipment was subject to a certain load. Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worse-case scenario;
- As it is unknown which processes and equipment will be operational, modelling considers a scenario where all processes and equipment are under full load 100% of the time. The result is that projected noise levels would be over-estimated;
- The impact of atmospheric absorption is simplified and very uniform meteorological conditions are considered;
- Many environmental models are not highly suited for close proximity calculations, alternatively, not suited to model noise levels far from the noise source; and
- Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform.
- Modelling consider uniform average noise levels that may not be realistic considering the real "characteristic". Road traffic noise is an especially complex phenomenon that constantly fluctuates in intensity and pitch. It is the cumulative effect of a number of road vehicles (traffic volume) with each vehicle travelling at different speeds, each vehicle having a different characteristic (road/tyre interaction, engine noise, transmission noise, aerodynamic noise, braking system, exhaust system, different state of repair and maintenance) that impact on the noise level from the vehicle and ultimately the noise from the road traffic.

- Due to time and budgetary constraints modelling cannot consider every building, wall, tree, etc. that can ultimately impact on the propagation of noise from the noise source due a number of factors.
- This report is based on an assumption about potential equipment to be used on the project. As can be seen from **Table 4-2** there exist a significant number of equipment, each frequently with a different sound power emission level and spectral. Modelling will assume a certain type of equipment that could potentially differ in type and number from the equipment to be used by the developer.

Due to these assumptions modelling generally could be out with as much as +10 dBA, although values ranging from 3 to 5 dBA is more common. However, even considering the potential inaccuracy it still provides an invaluable tool to calculate the potential of a noise impact of occurring and allow the early identification of noise concerns. It should therefore be noted that modelling is not used to calculate noise levels but rather a noise rating levels that can be used to identify issues of concern.

7 MODELLING RESULTS AND IMPACT ASSESSMENT

7.1 CONSTRUCTION PHASE IMPACT

7.1.1 Description of Construction Activities Modelled

Construction activities highly depend on the final mining plan and schedule. The mining plan as received from the client was reviewed and potential locations where noisy activities may take place identified. A layout as conceptualised and modelled is presented in **Figure 7-1**.

As can be seen from this conceptual scenario a number of different activities could take place, at a number of locations, each with a specific impact on the closest potentially noise-sensitive developments.

Because of the various potential activities that could take place during the construction phase, a conceptual worse-case scenario was considered including:

- Preparation of boxcut area – Bulldozer clearing vegetation and topsoil
- Excavator loading topsoil/softs on LHD trucks for removal to stockpiles
- Drilling of the interburden
- LHD trucks idling near excavation activities
- LHD truck offloading softs at a number of stockpiles
- General noise for a number of construction activities
- Diesel generator operating in vicinity of general construction activities
- General noise in areas where the plant, offices and workshops are to be constructed
- TLB digging foundations for the conveyor belt
- 12 light and 12 heavy vehicles traveling between the various activities at an average speed of 60 km/h.

The input variables will be selected to represent a worse-case scenario, with little mitigation measures implemented. All equipment is operating under full load and all activities taking place simultaneously at a number of locations close to the community (worst case scenario). The potential shielding that other buildings may provide is not considered. Atmospheric conditions would be ideal for sound propagation (50% humidity and 25^o C) with a slight south south-easterly wind. Ambient sound levels were assumed to be 30 dBA (quiet rural area). While certain receptors may be relocated this will not be considered in this report.

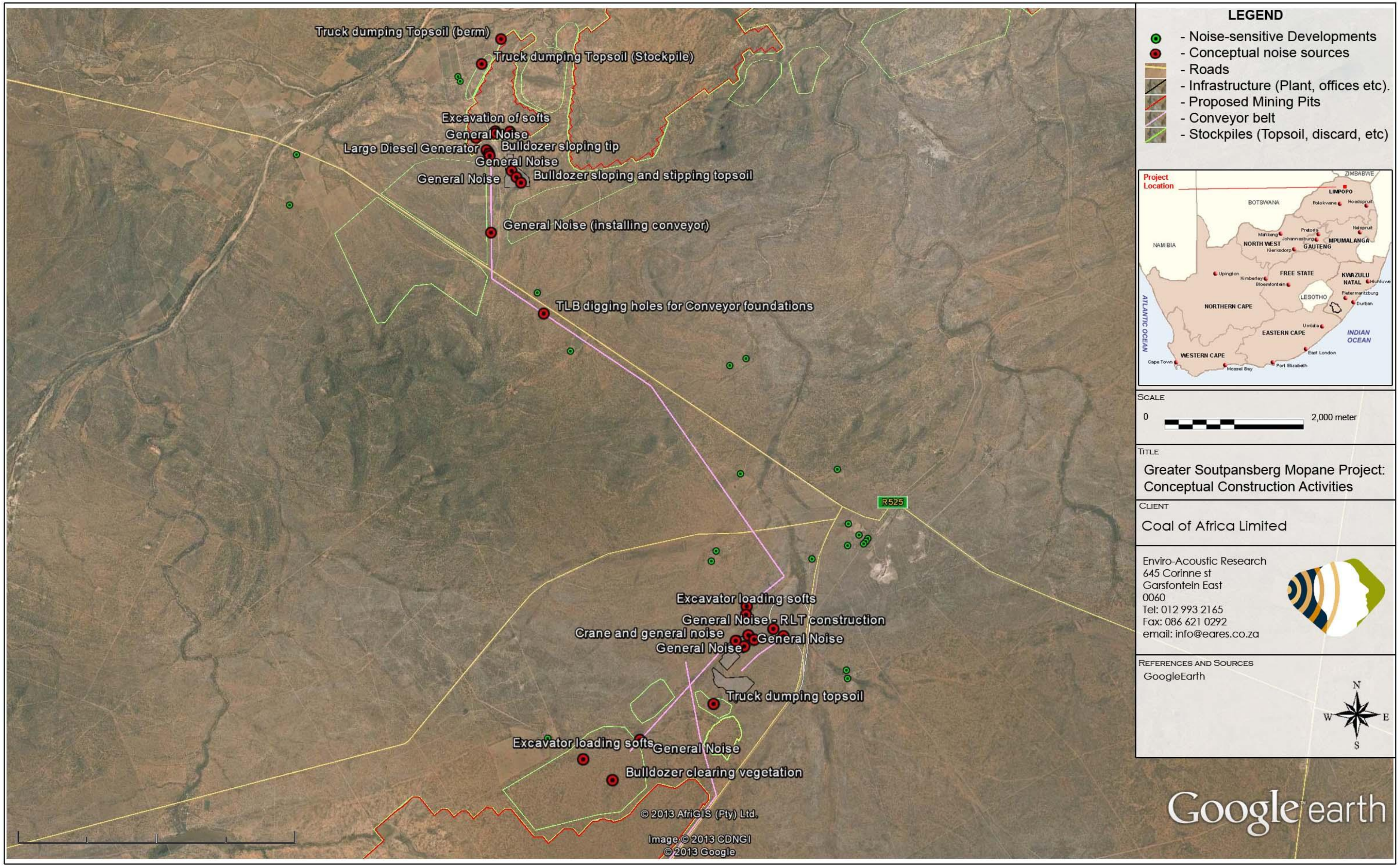

Figure 7-1: Conceptualised locations of noisy construction activities – larger site

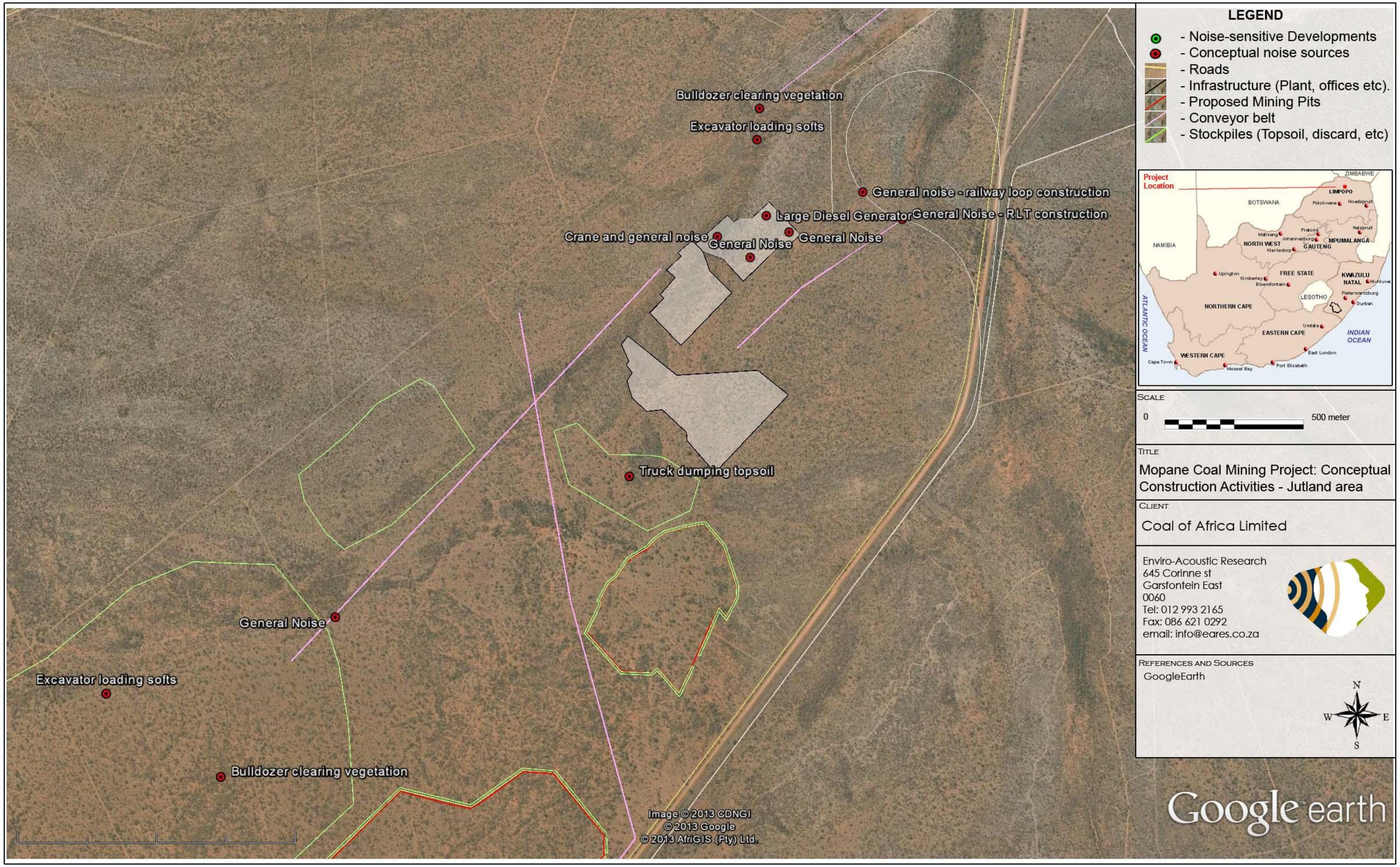

Figure 7-2: Conceptualised locations of noisy construction activities – Jutland area

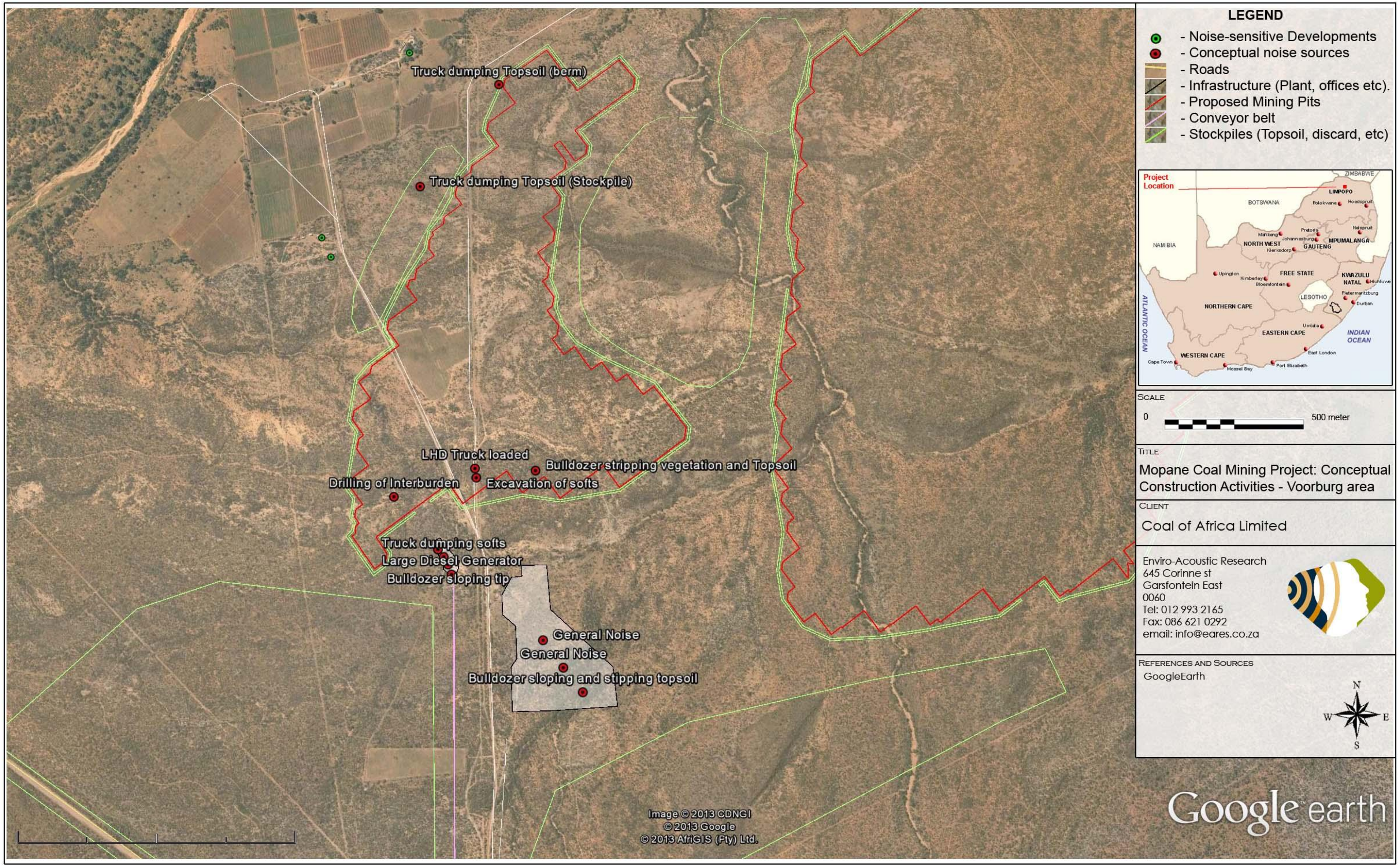

Figure 7-3: Conceptualised locations of noisy construction activities – Voorburg area

7.1.2 Results: Construction Phase

The scenario as defined in **section 4.2.1** and **7.1.1** were modelled to calculate the projected ambient noise levels. The sound power levels used in this modelling is presented in **Table 7-1**. The worst-case scenario is assumed and the noise contours will be applicable for both the day- and night-time periods (up to the 45 dBA contour for daytime and 35 dBA for the night-time period). A potential worst case scenario is presented with all activities taking place simultaneously during a slight south south-easterly wind in good sound propagation conditions (25^{o} C and 50% humidity). These noise contours are illustrated in **Figure 7-6**.

Table 7-1: Sound power emission levels used in modelling

Equipment	Sound power level, dB re1 pW, in octave band, Hz							SPL
process	63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	(dBA)
Bulldozer CAT D10	118.3	115.2	111	109.1	107.5	103	97	111.9
Bulldozer CAT D11	121.2	112.2	111.4	110.9	110.4	101.5	93.7	113.3
Crane	89	98	101	103	102	102	98	107.5
Drilling Machine	107.2	109.4	109.2	106.1	104.7	101.2	99.8	109.6
Dumper/Haul truck - Terex 30 ton	102.4	105.3	108.9	108.8	108.2	105.1	99.2	112.2
Excavator - Hitachi EX1200	112.9	114.3	116.7	107.9	107.6	102.9	102.5	113.1
General noise	95	100	103	105	105	100	100	108.8
JBL TLB	101	105	104	105.5	104.5	101	99	108.8
Water Dozer, CAT	112.9	114.5	111.5	109.7	108.4	107.2	104	113.8

Due to the inter-dependence on the construction requirements it is unlikely that all construction activities would be taking place simultaneously, but it is definite that a number of different construction activities would be taking place at the same time. The potential impact of three noise sources operating at one location (108 dBA sound power emission level for a bulldozer) was modelled to allow for the identification of potential issues. The modelled noise level (for 3 bulldozers operating) was plotted over distance (see **Figure 7-4**) together with the noise levels as calculated for the conceptual scenario. Noise due to linear activities (roads) were also evaluated and plotted as illustrated in **Figure 7-5**.

Based on **Figure 7-4**, if these noisy activities takes place within approximately

- 200 meters from a noise-sensitive receptor the noise level will exceed the daytime rating levels for an urban area (see **Table 5-1** for SANS 10103:2008 noise district rating levels);
- 300 meters from a noise-sensitive receptor the noise level will exceed the daytime rating levels for a sub-urban area;

- 500 meters from a noise-sensitive receptor the noise level will exceed the daytime rating levels for a rural area or the night-time (if there are night-time construction activities) rating level for an urban area;
- 800 meters from a noise-sensitive receptor the noise level will exceed the night-time (if there are night-time construction activities) rating level for an sub-urban area;
- 1 200 meters from a noise-sensitive receptor the noise level will exceed the night-time (if there are night-time construction activities) rating level for an rural area;

In reality, cumulative effects from a number of noisy activities taking place simultaneously could double these distances (refer also to **Figure 7-4**).

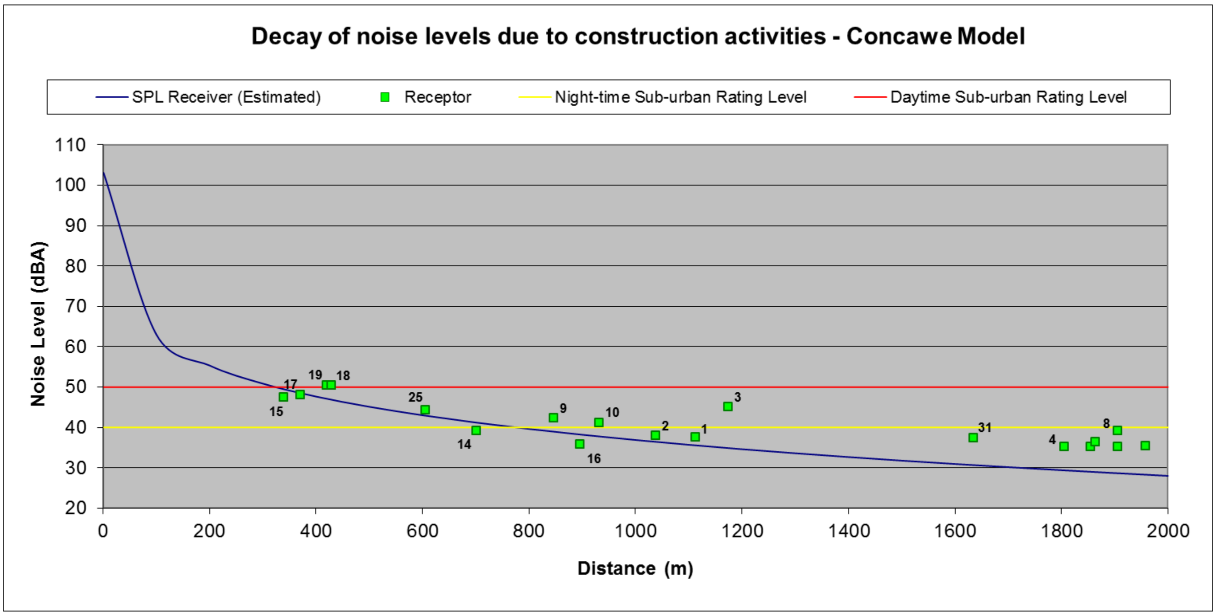

Figure 7-4: Construction noise: Projected Construction Noise Levels as distances increase between NSDs and locations where construction can take place – illustrative scenario

Similarly, considering on **Figure 7-5**, if there are a noise-sensitive receptor within approximately -

- 8 meters from a road the noise level will exceed the daytime rating levels for an urban area (see **Table 5-1** for SANS 10103:2008 noise district rating levels);
- 40 meters from a road the noise level will exceed the daytime rating levels for a sub-urban area;
- 70 meters from a road the noise level will exceed the daytime rating levels for a rural area or the night-time (if there are night-time construction activities with the projected traffic volume) rating level for an urban area;
- 100 meters from a road the noise level the will exceed the night-time (if there are night-time construction activities) rating level for an sub-urban area;

- 230 meters from a road the noise level the will exceed the night-time (if there are night-time construction activities) rating level for an rural area;

More importantly are the prevailing ambient sound levels surrounding this receptor. A receptor used to ambient sound levels less than 30 dBA (very quiet) could experience noise levels of approximately 40 dBA (2 000 meters downwind from such noisy activities) due to the addition of the noisy activities. This is more than 7 dB higher than the prevailing ambient sound level, it will be highly detectable and the receptor may find this noise disturbing and complain (see **Figure 5-2**). However, a receptor staying only 500 meters from such a noisy activity may be used to higher noise levels (due to other sources such as animals, road traffic, etc), e.g. 50 dBA. The addition of the new noise sources may in such a case not even be detected by this receptor. As discussed in **section 5.1**, the attitude of a receptor with regards to the developer is a significant determinant on their acceptance levels with increased noise levels.

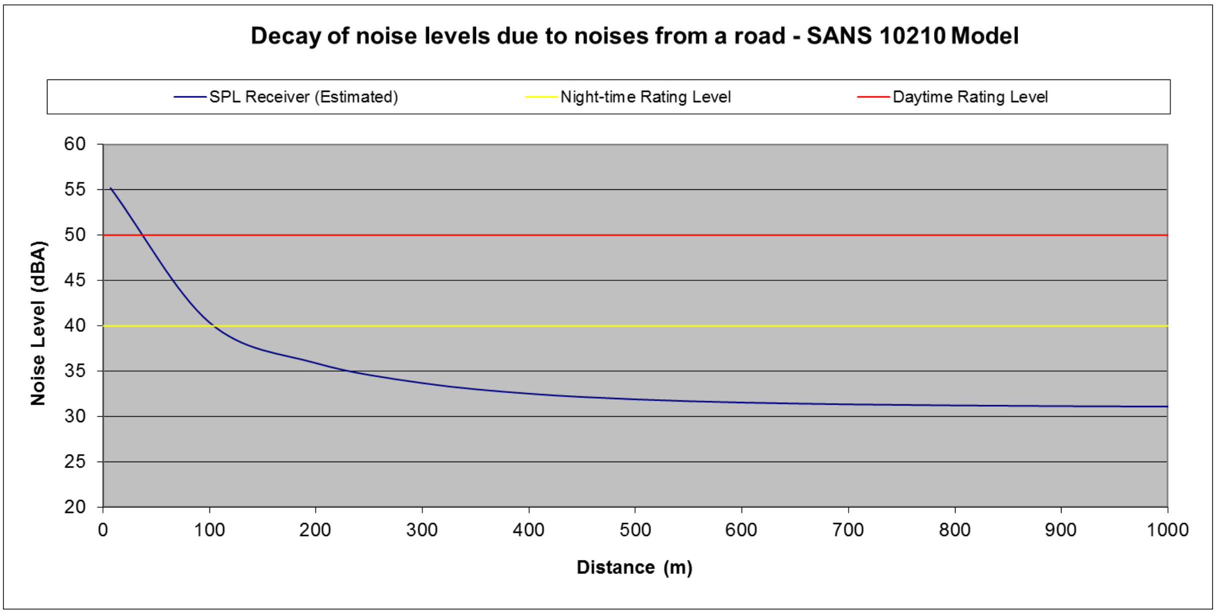

Figure 7-5: Construction noise: Projected Road Traffic Noise Levels as distances increase between a conceptual NSD and road (carrying 12 light and 12 heavy vehicles per hour travelling at 60 km/hr on a gravel road)

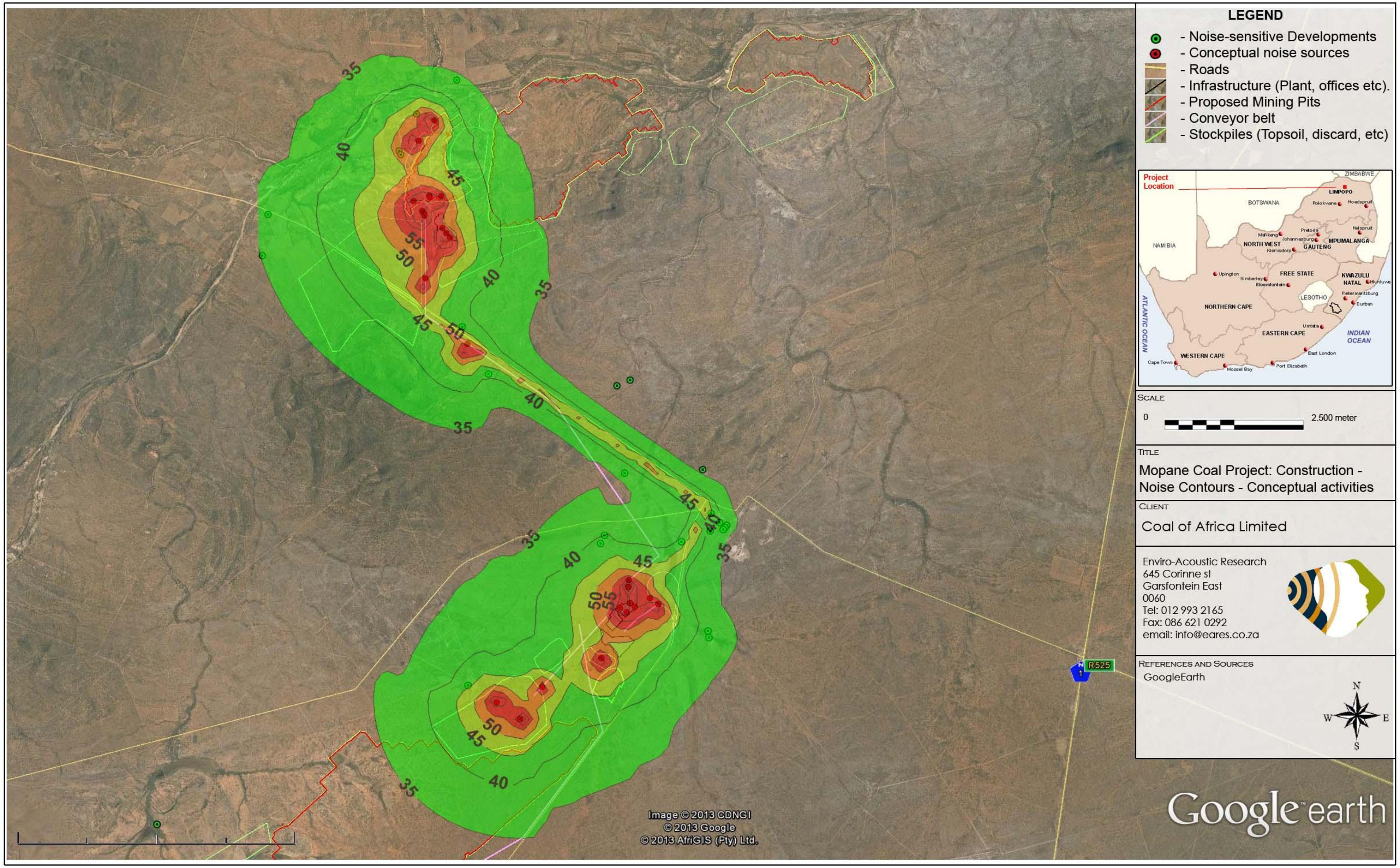

Figure 7-6: Projected Construction Noise Levels in contours of equal sound levels

7.1.3 Impact Assessment: Construction Phase

Daytime noise impact:

Based on the preceding figures, if construction activities are taking place closer than 500 meters (300 meters for sub-urban and 500 for rural district) from the potential noise-sensitive receptor noise levels could exceed the respective daytime rating levels. Equivalent daytime ambient sound levels were measured around between 43 – 64 dBA, ranging between 22 and 75 dBA (10-minute measurements) and the projected noise levels could change ambient sound levels with more than 7 dBA within 500 meters from the noisy activities at times.

Table 7-2: Impact Assessment: Daytime Construction Activities

Nature:	***Noise impact at the surrounding communities (refer Table 5-2, Table 5-3, Table 5-4 and Table 5-5)***
Acceptable Rating Level	Sub-urban area: 50 dBA outside during day (***L_{Req} = 50 dBA)*** Rural area: 45 dBA outside during day (***L_{Req} = 45 dBA)***
Extent ($\Delta L_{Aeq,d}$>7dBA)	Noises will impact on the ambient noise levels of the neighbouring area and community (sub-urban district). **Local** (2) Noises will impact on the ambient noise levels of a rural neighbouring area and community. **Regional** (3)
Duration	Activities in the vicinity of the receptors could last up to the duration of the construction period, but mostly for a portion of the construction period **Short term** (2)
Magnitude / Severity ($L_{A(calculated)}$> L_{Req})	*Estimated noise level ($L_{Aeq,D}$) higher than daytime rating level ($L_{Req,D}$) and $\Delta L_{Aeq,D}$ > 7 dBA for closest NSDs (refer **Figure 7-6**)* **High** (8)
Activity Probability	*The projected noise levels will be higher than the measured ambient sound levels, the Sub-urban as well as the Rural Rating Levels during periods that construction activities takes place close to receptors* **Highly Likely** (4)
Significance – Sub-urban	**48 (Moderate)**
Significance – Rural	**52 (Moderate)**
Status	Negative
Reversibility	High
Comments	-
Can impacts be mitigated?	Yes, see **section 8.1**.
Mitigation:	See, **section 8.1**.
Cumulative impacts:	This impact is cumulative with existing ambient sounds as well as other noisy activities taking place in area.
Residual Impacts:	This impact will disappear once construction activities are completed.

Night-time noise impact:

Based on the preceding figures, if construction activities are taking place closer than 1 200 meters (800 meters for sub-urban and 1 200 for rural district) from the potential noise-sensitive receptor noise levels could exceed the respective night-time rating levels. Equivalent night-time ambient sound levels were measured around between 33 – 64 dBA, ranging between 19 and 75 dBA (10-minute measurements) and the projected noise levels could change ambient sound levels with more than 7 dBA within 1 500 meters from the noisy activities at times.

Table 7-3: Impact Assessment: Night-time Construction Activities

Nature:	***Noise impact at the surrounding communities*** ***(****refer Table 5-2, Table 5-3, Table 5-4 and Table 5-5****)***
Acceptable Rating Level	Sub-urban area: 40 dBA outside at night (***L_{Req} = 40 dBA)*** Rural area: 35 dBA outside at night (***L_{Req} = 35 dBA)***
Extent ($\Delta L_{Aeq,n}$>7dBA)	Noises will impact on the ambient noise levels of the neighbouring area and community - both a rural and sub-urban district rating levels. **Regional** (3)
Duration	Activities in the vicinity of the receptors could last up to the duration of the construction period, but mostly for a portion of the construction period **Short term** (2)
Magnitude / Severity ($L_{A(calculated)}$> L_{Req})	*Estimated noise level ($L_{Aeq,n}$) higher than night-time rating level ($L_{Req,n}$) and $\Delta L_{Aeq,n}$ > 10 dBA for NSDs within 1 500 meters from activities (refer* ***Figure 7-6****)* **Very High** (10)
Activity Probability	*The ambient noise levels will be significantly higher than the measured ambient sound levels as well as the Rural Rating Level at all receptors within 1 500 meters from the activities.* **Definite** (5)
Significance	**75 (High)**
Status	Negative
Reversibility	High
Comments	-
Can impacts be mitigated?	Yes, see **section 8.1**.
Mitigation:	See, **section 8.1**.
Cumulative impacts:	This impact is cumulative with existing ambient sounds as well as other noisy activities taking place in area.
Residual Impacts:	This impact will disappear once construction activities are completed.

7.2 RESULTS: OPERATIONAL PHASE

The mining plan as received from the client was reviewed and potential locations where noisy activities may take place identified. Two distinctive phases will be discussed in this section, namely;

- the operation of the opencast section (just after the construction phase, year 2019 – mining activities at Voorburg and plant activities at Jutland) – this is the worst-case scenario as future mining activities actually moves away from the receptors; and
- the operation of the opencast section (year 2030 - mining activities at both Voorburg and Jutland as well as plant activities at Jutland).

7.2.1 Operation of the Opencast – year 2019

Layout as conceptualised and modelled is presented in **Figure 7-7** (more detailed conceptual activities in **Figure 7-8** and **Figure 7-9**). The sound power emission levels used for modelling are presented in **Table 7-4**.

Because of the various potential activities that could take place during the operational phase, a conceptual worse-case scenario was considered including:

- Various mining activities (Excavation and loading of coal, interburden and overburden; Drilling activities – at Voorburg Section only)
- Tipping activities at material tip (tipping; crushing; material handling);
- Material handling – hauling of waste rock to stockpiles;
- Transfer of coal via conveyor belt system to the plant at Jutland;
- Various plant activities at the Jutland Section (material handling; feed screens; beneficiation [high gravity, low gravity and fines]; discard disposal; material handling);
- Activities at the Rapid Load Out Terminal (diesel locomotive idling; material handling).

<u>Impact Assessment: Operational Phase</u>

As the ambient sound levels are generally lower at night, increased noises coupled with more stable atmospheric conditions creates situations where noise can be heard over long distances. This, coupled with the lower rating level, makes the night-time period ideal to evaluate the potential noise impact.

Table 7-4: Sound power emission levels used in modelling – 2019

Equipment	Sound power level, dB re1 pW, in octave band, Hz							SPL
process	63	125	250	500	1000	2000	4000	(dBA)
Bulldozer CAT D10	118.3	115.2	111	109.1	107.5	103	97	111.9
Bulldozer CAT D11	121.2	112.2	111.4	110.9	110.4	101.5	93.7	113.3
Coal crushing plant (50 k tons)	110.6	111.2	110.9	111.2	110.8	107	100.6	114.5
Coal beneficiation plant	110.9	107.2	108.9	105.2	103.2	96.2	91.1	107.5
Coal silo (Material Transfer)	111.6	104.1	105.2	102.2	97.1	91.3	87.9	103.2
Coal Yard Equipment	110	107	104	105	101	99	96	106.8
Conveyor Transfer points	98.3	97.3	97.5	96.7	95.1	90.9	87.6	99.4
Coal Screen	103.5	101.1	102.1	101.5	99.9	98.8	94.3	105.1
Diesel loco moving	80.1	102.1	106.6	111.1	95.9	92.8	76.1	108.7
Drilling Machine	107.2	109.4	109.2	106.1	104.7	101.2	99.8	109.6
Dumper/Haul truck - CAT 700	107.9	113.2	116.9	114.4	110.6	106.8	100.2	115.9
Excavator - Hitachi EX1200	112.9	114.3	116.7	107.9	107.6	102.9	102.5	113.1
FEL (988)	105	117	113	114	111	107	101	115.6
Feed Screen	106	108.9	107.7	109	109.2	109	107.1	114.8
Grader	100	111	108	108	106	104	98	110.9
Water Dozer, CAT	112.9	114.5	111.5	109.7	108.4	107.2	104	113.8

Night-time noise impact:

Considering the noise contours illustrated in **Figure 7-10** (mitigation effect due to stockpiles acting as barriers included) an area up to 700 meters can be impacted (downwind from mining activities, behind barrier) as mining activities can raise noise levels to exceed a night-time rating level of 40 dBA.

Night-time rating levels of 40 dBA can also be impacted by increased noises approximately 2 000 meters from the material tip (areas with a direct line of sight to the material tip [no barriers, downwind]. Similarly, an area up to 1 700 meters downwind from the plant may be influenced.

Night-time equivalent ambient sound levels were measured between 33 and 64 dBA, with 10-minutes measurements ranging between less than 20 to 73 dBA. Because of the relationship between change in ambient sound levels and the prevailing ambient sound level it is difficult to accurately estimate the potential extent of this noise impact. Based on ambient sound levels of 35 dBA (typical for a quiet rural area) the projected noise levels could change ambient sound levels with more than 7 dBA within approximately 1 600 meters from the noisy activities (no noise mitigation such as a berm or stockpile).

Table 7-5: Impact Assessment: Night-time Operations – Year 2019 mining

Nature:	***Noise impact at the surrounding communities*** ***(****refer Table 5-2, Table 5-3, Table 5-4 and Table 5-5****)***
Acceptable Rating Level	Sub-urban area: 40 dBA outside at night (***L_{Req} = 40 dBA)*** Rural area: 35 dBA outside at night (***L_{Req} = 35 dBA)***
Extent ***($\Delta L_{Aeq,n}$>7dBA)***	Noises will impact on the ambient noise levels of a rural neighbouring area and community – further than 1 000 meters from activity. **Regional** (3)
Duration	Activities in the vicinity of the receptors could last the direction of the operational phase **Long term** (4)
Magnitude / Severity ***($L_{A(calculated)}$> L_{Req})***	*Estimated noise level ($L_{Aeq,n}$) higher than night-time rating level ($L_{Req,n}$) and $\Delta L_{Aeq,n}$ > 10 dBA for NSDs within 1 500 meters from activities during quiet time periods (refer* ***Figure 7-10****)* **Very High** (10)
Activity Probability	*Excluding all receptors living on, or within approximately 100 meters from the footprint of the mining activities, there are no receptors living within the 45 dBA contours (International night-time guideline level). Night-time equivalent ambient sound levels were measured between 33 and 64 dBA, with 10-minutes measurements ranging between less than 20 to 73 dBA. The noises from the activity would be audible to receptors within 4 000 meters during the quietest times, but unlikely to be considered a disturbing noise. The ambient noise levels will be higher than the measured ambient sound levels as well as the Sub-Urban Rating Level at receptors within approximately 1 000 meters from mining activities and 300 meters from the conveyor belt at times.* **Possible** (2)
Significance	**34 (Moderate)**
Status	Negative
Reversibility	High
Comments	-
Can impacts be mitigated?	Yes, see **section 8.2**.
Mitigation:	See, **section 8.2**.
Cumulative impacts:	This impact is cumulative with existing ambient sounds as well as other noisy activities taking place in area.
Residual Impacts:	This impact will disappear once operational activities cease.

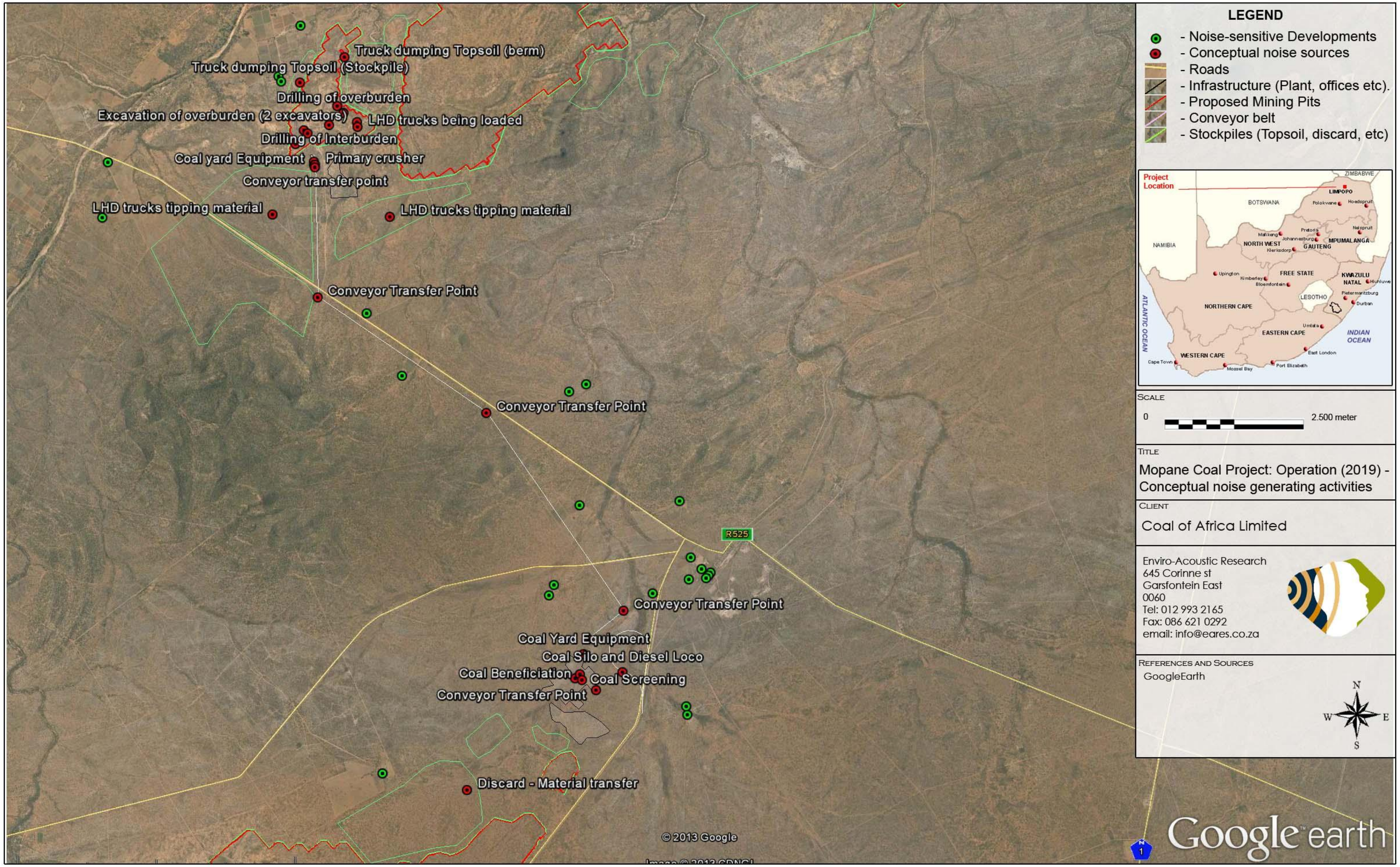

Figure 7-7: Operational phase – First year of operation, conceptual activities: Overview

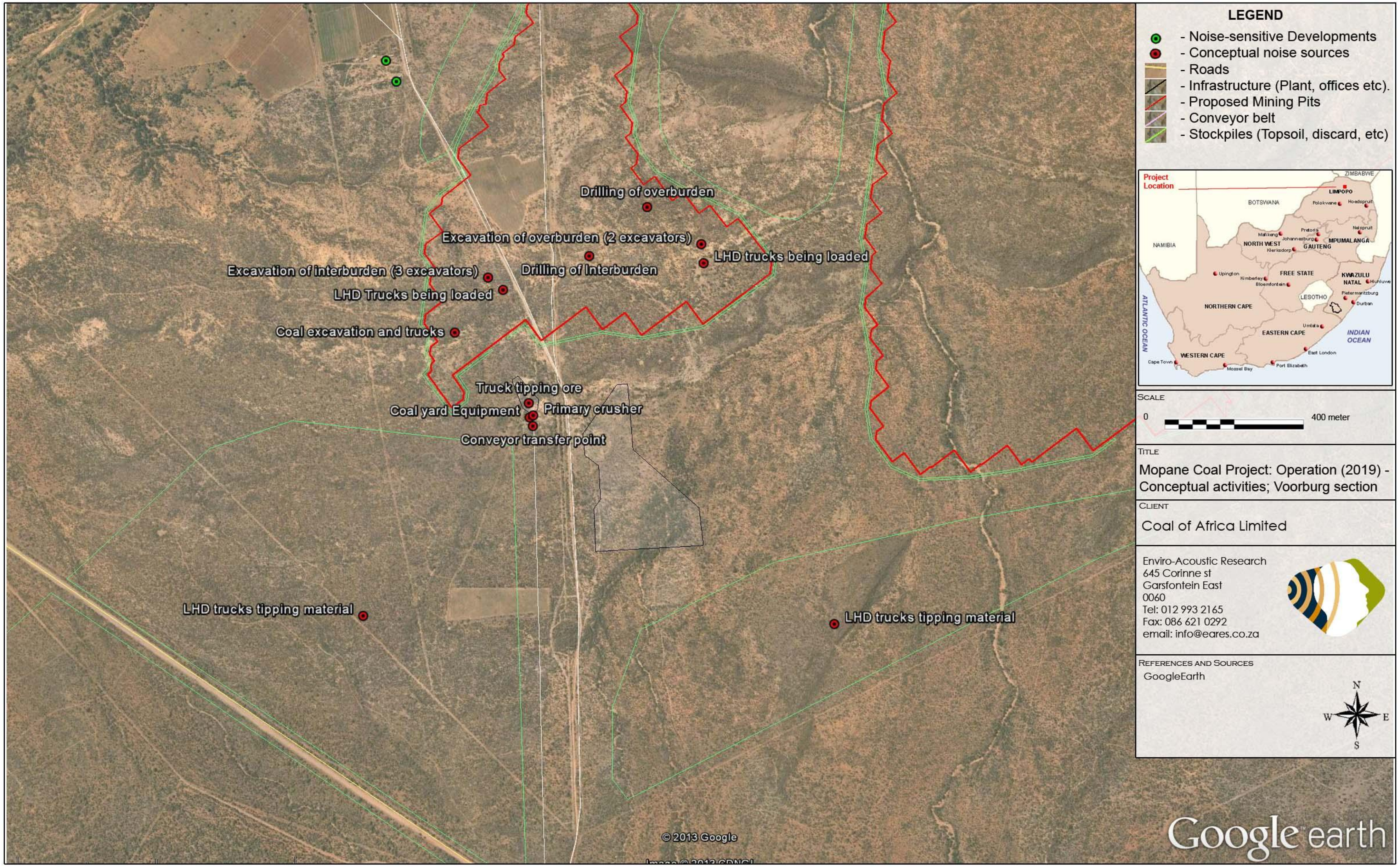

Figure 7-8: Operational phase – First year of operation, conceptual activities: Voorburg Section

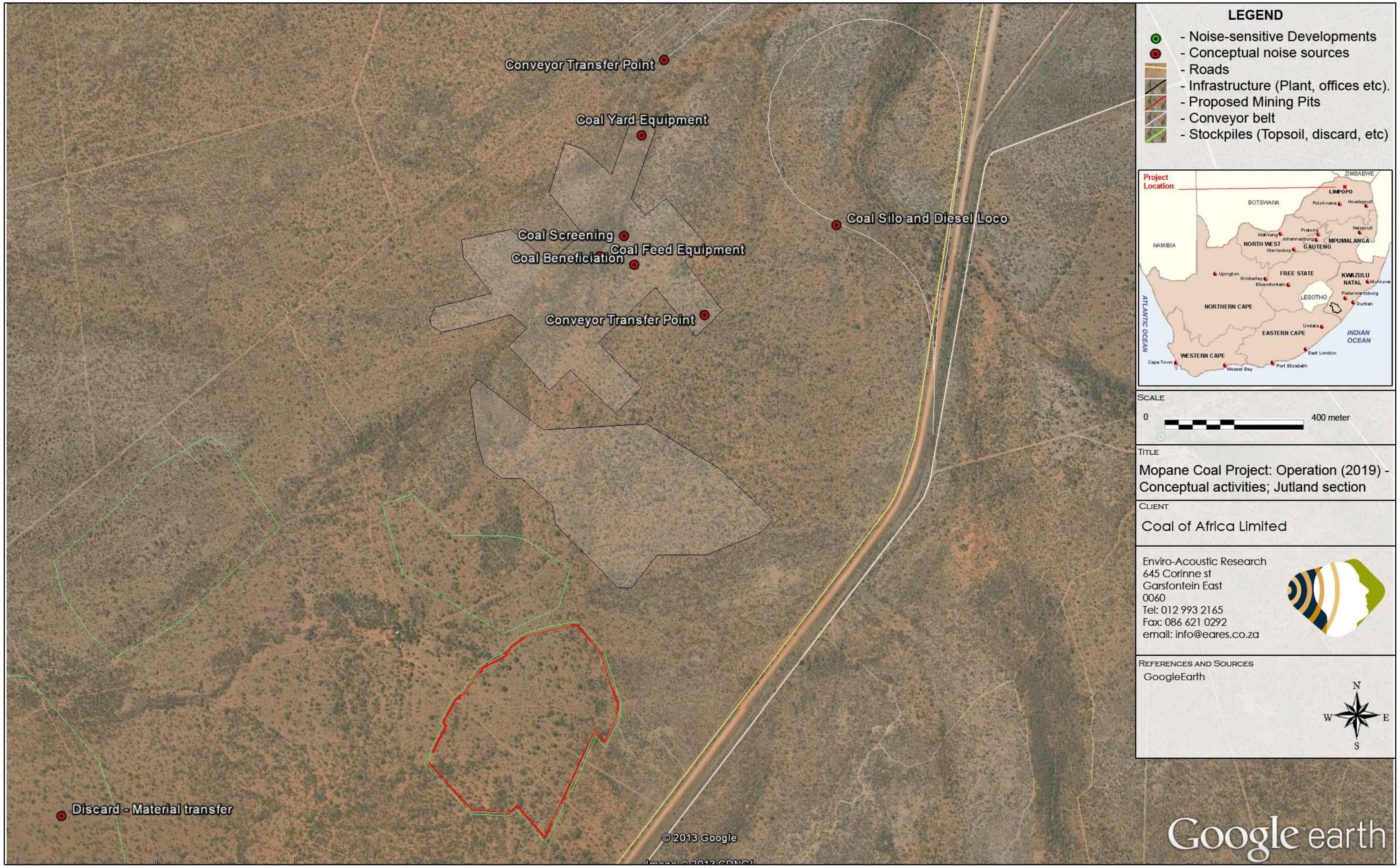

Figure 7-9: Operational phase – First year of operation, conceptual activities: Jutland Section

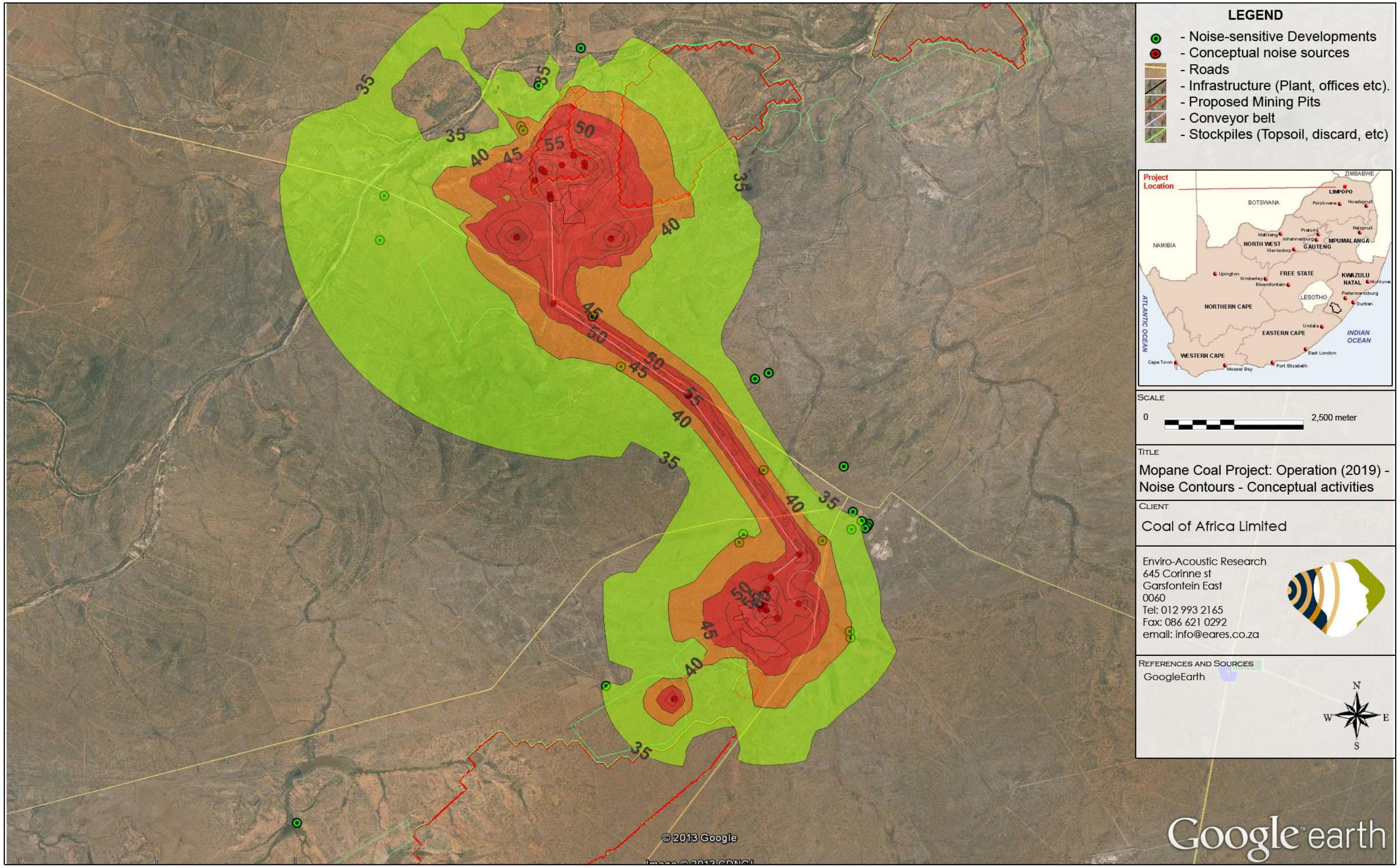

Figure 7-10: Night-time operations: Projected noise contours – Start of mining operations

7.2.2 Operation of the Opencast - 2030 (mining at Voorburg and Jutland Sections)

Layout as conceptualised and modelled is presented in **Figure 7-11**. The sound power emission levels used for modelling are presented in **Table 7-4**.

Because of the various potential activities that could take place during the operational phase, a conceptual worse-case scenario was considered including:

- Various mining activities (Excavation and loading of coal, interburden and overburden; Drilling activities – at Voorburg Section)
- Various mining activities (Excavation and loading of coal, interburden and overburden; Drilling activities – at Jutland Section)
- Tipping activities at material tip (tipping; crushing; material handling);
- Material handling – hauling of overburden/interburden to old mining area;
- Transfer of coal via conveyor belt system to the plant at Jutland;
- Various plant activities at the Jutland Section (material handling; feed screens; beneficiation [high gravity, low gravity and fines]; discard disposal; material handling [Front End Loader]);
- Activities at the Rapid Load Out Terminal (diesel locomotive idling; material handling).

<u>Impact Assessment: Operational Phase (2030)</u>

As the ambient sound levels are lower at night, increased noises coupled with more stable atmospheric conditions creates situations where noise created at night can be heard over long distances. This, coupled with the lower rating level, makes the night-time period ideal to evaluate the potential noise impact.

Night-time noise impact:

Considering the noise contours illustrated in **Figure 7-14** (mitigation effect due to stockpiles acting as barriers included) an area up to 1 100 meters can be impacted (downwind from mining activities, behind barrier) as mining activities can result in noise levels exceeding a night-time rating level of 40 dBA.

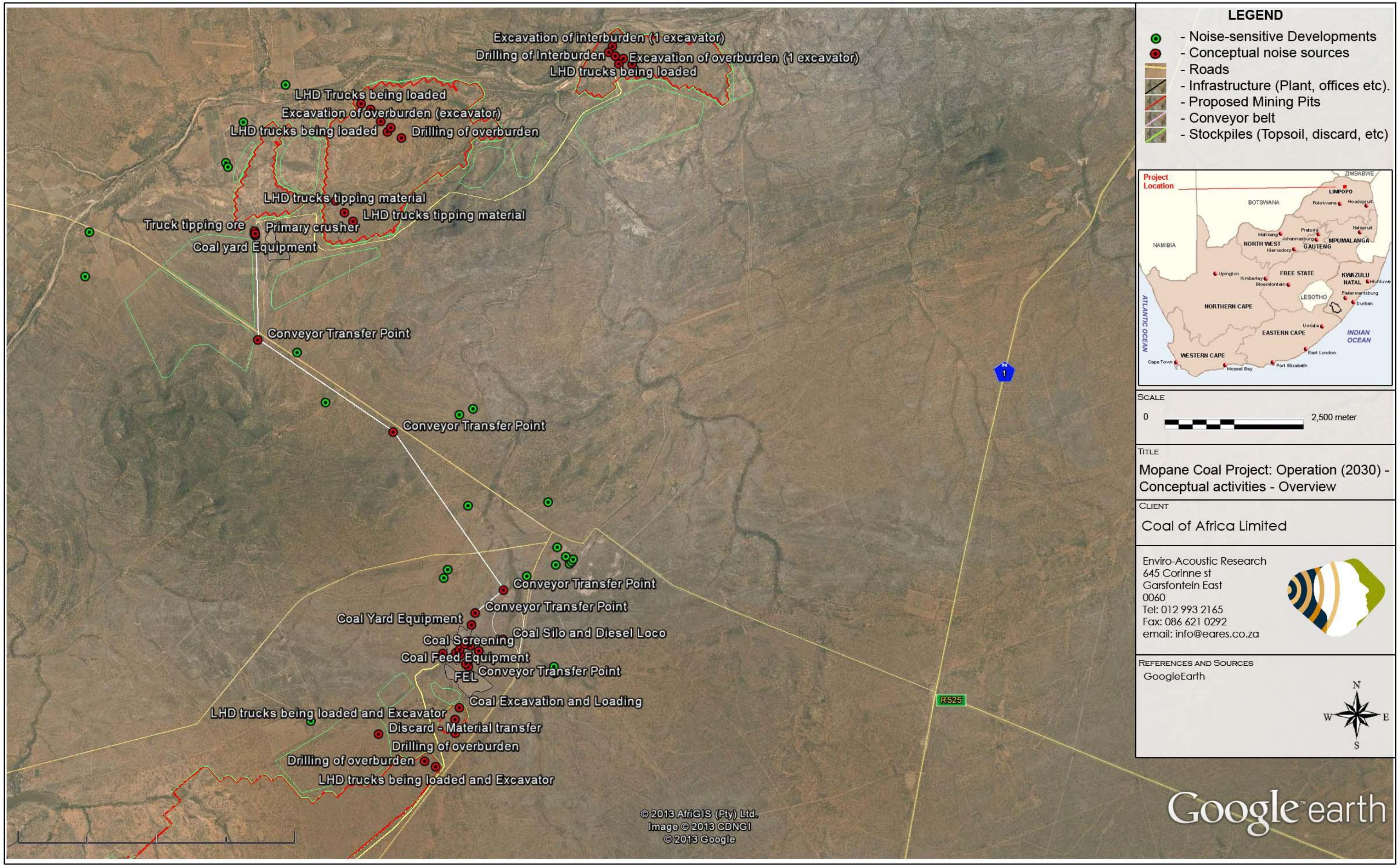

Figure 7-11: Operational phase – Year 2030, conceptual activities: Overview

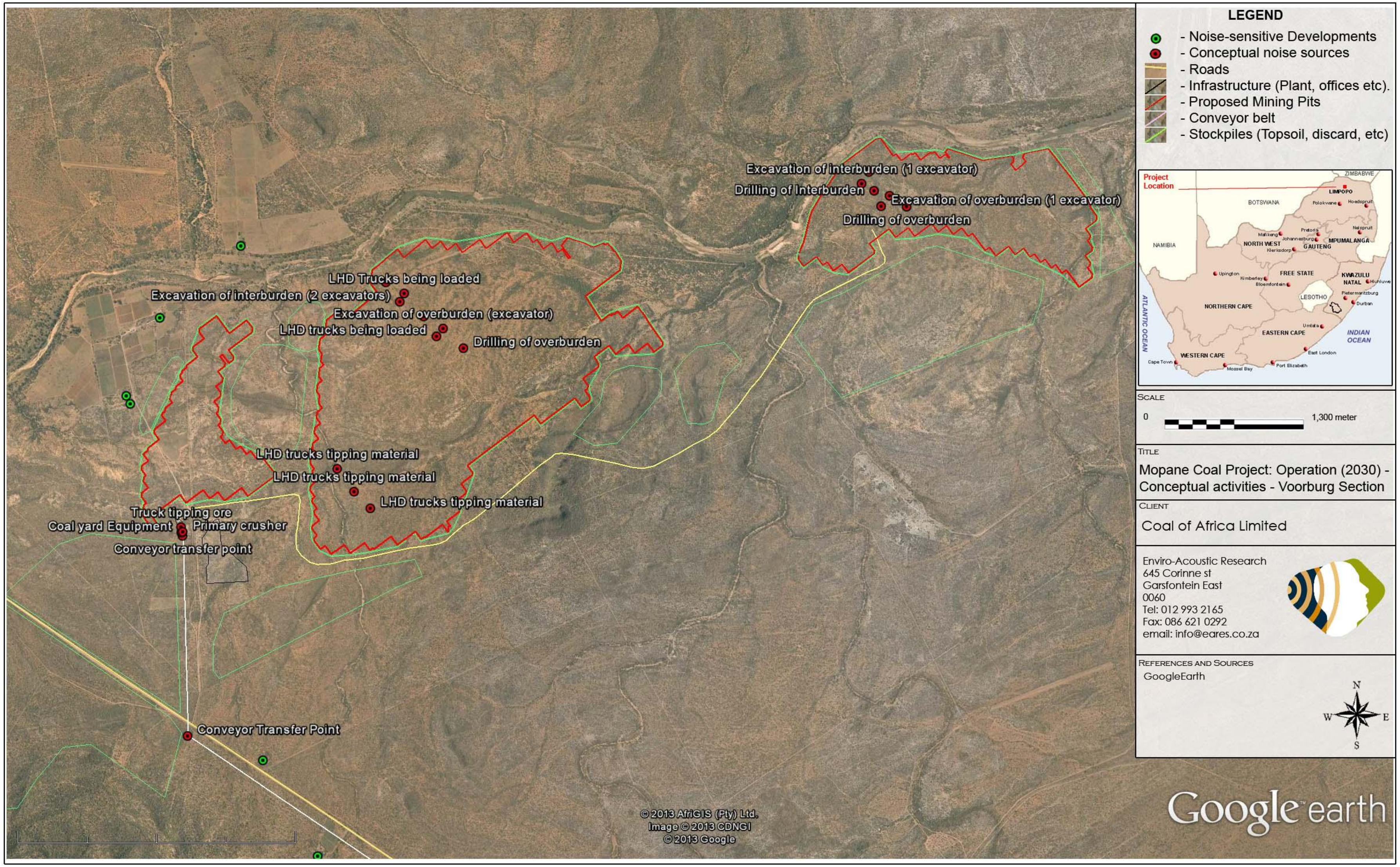

Figure 7-12: Operational phase – Year 2030, conceptual activities: Voorburg Section

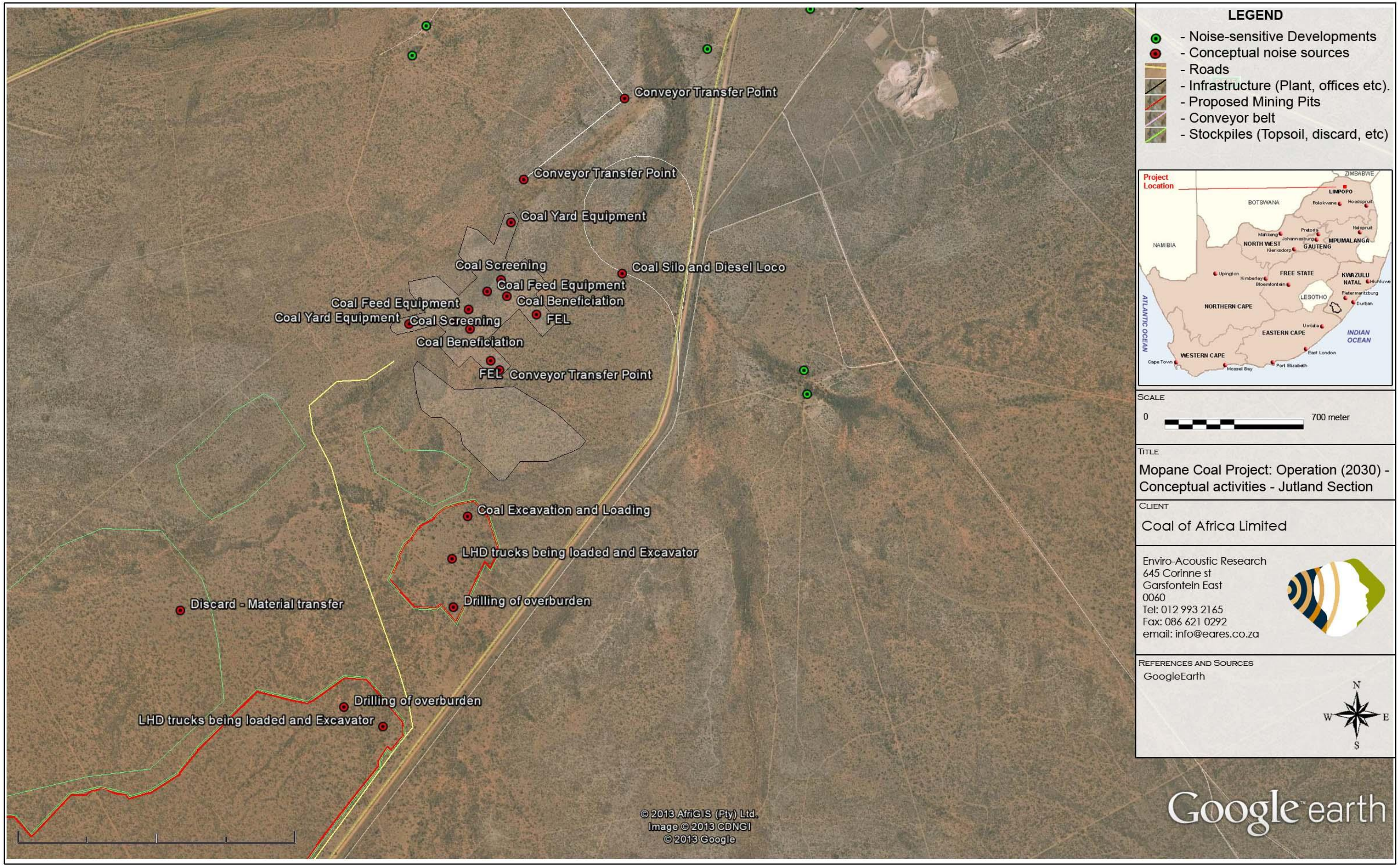

Figure 7-13: Operational phase – Year 2030, conceptual activities: Jutland Section

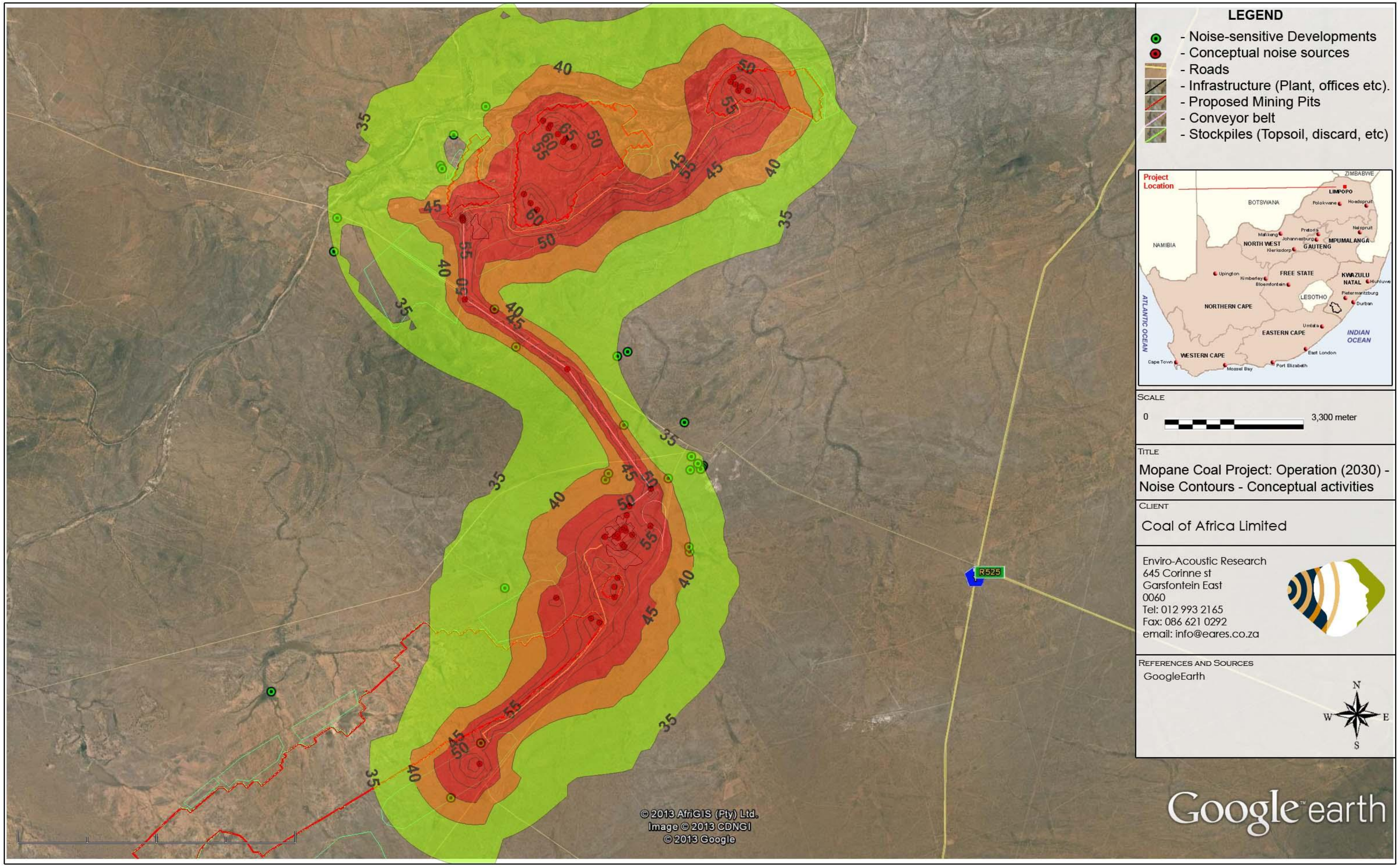

Figure 7-14: Night-time operations: Projected noise contours – Year 2030 mining operations

Night-time rating levels of 40 dBA can be exceeded by increased noises approximately 1 900 meters from the material tip (areas with a direct line of sight to the material tip [no barriers, downwind]). Similarly, an area up to 2 000 meters downwind from the plant may be influenced (no barriers, downwind).

Night-time equivalent ambient sound levels were measured between 33 and 64 dBA, with 10-minutes measurements ranging between less than 20 to 73 dBA. Because of the relationship between change in ambient sound levels and the prevailing ambient sound level it is difficult to accurately estimate the potential extent of this noise impact. Based on ambient sound levels of 35 dBA (typical for a quiet rural area) the projected noise levels could change ambient sound levels with more than 7 dBA within approximately 1 600 meters from the noisy activities (with no noise mitigation such as a berm or stockpile).

Table 7-6: Impact Assessment: Night-time Operational Activities – Year 2030

Nature:	***Noise impact at the surrounding communities*** ***(****refer Table 5-2, Table 5-3, Table 5-4 and Table 5-5****)***
Acceptable Rating Level	Sub-urban area: 40 dBA outside at night (***L_{Req} = 40 dBA)*** Rural area: 35 dBA outside at night (***L_{Req} = 35 dBA)***
Extent (Δ$L_{Aeq,n}$>7dBA)	Noises will impact on the ambient noise levels of a rural neighbouring area and community – further than 1 000 meters from activity. **Regional** (3)
Duration	Activities in the vicinity of the receptors could last the direction of the operational phase **Long term** (4)
Magnitude / Severity ($L_{A(calculated)}$> L_{Req})	*Estimated noise level ($L_{Aeq,n}$) higher than night-time rating level ($L_{Req,n}$) and Δ$L_{Aeq,n}$ > 10 dBA for NSDs within 1 500 meters from activities (refer* ***Figure 7-6****)* **Very High** (10)
Activity Probability	*Excluding all receptors living on, or within approximately 100 meters from the footprint of the mining activities, there are no receptors living within the 45 dBA contours (International night-time guideline level). Night-time equivalent ambient sound levels were measured between 33 and 64 dBA, with 10-minutes measurements ranging between less than 20 to 73 dBA. The noises from the activity would be audible to receptors within 4 000 meters during the quietest times, but unlikely to be considered a disturbing noise. The ambient noise levels will be higher than the measured ambient sound levels as well as the Sub-Urban Rating Level at receptors within approximately 1 000 meters from mining activities and 300 meters from the conveyor belt at times.* **Possible** (2)
Significance	**34 (Moderate)**
Reversibility	High
Comments	-
Can impacts be mitigated?	Yes, see **section 8.2**.
Mitigation:	See, **section 8.2**.
Cumulative impacts:	This impact is cumulative with existing ambient sounds as well as other noisy activities taking place in area.
Residual Impacts:	This impact will disappear once operational activities cease.

8 MITIGATION OPTIONS

8.1 CONSTRUCTION PHASE

It will be assumed that all receptors staying on, or within a 100 meter distance from any mining activity will be relocated. This would include receptors such as NSD22, NSD23, NSD27, NSD28 and potentially NSD26 (refer also **Figure 1-4**).

The projected noise impact from the construction activities would be limited to the site and surrounding area. Due to the proximity of receptors to the proposed activities it is highly likely (daytime) to definite (night-time) that potential noise-sensitive developments will experience a noise impact with a magnitude higher than the Rural to Sub-urban Rating Level when heavy equipment operate within a distance of 800 meters from receptors (night-time).

The significance of the noise impact would be moderate for daytime activities and high for night-time activities. Mitigation measures are highlighted for the developer, operators and contractors.

Projected daytime noise levels are within the guideline levels as defined by the International Finance Corporation's Environmental, Health and Safety (EHS) Guidelines (see **Table 2-1**), but should night-time activities take place will exceed their night-time guidelines.

Mitigation options included both management measures as well as technical changes. Management options to reduce the noise impact during the construction phase include:

- Ensure a good working relationship between the mining management and all potentially sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them. Information that should be provided to the potentially sensitive receptor(s) include:
    - Proposed working times,
    - how long the activity is anticipated to take place,
    - what is being done, or why the activity is taking place, and
    - contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- When noisy activities are to take place very close to potentially sensitive receptors (development of access routes, security fencing or other

infrastructure closer than 500 meters from a receptor), co-ordinate the working time with periods when the receptors are likely not to be at home. An example would be to work within the 8 am to 2 pm time-slot to minimise the significance of the impact because:
    - Potentially receptors are most likely at school or at work, minimizing the probability of an impact happening.
    - Normal daily activities will generate other noises that would most likely mask construction noises, minimizing the probability of an impact happening.
- Berms and stockpiles with a potential to act as a noise barrier should be constructed as soon as possible. This construction activities should preferably only take place during the daytime period up to the point where these berms or stockpiles can act as a noise barrier for potential night-time activities;
- Minimize equipment or activities at high levels, such as the development of the material tip being significantly higher than the surrounding landscape. It limits the mitigation of this noise using berms or barriers. The developer may consider keeping the material tip at ground height or even slightly below ground level;
- The can consider relocating the material tip slightly to the south, or constructing the non-carbonaceous in such a manner to provide more shielding to NSD20 and NSD21;
- Minimize any work that needs to take place at night. Night-time construction work should be limited to localities that are further than;
    - 2 000 meters from a noise-sensitive community when there is a direct line of sight (no barrier between the activity and receptor).
    - 1 000 meters from a noise-sensitive community when there exist a barrier between the activity and receptor.

Technical solutions to reduce the noise impact during the construction phase include:

- Using the smallest/quietest equipment for the particular purpose.
- Ensuring that equipment is well maintained and fitted with the correct and appropriate noise abatement measures.
- Enclosing the equipment that can generate the most noise in a building to ensure that the line of sight is broken to potentially noise-sensitive receptors. This is especially important for the primary crusher situated at

the Voorburg Section as well as sections of the conveyor belt running within 200 meters from potential noise-sensitive receptors.

8.2 OPERATIONAL PHASE

It will be assumed that all receptors staying on, or within a 100 meter distance from any mining activity will be relocated. This would include receptors such as NSD22, NSD23, NSD27, NSD28 and potentially NSD26 (refer also **Figure 1-4**).

The significance of the noise impact is considered to be moderate for night-time operational activities. Projected noise levels may at times impact on ambient sound levels during quiet periods, but are unlikely to be a disturbing noise. Noise levels are within the night-time guideline levels as defined by the International Finance Corporation's Environmental, Health and Safety (EHS) Guidelines (see **Table 2-1**).

The layout as evaluated (also considering the locations of the various stockpiles) would allow some mitigation of noises from the activities. The implementation of the mitigation measures as proposed for the construction phase would further assist in reducing noise levels.

Mitigation options included both management measures as well as technical changes. Management options to reduce the noise impact during the construction phase include:

- Mitigation measures as identified for construction phase still valid.
- Environmental awareness training should include a noise component, allowing employees and contractors to realize the potential noise risks that activities (especially night-time activities) pose to the surrounding environment. All employees and contractors should receive this training.
- Reverse warning systems should be able to be disabled when it is required to use these vehicles at night from the mining area close to receptors, alternatively the developer should investigate the use of white-noise generators instead of reverse alarms.

Other mitigation measures that could further reduce the potential noise impact include:

- Ensuring that all equipment and machinery are well maintained and equipped with silencers (where possible).

- All equipment (especially crushers, conveyor transfer points and screens) should be enclosed where practically possible.

In addition:

1. Good public relations are essential, and at all stages surrounding receptors should be educated with respect to the potential sounds that could be generated by the mining activity. The information presented to stakeholders should be factual and should not set unrealistic expectations. It is counterproductive to suggest that the mining operation will be inaudible, or to use vague terms like "quiet". Mining activities have the potential to generate significant noise that could be heard at some distance from the operation, especially at night when a quiet environment is more desirable and sought after. The magnitude (or intensity) of the sound will depend on a multitude of variables and will vary from day to day and from place to place with environmental and operational conditions. Audibility is distinct from the sound level, since it depends on the relationship between the sound character and level from the various activities and the ambient sound character and level.
2. Community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. Mining could offer a benefit to the community and local economy. A positive community attitude throughout the greater area should be fostered, particularly with those residents near the mining operation, to ensure they do not feel taken advantage of.
3. The developer must implement a line of communication where complaints could be lodged/registered. All potentially sensitive receptors should be made aware of this line of communication. The mining operation should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop. For example, sudden and sharp increases in sound levels could result from mechanical malfunctions, changes in operators, equipment and even operating protocols. Problems of this nature can be corrected quickly, and it may be in the mine's interest to do so.

9 ENVIRONMENTAL MANAGEMENT PLAN

9.1 CONSTRUCTION PHASE

Various construction activities would be taking place during the development of the mine and may pose a noise risk to the surrounding environment and potential noise-sensitive developments.

Projected noise levels during construction of the mining operation were modelled using the methodology as proposed by SANS 10357:2004. The resulting future noise projections indicated that the construction activities as modelled for the worst case scenario may not comply with both the Noise Control Regulations (GN R154) and with the SANS 10103:2004 guidelines for all NSD.

However, as with all modelling exercises it is impossible to evaluate all potential activities that could result in a noise impact. These activities could include temporary or short-term activities, such as small equipment used (such as the digging of trenches to lay underground power-lines) in the establishments of security fences, access routes or generated by the construction traffic itself.

As such certain objectives are recommended to define the performance of the developer in mitigating any projected noise impacts and reducing the significance of any noise impact.

OBJECTIVE	**Control noise pollution stemming from construction activities**
Project Component(s)	Construction of infrastructure, including site establishment, the digging of foundations, erection of structures and fencing, development of access roads, etc.
Potential Impact	• Increased noise levels at potentially noise-sensitive developments/receptors • Increasing the ambient sound levels in the area. • Potentially changing the acceptable land use capability.
Activity/Risk source	• Any daytime construction activities taking place within 500 meters from any potentially noise-sensitive developments (NSDs). • Any night-time construction activities taking place within 1,200 meters from any potentially noise-sensitive developments (NSDs).
Mitigation Target/Objective	• Ensure equivalent A-weighted noise levels below 55 dBA at potentially noise-sensitive receptors (daytime). • Ensure equivalent A-weighted noise levels below 45 dBA at potentially noise-sensitive receptors (night-time). • Define the noisy areas with a set boundary ensuring that equivalent A-weighted noise levels at the mining boundary does not exceed 65 dBA (if measured over 24 hours this should be 61 dBA); • Ensure that maximum noise levels (due to the mining activities) at potentially noise-sensitive receptors are less than 65 dBA; • Ensuring compliance with the National Noise Control Regulations.

Mitigation: Action/Control	Responsibility	Timeframe
Design a noise monitoring programme (after the details of all mitigation measures to be implemented are known).	- Acoustical Consultant	Before operational phase commence
Implement a noise monitoring programme. Note: If there are no noise-sensitive receptors within 2 000 from any mining activities no routine noise monitoring will be required.	- Acoustical Consultant / Environmental Control Officer	Quarterly monitoring
Establish a line of communication and notify all stakeholders and NSDs of the means of registering any issues, complaints or comments.	- Environmental Control Officer	All phases of project
Notify potentially sensitive receptors about work to take place at least 2 days before the activity in the vicinity (within 500 meters) of the NSD is to start. Following information to be presented in writing: - Description of Activity to take place; - Estimated duration of activity; - Working hours; - Contact details of responsible party.	- Contractor - Environmental Control Officer	At least 2 days, but not more than 5 days before activity is to commence
Ensure that all equipment is maintained and fitted with the required noise abatement equipment.	- Workshop Supervisor	During normal preventative maintenance
When any noise complaints are received, noise monitoring should be conducted at the complainant, followed by feedback regarding noise levels measured.	- Acoustical Consultant / Approved Noise Inspection Authority	Within 7 days after complaint was registered
The construction employees/contractors must abide by the local by-laws regarding noise	- Contractor - Environmental Control Officer	Duration of construction phase
Where possible construction work should be undertaken during normal working hours (06H00 – 18H00), from Monday to Saturday; If agreements can be reached (in writing) with the all the surrounding (within a 1,1000 distance) potentially sensitive receptors, these working hours can be extended.	- Contractor	As required
Establish a line of communication and notify all stakeholders and NSDs of the means of registering any issues, complaints or comments.	- Environmental Control Officer	All phases of project

Performance indicator	• **No noise complaints are registered**
Monitoring	Quarterly noise measurements to be conducted at selected community members in the vicinity of the development during the construction period over a period of 24 hours in 10-minute bins, similar to the methodology employed in this report. Noise monitoring to take place every time that a relevant noise complaint is registered.

9.2 OPERATIONAL PHASE

Noise modelling conducted highlighted that the operation of the mine may not comply with the Noise Control Regulations (GN R154) or with the fixed SANS 10103:2008 guidelines during the night-time. The daytime scenario was not investigated as the night-time period is more critical to evaluate. Noise levels however will not exceed the guideline levels as set by the International Finance Corporation.

Mitigation measures were recommended that will reduce the noise levels (as experienced by the community). The following objectives and targets are recommended to define the performance of the mine in mitigating the projected noise impacts and reducing the significance of any noise impacts.

OBJECTIVE	**Control noise pollution stemming from operation of Mine**
Project Component(s)	Operational Phase
Potential Impact	• Increased noise levels at potentially sensitive receptors; • Changing ambient sound levels could change the acceptable land use capability; • Changing ambient sound levels could increase annoyance and potential complaints; • Disturbing character of sound.
Activity/Risk source	Numerous simultaneous operational activities
Mitigation Target/Objective	• Ensure equivalent A-weighted noise levels below 55 dBA at potentially noise-sensitive receptors (daytime). • Ensure equivalent A-weighted noise levels below 45 dBA at potentially noise-sensitive receptors (night-time). • Define the noisy areas with a set boundary ensuring that equivalent A-weighted noise levels at this boundary does not exceed 65 dBA (if measured over 24 hours this should be 61 dBA); • Ensure that maximum noise levels at potentially noise-sensitive receptors are less than 65 dBA; • Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 7 dBA; • Ensuring compliance with the National Noise Control Regulations.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Add additional noise measurement points at any complainants that registered a valid noise complaint.	- Acoustical Consultant	With quarterly monitoring
If similar noise complaints continue, or is frequently raised the complaint should be investigated further with feedback to the surrounding stakeholders / complainant.	- Acoustical Consultant	If required

Performance indicator	• **No noise complaints are registered** • **Compliance with National Noise Control Regulations** • **Compliance with IFC noise guideline levels for residential areas**
Monitoring	Quarterly noise monitoring by an Acoustic Consultant as well as when noise complaints are registered. If no noise complaints or issues are registered or noise monitoring registers compliance with the National Noise Control Regulations the frequency of the noise monitoring can be reduced.

10 CONCLUSIONS AND RECOMMENDATIONS

This report is an Environmental Noise Impact Assessment of the predicted noise environment due to the development of the Greater Soutpansberg Mopane Project south-west of the Musina in Limpopo making use of a predictive model to identify issues of concern.

Measurements, a site assessment and available documents indicate that ambient sound levels in the area can be low at times and that the development character is typical of a rural area. In terms of ambient sound levels measured the area can be classified as a SANS 10103:2008 Sub-urban District in terms of the acceptable rating level for noise, although measurements did show two locations conforming to a rural rating level. Acceptable zone sound levels for this area would correspond to 50 dBA during the day and 40 dBA at night although it is recommended that the sound levels as recommended by International Institutions be used as the performance indicator (55 dBA during the day and 45 dBA at night).

With the input data as used, this assessment indicated that there is a potential noise impact of moderate significance during the construction phase. The layout as evaluated however provides a number of berms and stockpiles that will assist in the attenuation of noises from the mining activities during the operational phase. Subsequently, the potential noise impact would be of a moderate significance during the night-time period during the operational phase.

Mitigation measures were proposed that could further reduce the noise levels as experienced by the closest noise-sensitive developments (the magnitude of the reduction depending on the selection of the mitigation measures).

Because there still exists a risk of a noise impact, noise monitoring is recommended. As there exists scope for further mitigation measures such a noise monitoring program can only be designed after all mitigation measures are designed and known. Once designed it should be implemented on a quarterly basis for a period of one year before the construction activities start to define pre-mining ambient sound levels.

Quarterly noise monitoring is also recommended to be conducted during the first year of operation, and, depending on the findings of the monitoring report, to be extended, reduced or stopped. Noise measurements should be conducted over a period of 24 hours as per the methodology employed in this report.

Measurements should be collected in 10-minute bins over the measurement period. Variables recommended to be analysed include $\mathbf{L_{AMin}}$, $\mathbf{L_{AIeq}}$, $\mathbf{L_{Aeq,f}}$, $\mathbf{L_{Aeq}}$, $\mathbf{L_{Ceq}}$, $\mathbf{L_{AMax}}$, $\mathbf{L_{A10}}$, $\mathbf{L_{A90}}$ and spectral analysis. If all potential noise-sensitive receptors living within the 40 dBA contour are relocated before the mining project starts noise measurements can be dispensed with.

Additional measurements should be collected at the location of any receptors that have complained to the mine regarding noise originating from the operation. Feedback regarding noise measurements should be presented to all stakeholders and other interested and affected parties in the area.

This report should also be made available to all potentially sensitive receptors in the area, or the contents explained to them to ensure that they understand all the potential noise risks that the mining operation may have on them and their families.

11 THE AUTHOR

The author of this report, M. de Jager (B. Ing (Chem), UP) graduated in 1998 from the University of Pretoria. He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker enclosure design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. As from 2007 he has been involved with the following projects:

- Full Noise Impact Studies for a number of Wind Energy Facilities, including: Cookhouse, Amakhala Emoyeni, Dassiesfontein/Klipheuwel, Rheboksfontein, AB, Dorper, Suurplaat, Gouda, Riverbank, Deep River, West Coast, Happy Valley, Canyon Springs, Tsitsikamma WEF, West Coast One, Karoo, Velddrift and Saldanha.
- Full Noise Impact Studies for a number of mining projects, including: Skychrome (Pty) Ltd (A Ferro-chrome mine),Mooinooi Chrome Mine (WCM), Buffelsfontein East and West (WCM),Elandsdrift (Sylvania),Jagdlust Chrome Mine (ECM),Apollo Brick (Pty) Ltd (Clay mine and brick manufacturer), Arthur Taylor Expansion project (X-Strata Coal SA), Klipfontein Colliery (Coal mine), Landau Expansion project (Coal mine), Modelling for Tweefontein Colliery Expansion.

The author is an independent consultant to the project, for Coal of Africa. He,

- does not and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations;
- have and will not have no vested interest in the proposed activity proceeding;
- have no and will not engage in conflicting interests in the undertaking of the activity;
- undertake to disclose all material information collected, calculated and/or findings, whether favourable to the development or not; and
- will ensure that all information containing all relevant facts be included in this report.

12 REFERENCES

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APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
Controlled area (as per National Noise Control Regulations)	a piece of land designated by a local authority where, in the case of- (a) road transport noise in the vicinity of a road- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65 dBA; or (ii) the equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period extending from 06:00 to 24:00 as calculated in

	accordance with SABS 0210-1986, titled: "Code of Practice for calculating and predicting road traffic noise", published under Government Notice No. 358 of 20 February 1987, and projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; (b) aircraft noise in the vicinity of an airfield, the calculated noisiness index, projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; or (c) industrial noise in the vicinity of an industry- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or (ii) the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 61 dBA;
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time	(1) Averaging detection time used in sound level meters.

weighting	(2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.
Footprint area	Area to be used for the construction of the proposed development, which does not include the total study area.
Free Field Condition	An environment where there is no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.
Green field	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exists.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
I (impulse) time weighting	(1) Averaging detection time used in sound level meters as per South African standards and Regulations. (2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.
Impulsive sound	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
L_{A90}	the sound level exceeded for the 90% of the time under consideration
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
L_{AMin} *and* L_{AMax}	Is the RMS (root mean squared) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.

Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Mitigation	To cause to become less harsh or hostile.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by

	a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Tread braked	The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.

Appendix A: Measurement Location Photos

APPENDIX B

Site Investigation – Photos of monitoring locations

Photo B.1: Measurement location MAS01

Photo B.2: Measurement location MAS02

Photo B.3: Measurement location MAS03

Photo B.4: Measurement location MAS04

Photo B.5: Measurement location MAS05

Photo B.6: Measurement location MAS06

Photo B.7: Measurement location MAS07

End of Report