Appendix D9
Environmental Acoustic Impact Assessment
Kareerand Tailings Storage Facility Expansion Project
- WSP, 2020

GCS
Water & Environmental Consultants

MINE WASTE SOLUTIONS

ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT

KAREERAND TAILINGS STORAGE FACILITY EXPANSION PROJECT

26 MAY 2020

ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT

KAREERAND TAILINGS STORAGE FACILITY EXPANSION PROJECT

MINE WASTE SOLUTIONS

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GLOSSARY OF TERMS

Sound	Sound is small fluctuations in air pressure, measured in Newtons per square meter (N/m^2) or Pascals (Pa) that are transmitted as vibrational energy via a medium (air) from the source to the receiver. The human ear is a pressure transducer, which converts these small fluctuations in air pressure into electrical signals, which the brain then interprets as sound.
Noise	Noise is generally defined as unwanted sound.
Sound or noise level	A sound or noise level is a sound measurement that is expressed in decibels (dB or dB(A)).
dB or dB(A)	The human ear is a sensitive instrument that can detect fluctuations in air pressure over a wide range of amplitudes. This limits the usefulness of sound quantities in absolute terms. For this reason, a sound measurement is expressed as ten times the logarithm of the ratio of the sound measurement to a reference value, 20 micro (millionth) Pa. This process converts a scale of constant increases to a scale of constant ratios and considerably simplifies the handling of sound measurement quantities. The attached 'A' indicates that the sound measurement has been A-weighted.
dB(Z)	Historically sound levels were read off a hand held meter and the noise levels were noted in dB, after the development of different weighting curves sound levels were noted as Z-weighting or dB(Z) to reduce the confusion with different type of weighting applied noise levels. dB(Z) refers to linear noise levels.
A-weighting	The human ear is not equally sensitive to sound of all frequencies, i.e. it is less sensitive to low pitched (or 'bass') than high pitched (or 'treble') sounds. In order to compensate when making sound measurements, the measured value is passed through a filter that simulates the human hearing characteristic. Internationally this is an accepted procedure when working with measurements that relate to human responses to sound/noise.
Ambient sound level	Ambient noise will be defined as the totally encompassing sound in a given situation at a given time, and is usually composed of sound from many sources, both near and far.
Annoyance	General negative reaction of the community or person to a condition creating displeasure or interference with specific activities.
Sound pressure	Sound pressure is the force of sound exerted on a surface area perpendicular to the direction of the sound and is measured in N/m^2 or Pa. The human ear perceives sound pressure as loudness and can also be expressed as the number of air pressure fluctuations that a noise source creates.
Sound pressure level	The sound pressure level is a relative quantity as it is a ratio between the actual sound pressure and a fixed reference pressure. The reference pressure is usually the threshold of hearing, namely 20 microPascals (µPa).
Sound power	Sound power is the rate of sound energy transferred from a noise source per unit of time in Joules per second (J/s) or Watts (W).
Sound power level	The sound power level is a relative quantity as it relates the sound power of a source to the threshold of human hearing (10^{-12} W). Sound power levels are expressed in dB(A), as they are referenced to sound detected by the human ear (A-weighted).
Noise nuisance	Noise nuisance means any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person.
Octave bands	The octave bands refer to the frequency groups that make a sound. The sound is generally divided in to nine groups (octave bands) ranging from 32 Hertz (Hz) to 8,000 Hz. The lower frequency ranges of a sound have a vibrating character where the higher frequency of sound has the character of high pitched sound. In viewing the total octave bands scale from 32 Hz to 8000 Hz the character of the sound can be described.

ACRONYMS AND ABBREVIATIONS

dB	Decibel
dB(A)	A-weighted sound measurement
dB(C)	C-weighted sound measurement
dB(Z)	Z-weighted sound measurement
ECA	Environmental Conservation Act 73 of 1989
EIA	Environmental Impact Assessment
Hz	Hertz
L_{Aeq}	Equivalent continuous sound pressure level
$L_{R,dn}$	Equivalent continuous day/night rating level
$L_{Req,d}$	Equivalent continuous rating level for day-time
$L_{Req,n}$	Equivalent continuous rating level for night-time
$L_{Req,T}$	Typical noise rating levels
MWS	Mine Waste Solutions
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management: Air Quality Act 39 of 2004
SABS	South African Bureau of Standards
SANS	South African National Standards
TSF	Tailings Storage Facility
WHO	World Health Organisation
WSP	WSP Environmental (Pty) Ltd

EXECUTIVE SUMMARY

Mine Waste Solutions (MWS), a subsidiary of AngloGold Ashanti, is a tailings dam reclamation operation situated in the North West Province. Currently tailings from the MWS plant are sent to the Kareerand Tailings Storage Facility (TSF). From 2021 onwards, the size of the Kareerand TSF will become a constraint to the capacity of operations at MWS. It has therefore been identified that the best approach to maintain the current operations is to expand the existing Kareerand TSF while at the same time increasing the final design height of the existing footprint to 122 m.

As part of the environmental authorisation process for the proposed project, an Environmental Acoustic Specialist Study is required in order to assess any acoustic impacts of the proposed expansion. This report details the findings of the environmental acoustic specialist study undertaken to investigate noise associated with the construction and operation of the proposed TSF expansion.

The construction phase of the project will include soil reclamation via excavators and dump trucks; trench construction with possible blasting; earthen wall construction via excavators, dump trucks and rollers; pipeline laying and construction of access roads. During the operational phase, similar operations will occur at the TSF expansion that are currently occurring at the TSF. Slurry will be pumped continuously to the TSF and soil for rehabilitation will be obtained from the construction phase stockpiles to be located along the road route of the TSF expansion. Placement of soil for rehabilitation will occur during day-time hours (06:00 to 18:00). An additional ten light duty vehicles will be put into operation around the TSF perimeter and on the TSF walls.

In order to assess the existing noise climate in the area surrounding the TSF facility, ambient noise monitoring was conducted at four on-site locations (historical monitoring locations) and at three residential receptor locations surrounding the site. An acoustic inventory was developed to identify all potential sources of noise associated with the construction and operational phases of the TSF expansion. The acoustic impacts of the proposed facility were then assessed through the use of the CadnaA acoustic model.

Baseline monitoring indicated current day-time noise levels at all seven monitoring locations are compliant with the South African National Standards (SANS) guideline rating levels. The main sources of noise identified at the on-site locations were pumps, trucks and activity of people. The R502 road is currently the main source of noise identified at both KR05 (Khuma Town) and KR06 (Hostel – since demolished), while very quiet conditions were noted at KR07 (house south of the TSF site).

Due to safety concerns at night, monitoring could not be undertaken at KR05 (Khuma Town) and KR06 (Hostel) and as such there is no night-time data to present for these locations. Night-time noise levels at all other locations remained well below their respective guideline levels. The highest L_{Aeq} noise level was recorded at KR01 (on-site). Dominant noise sources on-site included pumps and intermittent vehicles, while livestock and the S643 road were the dominant sources at the residential area south of the TSF (KR07).

Inclusion of monitored data that is presented alongside the predicted (modelled) data enables an assessment in the change in noise levels as a result of the TSF expansion. Such comparison essentially accounts for the cumulative impact of the project, taking the existing, background noise climate into consideration.

During the construction phase, noise levels at the on-site receptor locations are predicted to increase by between 5.5 and 25.4 dB(A). Such increases will result in “little” to “very strong” community response at the on-site receptor locations. It must be noted that these receptors are merely on-site locations utilised to match historical monitoring locations and do not represent sensitive receptors. Increases in noise levels at the off-site receptor locations as a result of the construction activities will range from 6.7 to 10.0 dB(A). Such increases will result in “little” to “medium” community response when the construction activities are occurring in closest proximity to each of the receptors. These increases are above the 7 dB(A) threshold for annoyance as per the South African Noise Control Regulations. It must be noted that these results represent a worst-case scenario when construction activities are occurring at the closest TSF boundary to the receptor in question and do not represent noise levels that will occur all the time. Such a scenario is unlikely to occur in reality.

Should complaints arise during the construction phase, various mitigation techniques can be employed. These options include both management and technical options. Such techniques include planning construction activities in consultation with local communities; limiting the number of simultaneous activities when in close proximity to a receptor; using temporary acoustic barriers for high impact activities; selecting equipment with the lowest possible sound power levels; and ensuring equipment is well-maintained to avoid additional noise generation.

During the operational phase, predicted day-time noise levels at all four of the on-site receptor locations are predicted to increase. Noise levels will increase by between 2.0 and 10.8 dB(A) resulting in "little" to "strong" community response. It must be noted that such receptors are not residential in nature and hence are not classified as sensitive. Assessment of noise levels at these locations are provided for on-site management purposes and to match the historical monitoring locations. The predicted day-time noise levels at one of the off-site sensitive receptor locations (Khuma Town) are predicted to increase marginally with the operation of the TSF expansion. Noise levels at this location will increase by 0.2 dB(A) resulting in "little" community response.

At night, when the reclamation activities cease, noise levels at all four on-site receptor locations are predicted to increase with the operation of the TSF expansion. Noise levels will increase by between 0.5 and 10.1 dB(A) resulting in "little" to "strong" community response. It must be noted that such receptors are not residential in nature and hence are not classified as sensitive. Assessment of noise levels at these locations are provided for on-site management purposes and to match the historical monitoring locations.

With reference to the off-site residential receptors, it is noted that the predicted night-time noise levels at KR06 (Hostel) and KR07 (residential area to the south) during the operation of the TSF expansion are undetectable (0.0 dB(A)) and as such, no negative impacts are envisaged at these receptors. With the absence of monitored data at KR05, an assessment of the increase in noise levels at this location could not be undertaken. Based on the generally low baseline (monitored) noise levels at all other receptors, it is envisaged that the impact at this location will also be minimal. Based on the low predicted noise levels and resultant minimal increases at all receptors, no buffers or areas to be avoided have been identified in this assessment.

With such minimal increases in noise levels during the operational phase, no mitigation recommendations for the operation of the proposed TSF expansion are proposed and it is envisaged that the operation of the facility can be authorised without any major impacts or complaints. With rehabilitation occurring simultaneously with the operational phase, the same mitigation recommendations provided for the construction phase can be applied to the rehabilitation phase.

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1 INTRODUCTION

Mine Waste Solutions (MWS), a subsidiary of AngloGold Ashanti, is a tailings dam reclamation operation situated in the North West Province. Currently tailings from the MWS plant are sent to the Kareerand Tailings Storage Facility (TSF). From 2021 onwards, the size of the Kareerand TSF will become a constraint to the capacity of operations at MWS. It has therefore been identified that the best approach to maintain the current operations is to construct an expansion to the existing Kareerand TSF while at the same time increasing the final design height of the existing footprint to 122 m.

Environmental authorisation in the form of an Environmental Impact Assessment (EIA) is required for the Kareerand TSF expansion. As part of the EIA, an Environmental Acoustic Specialist Study is required in order to assess any acoustic impacts of the proposed expansion. This report details the findings of the environmental acoustic specialist study undertaken to investigate noise associated with the construction and operation of the proposed TSF expansion. Below is a description of the project; followed by a discussion on the fundamentals of noise; a description of the methodology utilised in the study; the results of the study; as well as the assessment of related impacts.

1.1 TERMS OF REFERENCE

The terms of reference, designed to best meet the project requirements are summarised below:

— A baseline assessment of the current noise climate in the vicinity of the TSF which includes baseline sound level monitoring within the receiving environment;
— Compilation of a comprehensive acoustic inventory to account for all sources of noise during both the construction and operational phases;
— An acoustic modelling investigation to determine the impact of the noise associated with the proposed expansion;
— Submission of an Environmental Acoustic Impact Assessment report (this report), detailing all findings from the baseline assessment, acoustic inventory and acoustic modelling simulations; and
— Provide recommendations on the scope of any mitigation measures that may be applied to reduce noise associated with the proposed expansion, if necessary.

1.2 DECLARATION OF INDEPENDENCE

Kirsten Collett is an air quality and acoustic consultant with a Master of Science (Atmospheric Sciences) degree obtained from the University of the Witwatersrand. She is currently employed by WSP and has worked on environmental acoustic impact assessments, monitoring and modelling for a variety of clients over the past eight years. She has provided acoustic consulting support to various client industries including petrochemical, mining and production industries among others. She is also a registered Professional Natural Scientist (Pr. Nat. Sci.) with the South African Council for Natural Scientific Professions (SACNASP). Please see **Appendix A** for a short CV detailing project experience.

I hereby declare that I am fully aware of my responsibilities in terms of the National Environmental Management Act: Environmental Impact Assessment Regulations of 2014 and that I have no financial or other interest in the undertaking of the proposed activity other than the imbursement of consultants fees.

Name:	Kirsten Collett
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Signature:	

2 BACKGROUND

2.1 LOCALITY

The Kareerand TSF is located in the North West Province approximately 9.8 km southeast of Stilfontein. The expansion to the facility will extend to the west of the existing TSF (**Figure 1**). The surrounding land use is predominantly agricultural and natural land with scattered mining activities and settlements. The Vaal River runs through the area, about 2.5 km south of the existing TSF.

2.2 PROJECT DESCRIPTION

2.2.1 CURRENT OPERATIONS

After gold extraction at MWS, tailings is pumped in pipelines to a tank at the TSF pump station. From there the tailings is pumped to cyclones positioned around the perimeter of the TSF. The cyclones then separate the tailings into coarse and fine fractions. The coarse fraction is deposited around the perimeter of the TSF to construct an impoundment wall. The fine fraction is then deposited within the impoundment.

In the impoundment, the solids in the tailings settle out leaving excess water to form a pool. Water is extracted from the pool by means of a syphon system and routed to a return water dam from where it is pumped back to the reclamation pump stations.

As the wall of the TSF rises, the side slopes are covered and rehabilitated if feasible to prevent evolution of dust. Once delivery of the tailings to the TSF ceases, the final side slopes and the first ±200 m of the top area will be covered with soil and vegetated.

2.2.2 CONSTRUCTION PHASE

The optimum strategy for creating additional capacity for the TSF, is to construct an expansion to the existing TSF while at the same time increasing the final design height of the existing footprint to 122 m. Construction methods will consist of:

- Reclaiming soils from the footprint of the TSF expansion area via excavators and dump truck;
- Constructing trenches, which may require some blasting;
- Constructing earthen walls around the perimeter of the TSF expansion via excavators, dump trucks and rollers;
- Stockpiling of excess soil;
- Laying of pipelines; and
- Constructing access roads.

Construction is envisaged to begin in 2021 and continue to 2025, during day-time hours (06:00 to 18:00).

2.2.3 OPERATIONAL PHASE

Similar operations will occur at the TSF expansion that are currently occurring at the TSF. Slurry will be pumped continuously to the TSF and soil for rehabilitation will be obtained from the construction phase stockpiles to be located along the road route of the TSF expansion. Placement of soil for rehabilitation will occur during day-time hours (06:00 to 18:00). An additional ten light duty vehicles will be put into operation around the TSF perimeter and on the TSF walls.

2.2.4 REHABILITATION PHASE

As discussed above, rehabilitation will be conducted during the life of operation and extend to about four years after closure of the facility. Soil will be extracted from the stockpiles created during the construction phase. Soil will be placed on the outer slopes of the TSF initially and then on the top surface of the TSF after cessation of tailings deposition.

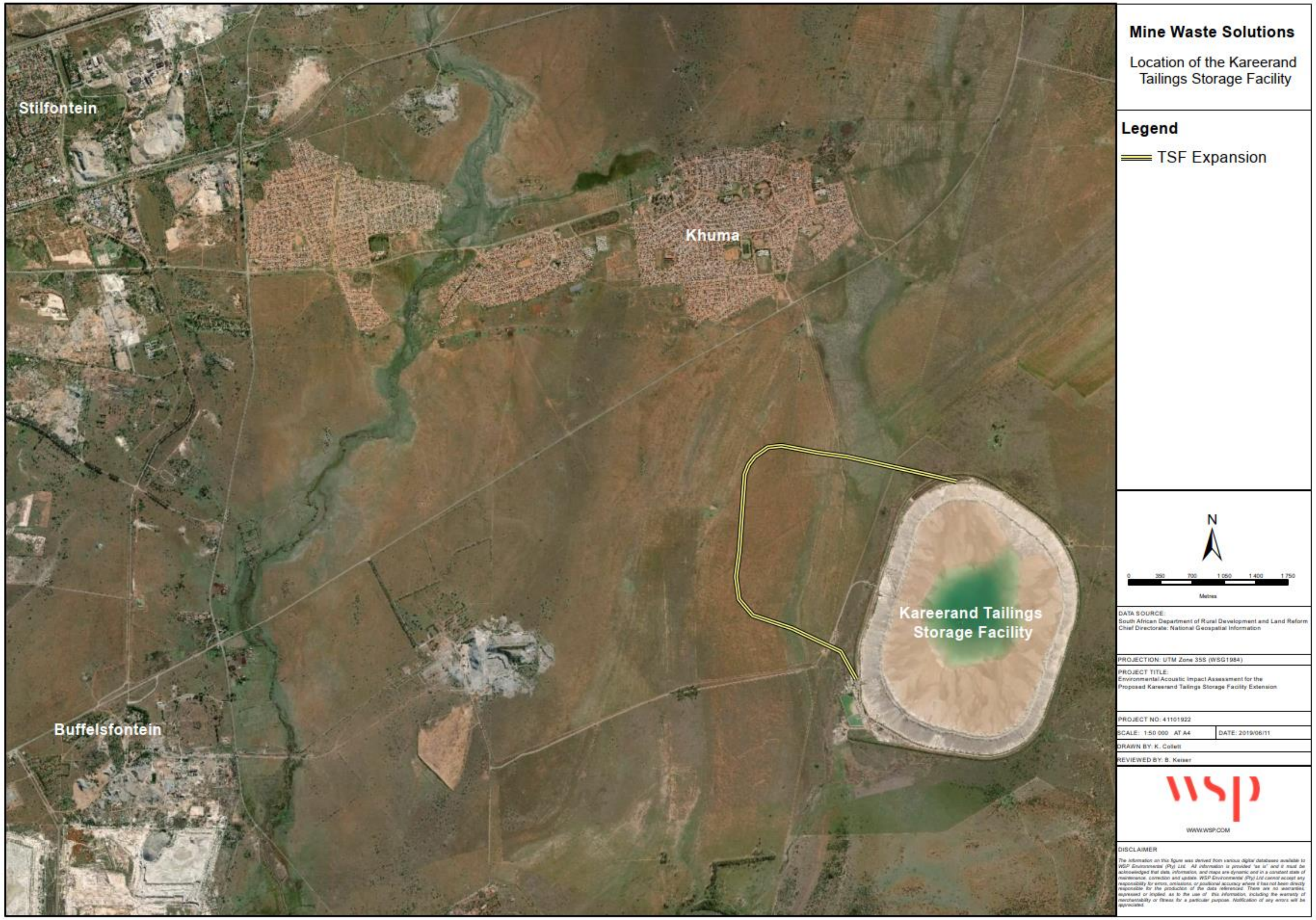

Figure 1: Location of the Kareerand Tailings Storage Facility and proposed expansion

3 ACOUSTIC FUNDAMENTALS

3.1 PRINCIPLES

Sound is defined as any pressure variation (in air, water or other medium) that the human ear can detect. Noise is defined as "unwanted sound". Noise can lead to health impacts and can negatively affect people's quality of life. Hearing impairment is typically defined as a decrease in the threshold of hearing. Severe hearing deficits may be accompanied by tinnitus (ringing in the ears). Noise-induced hearing impairment occurs predominantly in the higher frequency range of 3,000 to 6,000 Hertz (Hz), with the largest effect at 4,000 Hz. With increasing L_{Aeq} and increasing exposure time, noise-induced hearing impairment occurs even at frequencies as low as 2,000 Hz. However, hearing impairment is not expected to occur at L_{Aeq} levels of 75 dB(A) or below, even for prolonged occupational noise exposure.

Speech intelligibility is adversely affected by noise. Most of the acoustical energy of speech is in the frequency range of 100 to 6,000 Hz, with the most important cue-bearing energy being between 300 and 3,000 Hz. Speech interference is basically a masking process in which simultaneous interfering noise renders speech incapable of being understood. Environmental noise may also mask other acoustical signals that are important for daily life such as doorbells, telephone signals, alarm clocks, music, fire alarms and other warning signals.

Sleep disturbance is a major effect of environmental noise. It may cause primary effects during sleep and secondary effects that can be assessed the day after night-time noise exposure. Uninterrupted sleep is a prerequisite for good physiological and mental functioning and the primary effects of sleep disturbance are: (a) difficulty in falling asleep; and (b) awakenings and alterations of sleep stages or depth. The difference between the sound levels of a noise event and background sound levels, rather than the absolute noise level, may determine the reaction probability.

The annoyance due to a given noise source is subjective from person to person, and is also dependent upon many non-acoustic factors such as the prominence of the source, its importance to the listener's economy (wellbeing), and his or her personal opinion of the source. Increased exposure to noise can have negative effects on individuals, both physiological (influence on communication, productivity and even impaired hearing) and psychological effects (stress, frustration and disturbed sleep). As such, noise impacts need to be understood to mean one or a combination of negative physical, physiological or psychological responses experienced by individuals, whether consciously or unconsciously, caused by exposure to noise.

More technically, noise impacts are defined as the capacity of noise to induce annoyance depending upon its physical characteristics, including the sound pressure level, spectral characteristics and variations of these properties with time. During day-time, individuals may be annoyed at L_{Aeq} levels below 55 dB(A), while very few individuals are moderately annoyed at L_{Aeq} levels below 50 dB(A). Sound levels during the evening and night should be 5 to 10 dB(A) lower than during the day (World Health Organisation, 1999).

Table 1: Typical noise levels

Sound Pressure Level (dB(A))	Typical Source	Subjective Evaluation
130	threshold of pain	intolerable
120 110	heavy rock concert grinding on steel	extremely noisy
100 90	loud car horn at 3 m construction site with pneumatic hammering	very noisy
80 70	kerbside of busy street loud radio or television	loud
60 50	department store general office	moderate to quiet
40 30	inside private office inside bedroom	quiet to very quiet
20	unoccupied recording studio	almost silent

3.2 NOISE PROPAGATION

Sound is a pressure wave that diminishes with distance from source. Depending on the nature of the noise source, sound propagates at different rates. The three most common categories of noise are point sources (specified single point of noise generation), line sources (multiple linear noise generating points, such as a road) and area sources (specified single area of noise generation). The most important factors affecting noise propagation are:

— The type of source (point, line or area);

— Obstacles such as barriers and buildings;

— Distance from source;

— Atmospheric absorption;

— Ground absorption; and

— Reflections.

Research has shown that doubling the distance from a noise source results in a proportional decline in noise level. Sound propagation in air can be compared to ripples on a pond. The ripples spread out uniformly in all directions, decreasing in amplitude as they move further from the source. An acoustically hard site exists where sound travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. These are examples of reflective ground, where the ground cover provides little or no attenuation. The standard attenuation rate for hard site conditions is 6 dB(A) per doubling of distance for point sources. Thus, if you are at a position one meter from the source and move one meter further away from the source, the sound pressure level will drop by 6 dB(A), moving to 4 meters, the drop will be a further 6 dB(A), and so on. When ground cover or normal unpacked earth (i.e. a soft site) exists between the source and receptor, the ground becomes absorptive to sound energy. Absorptive ground results in an additional noise reduction of approximately 1.5 dB(A) per doubling of distance.

This methodology is only applicable when there are no reflecting or screening objects in the sound path. When an obstacle is in the sound path, part of the sound may be reflected and part absorbed and the remainder may be transmitted through the object. How much sound is reflected, absorbed and/or transmitted depends on many factors, including the properties of the object. When receptor locations are not in the line of sight of the noise source, there may be up to 20 dB(A) attenuation for broadband noise, with a further 10 to 15 dB(A) attenuation when inside the average residence and the windows are open.

3.3 CHARACTERISTICS OF NOISE

The human ear simultaneously receives sound (normal un-weighted sound or Z-weighting dB(Z)) at many frequencies (octave bands) at different amplitudes. The ear then adjusts its sensitivity based on the amplitude of the sound observed. This focuses the sound and makes it audible by adjusting the amplitude of the low, middle and high frequencies. To measure how a person experiences sound, an electronic weighting adjusted to the Z-weighted sound was developed, including three different weighting curves, namely:

— **A-weighting** - This measurement is often noted as dB(A) and this weighting curve attempts to make the noise level meter respond closely to the characteristics of a human ear. It adjusts the frequencies at low and high frequencies. Various national and international standards relate to measurements recorded in the A-weighting of sound pressure levels;

— **B-weighting** - is similar to A-weighting but with less attenuation. The B-weighting is very seldom, if ever, used. The B-weighting follows the C-weighted trend;

— **C-weighting** - is intended to represent how the ear perceives sound at high decibel levels. C-weighted measurements are reported as dB(C); and

— **Z-weighting** - this refers to linear, un-weighted noise levels.

The weighting is employed by arithmetically adding a table of values (**Table 2**), listed by octave bands, to the measured linear sound pressure levels for each specific octave band. The resulting octave band measurements are logarithmically added to provide a single weighted value describing the sound, based on the applied weighting curve (**Figure 2**). Thus, if the A-weighted curve was applied to the sound, the noise level is noted as dB(A).

Table 2: Frequency weighting table for the different weighting curves

Frequency (Hz)	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
A-weighting	-39.4	-26.2	-16.1	-8.6	-3.2	0	1.2	1	1.1
B-weighting	-17.1	-9.3	-4.2	-1.3	-0.3	0	-0.1	-0.7	-2.9
C-weighting	-3	-0.8	-0.2	0	0	0	-0.2	-0.8	-3
Z-weighting	0	0	0	0	0	0	0	0	0

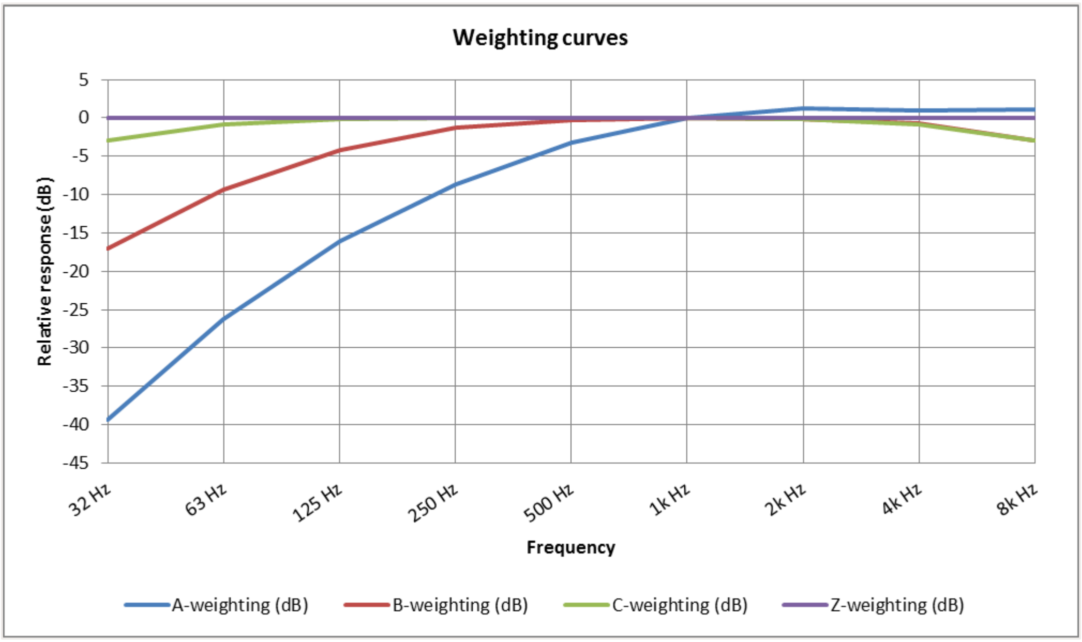

Figure 2: Weighting curves

4 LEGISLATIVE FRAMEWORK

4.1 SOUTH AFRICAN LEGISLATION

4.1.1 SOUTH AFRICAN NOISE CONTROL REGULATIONS

In South Africa, environmental noise control has been in place for three decades, beginning in the 1980s with codes of practice issued by the South African National Standards (formerly the South African Bureau of Standards, SABS) to address noise pollution in various sectors of the country. Under the previous generation of environmental legislation, specifically the Environmental Conservation Act 73 of 1989 (ECA), provisions were made to control noise from a National level in the form of the Noise Control Regulations (GNR 154 of January 1992). In later years, the ECA was replaced by the National Environmental Management Act 107 of 1998 (NEMA) as amended. The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA) was published in line with NEMA and contains noise control provisions under Section 34:

> *"(1) The minister may prescribe essential national standards –*
>
> > *(a) for the control of noise, either in general or by specific machinery or activities or in specified places or areas; or*
> >
> > *(b) for determining –*
> >
> > > *(i) a definition of noise; and*
> > >
> > > *(ii) the maximum levels of noise.*
>
> *(2) When controlling noise, the provincial and local spheres of government are bound by any prescribed national standards."*

Under NEMAQA, the Noise Control Regulations were updated and are to be applied to all provinces in South Africa. The Noise Control Regulations give all the responsibilities of enforcement to the Local Provincial Authority, where location specific by-laws can be created and applied to the locations with approval of Provincial Government. Where province-specific regulations have not been promulgated, acoustic impact assessments must follow the Noise Control Regulations. These regulations define the following:

— **Ambient Sound Level:** the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes, after such meter had been put into operation;

— **Zone Sound Level**: a derived dB(A) value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area; and

— **Disturbing Noise**: a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dB(A) or more.

With the above definitions in mind, regulation 4 of the Noise Control Regulations stipulate that no person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof.

Furthermore, NEMAQA prescribes that the Minister must publish maximum allowable noise levels for different districts and National noise standards. These have not yet been accomplished and as a result all monitoring and assessments are done in accordance with the SANS 10103:2008 and 10328:2008 as discussed in the sections that follow.

4.1.2 SOUTH AFRICAN NATIONAL STANDARDS (SANS)

The SANS 10328:2008 (*Methods for Environmental Noise Impact Assessments*) presently inform environmental acoustic impact assessments in South Africa. This standard defines that the purpose of an Environmental Acoustic Impact Assessment is to determine and quantify the acoustical impact of, or on, a proposed development. It also stipulates the methods used to assess impacts as well as the minimum requirements to be investigated and included in the Environmental Acoustic Impact Assessment report as part of the EIA. These minimum requirements include:

1) The purpose of the investigation;
2) A brief description of the planned 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 investigated;
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 investigated;
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) If 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.

The SANS 10103:2008 document (*The measurement and rating of environmental noise with respect to speech communication*) provides methods and guidelines to assess working and living environments with respect to acoustic comfort as well as respect to possible annoyance by noise. As applicable to this assessment, SANS 10103 provides guideline typical rating levels for noise in different districts. These rating levels are presented in **Table 3**.

Table 3: Typical rating levels for noise in districts (adapted from SANS 10103:2008)

Type of District	Classification	Equivalent Continuous Rating level for Noise ($L_{Req,T}$) (dB(A)) Outdoors	
		Day-time ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
a) Rural	A	45	35
b) Suburban (with little road traffic)	B	50	40
c) Urban	C	55	45
d) Urban (with one or more of the following: workshops, business premises and main roads)	D	60	50
e) Central Business Districts	E	65	55
f) Industrial District	F	70	60

As stipulated in SANS 10103:2008, noise can pose as an annoyance to a community if the increase in average noise levels exceeds the ambient noise by a certain degree. These specified increases together with the relevant estimated community responses are presented in **Table 4**. Such changes in ambient (residual) noise levels are assessed in this report with the resultant community response determined.

Table 4: Categories of community/group response (adapted from SANS 10103:2008)

Excess ($\Delta L_{Req,T}$)[a] dB(A)	Estimated Community or Group Response	
	Category	Description
0 – 10	Little	Sporadic Complaints
5 – 15	Medium	Widespread Complaints
10 – 20	Strong	Threats of community/group action
>15	Very Strong	Vigorous community/group action

Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.
[a] $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:
1) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation);
2) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level of the ambient noise given in Table 1 of the code;
3) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from Table 2 of the code; or
4) $L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in the area because of the proposed development under investigation.

4.2 WORLD HEALTH ORGANISATION GUIDELINES FOR COMMUNITY NOISE

The World Health Organisation (WHO) together with the Organisation for Economic Co-operation and Development (OECD) are the main international bodies that have collected data and developed assessments on the effects of exposure to environmental noise. This has provided the following summary of thresholds for noise nuisance in terms of the outdoor day-time equivalent continuous A-weighted sound pressure level (L_{Aeq}) in residential districts:

- At 55 - 60 dB(A) noise creates annoyance;
- At 60 - 65 dB(A) annoyance increases considerably; and
- Above 65 dB(A) constrained behaviour patterns, symptomatic of serious damage caused by noise

The WHO therefore recommends a maximum outdoor day-time (07:00 – 22:00) L_{Aeq} of 55 dB(A) in residential areas and schools in order to prevent significant interference with normal activities. It further recommends a maximum night-time (22:00 – 07:00) L_{Aeq} of 45 dB(A) outside dwellings. No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

The WHO guideline for industrial noise is set at 70 dB(A) over a period of 24 hours. Anything above this level would cause hearing impairment, however, a peak noise level of 110 dB(A) is allowable on a fast response measurement.

5 METHODOLOGY

In order to assess the environmental acoustic impacts of the proposed expansion, both baseline (monitored) and proposed (modelled) noise levels were assessed. Comparisons of the existing and proposed noise levels at various specified sensitive receptors (noise receivers) enabled an assessment of changes in noise levels at these locations as a result of the proposed TSF expansion. Such changes essentially account for the cumulative impact of the project, taking the existing, background noise climate into consideration. These changes were then assessed against the SANS community or group responses (**Table 4**) in order to assess the anticipated impacts/responses as a result of such increases.

5.1 ACOUSTIC MONITORING

Ambient sound level measurements were undertaken on 10 August 2017 at four on-site locations (historical monitoring locations) as well as at three off-site sensitive receptor locations (**Table 5** and **Figure 3**). All sound level measurements were free-field measurements (i.e. at least 3.5 m away from any vertical reflecting surfaces). Measurement procedures were undertaken according to the relevant South African Code of Practice SANS 10103:2008. This guides the selection of monitoring locations, microphone positioning and equipment specifications. Sound level measurements were taken with a SABS-calibrated Type 1 Integrating Sound Level Meter. The sound level meter was calibrated before and after measurements were conducted and no significant drifts (differences greater than 0.5 dB(A)) were found to occur. The make and model as well as serial number and calibration validity of the sound level meter and calibrator are presented in **Table 6**.

Day-time and night-time measurements were conducted for fifteen minutes, allowing monitoring to be adequately representative. The monitoring was conducted during the relevant timeframes for day (06:00 to 22:00) and night (22:00 to 06:00) in accordance with the SANS methodology. The noise parameters recorded included:

- L_{Aeq} The equivalent continuous sound pressure level, normally measured (A-weighted);
- L_{Amax} The maximum sound pressure level of a noise event measured (A-weighted);
- L_{Zpeak} The peak noise level experienced during the measurement (Z-weighted); and
- L_{A90} The average noise level the receptor is exposed to for 90% of the monitoring period.

Table 5: Noise monitoring locations

ID	Description	Distance from TSF Expansion (m)	SANS District	SANS Classification*
KR01	On-site (SW fence line)	860	Industrial	F
KR02	On-site (SSW fence line)	920	Industrial	F
KR03	On-site (S fence line)	1,200	Industrial	F
KR04	On-site (W fence line)	150	Industrial	F
KR05	Khuma Town	1,140	Urban	C
KR06	Hostel (since demolished and rehabilitated)	2,230	Urban	C
KR07	Residential Area to South	3,500	Suburban	B

* As per Table 4

Table 6: Sound level meter and calibrator specifications

Sound level meter	Calibrator
Make & model: CEL 63X	**Make & model:** CEL-120/1
Serial number: 3134723	**Serial number:** 3939145
Date calibrated: November 2016	**Date calibrated:** November 2016
Calibration due date: November 2017	**Calibration due date:** November 2017

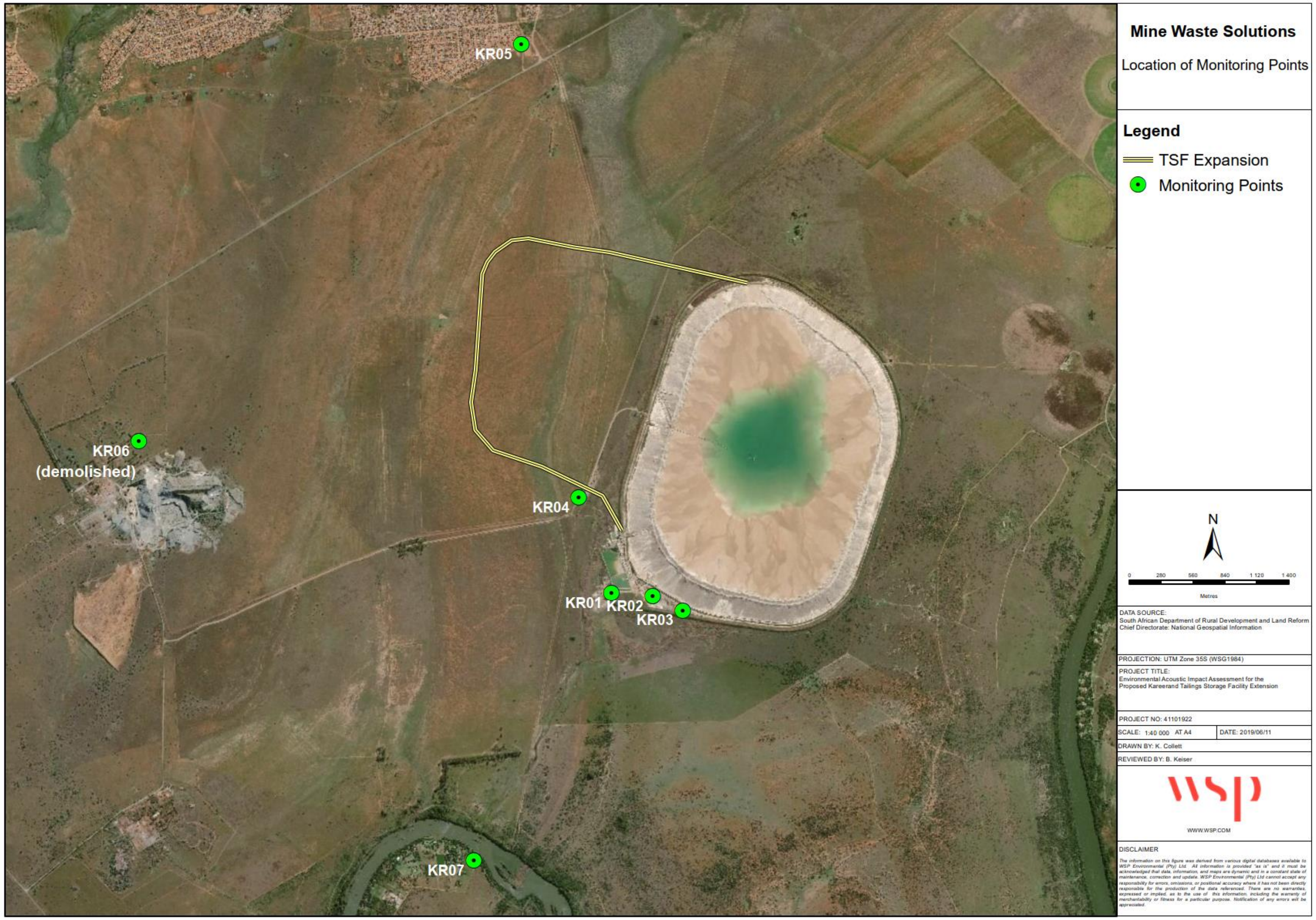

Figure 3: **Noise monitoring locations surrounding the facility**

5.2 CONSTRUCTION PHASE ASSESSMENT

Table 7 presents a list of potential construction equipment that will be utilised during the construction of TSF expansion as well as the sound power level (PWL) specifications of the equipment (BSI, 2009; BHP Billiton, 2010; CAT, 2019). Construction will be erratic in nature with no set locations for equipment at a given time. In order to represent a worst-case scenario, it is assumed that one of each piece of equipment will be operational simultaneously at a location on the TSF expansion in closest proximity to each sensitive receptor. Such a worst-case scenario is unlikely to occur in reality. The sum (logarithmic) of the PWLs from all noise sources was utilised to calculate resultant noise levels at specified distances from the facility. Such resultant receptor noise levels were calculated using attenuation-over-distance acoustic calculations. A separate scenario was assessed during a blasting event.

Table 7: Construction phase equipment and sound power level ratings

Equipment	No. in Operation	Sound Power Level (dB(A))
Bulldozers	2	114.0
Scrapers	4	118.0
Excavators	3	105.0
Dump Trucks	8	114.0
Graders	1	112.0
Rollers	4	104.0
Loaders	2	110.0
Watercarts	7	109.0
Telehandler	1	106.0
Diesel Bowser	2	109.0
Tipper Trucks	4	113.0
Mobile Crane	1	98.0
Staff Bus	2	106.0
Blasting	Intermittent	128.0

5.3 OPERATIONAL PHASE ASSESSMENT

5.3.1 ACOUSTIC INVENTORY

The sources of noise identified during the operational phase of the expansion of the TSF are presented in **Table 8**. These sources and sound power level data was used as input into the acoustic model.

Table 8: Operational phase noise sources and sound power level data

Source	No. in Operation	Operational Time	Sound Power Level (dB(A))	Location
Slurry Pumps	15	24 hours	104.0	Slurry Booster Pump Station
Return Water Pumps	2	24 hours	104.0	Return Water Pump Station
Dust Suppression Water Pumps	2	24 hours	104.0	Dust Suppression Water Sump
Gland Service Water Pumps	4	24 hours	104.0	Dust Suppression Water Sump
LDVs	10	24 hours	106.0	Around perimeter of entire TSF (existing and new)
Excavators	6	Daytime (06:00 - 18:00)	105.0	Around perimeter of entire TSF (existing and new)
Dump Trucks	3	Daytime (06:00 - 18:00)	114.0	Around perimeter of entire TSF (existing and new)
Mobile Crane	1	Daytime (06:00 - 18:00)	98.0	Return Water Pump Station and perimeter of TSF
Diesel Bowser	1	Daytime (06:00 - 18:00)	117.0	Around perimeter of entire TSF (existing and new)
8 ton Flat Truck	1	Daytime (06:00 - 18:00)	105.5	Around perimeter of entire TSF (existing and new)

It is understood that the rehabilitation phase will occur simultaneously with the operational phase. As such, noise associated with the rehabilitation activities has been included into the operational phase acoustic model. The sources of noise identified during the rehabilitation phase are presented in **Table 10**.

Table 9: Rehabilitation phase noise sources and sound power level data

Source	No. in Operation	Operational Time	Sound Power Level (dB(A))	Location
Excavators	3	Daytime (06:00 - 18:00)	105.0	On stockpiles along road route of expansion
Dump Trucks	17	Daytime (06:00 - 18:00)	114.0	Around perimeter of entire TSF (existing and new)
Dozer	2	Daytime (06:00 - 18:00)	114.0	Around perimeter of entire TSF (existing and new)
Loader	2	Daytime (06:00 - 18:00)	110.0	Around perimeter of entire TSF (existing and new)
LDVs	3	Daytime (06:00 - 18:00)	106.0	Around perimeter of entire TSF (existing and new)
Grader	1	Daytime (06:00 - 18:00)	112.0	Around perimeter of entire TSF (existing and new)
Diesel Bowser	1	Daytime (06:00 - 18:00)	117.0	Around perimeter of entire TSF (existing and new)

5.3.2 ACOUSTIC MODELLING

Acoustic modelling was used to calculate noise contours indicating the spatial extent of projected noise levels from the proposed expansion within a specified grid area (10 km x 10 km) as well as the noise levels at specific receivers (sensitive receptors). The acoustic modelling software used in this study is the internationally recognised package, CadnaA (Computer Aided Noise Abatement). The CadnaA software provides an integrated environment for noise predictions under varying scenarios and calculates the cumulative effects of various sources. The model uses ground elevations in the calculation of the noise levels in a grid and uses standard meteorological parameters that have an effect on the propagation of noise. CadnaA has been utilised in many countries across the globe for the modelling of environmental noise and town planning. It is comprehensive software for three-dimensional calculations, presentation, assessment and prediction of environmental noise emitted from industrial plants, parking lots, roads, railway schemes or entire towns and urbanized areas.

5.4 SENSITIVE RECEPTORS

Sensitive receptors are identified as areas that may be impacted negatively due to noise associated with the proposed expansion. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. The specific sensitive receptors considered in this study are the same as those locations selected in the monitoring campaign as presented in **Table 5** and **Figure 3**.

It is noted that receptors KR01, KR02, KR03 and KR04 are industrial and are located on-site. Such receptors are not sensitive in nature and have not been used to assess impacts on communities, but rather as on-site locations to assess the baseline noise climate and resultant changes in noise levels on-site as a result of the proposed expansion project.

It is also noted, that since the monitoring was conducted in 2017, the hostel (KR06) receptor has since been demolished and site rehabilitated. This location has been included in this assessment for data completeness purposes.

During the initial phase of the project, those receptors located east of the TSF (close to and beyond the Vaal River) were investigated, however, based on the large distance of these receptors from the proposed expansion area (~3 km), baseline monitoring and resultant modelling were not warranted. Due to the attenuation of noise over distance, environmental acoustic impact assessments generally investigate impacts up to 2.5 km from a facility (dependent on the size of the facility and noise sources at the site). As such, inclusion of these receptors into this assessment is not warranted.

6 ASSUMPTIONS AND LIMITATIONS

In this Environmental Acoustic Impact Assessment, various assumptions were made that may impact on the results obtained. These assumptions include:

— The information provided regarding the construction and operational activities is assumed to be representative of what will occur in reality;

— In order to represent a worst-case scenario, it was assumed that one of each piece of construction equipment will be operational simultaneously at a location on the TSF expansion in closest proximity to each sensitive receptor;

— The slurry and water pumps will be un-enclosed;

— The additional LDVs will operate on the perimeter of both the existing TSF area and the proposed expansion area;

— In the modelling assessment, the operational equipment was placed randomly at different locations around the existing TSF and expansion perimeter. Each source will not be static in nature and the exact locations of such cannot be accurately pin-pointed in such an assessment; and

— Due to security concerns, night-time monitoring results could not be obtained at receptor KR05 and KR06.

7 RESULTS

7.1 CURRENT NOISE CLIMATE

7.1.1 DAY-TIME

The results from the day-time noise monitoring campaign conducted on 10 August 2017 are presented in **Table 10** and **Figure 4**. Noise levels at the on-site locations were compared to the typical day-time rating level for noise in industrial areas (70 dB(A)), while noise levels at the hostel (since demolished) and Khuma town were assessed against the urban guideline level (55 dB(A)). Noise levels at the residential area to the south of the TSF was assessed against the suburban guideline level of 50 dB(A).

Noise levels at all seven monitoring locations are currently well below their respective guideline levels. The highest L_{Aeq} noise level was recorded at KR03 (on-site). The main sources of noise identified at the on-site locations were pumps, trucks and activity of people. The R502 road is currently the main source of noise identified at both KR05 (Khuma Town) and KR06 (Hostel), while very quiet conditions were noted at KR07 (house south of the TSF site).

Table 10: Day-time noise monitoring results

Location	Time	L_{Aeq} (dB(A))	L_{Amax} (dB(A))	L_{Amin} (dB(A))	SANS Guideline (dB(A))	Compliant
KR01 (on-site)	12:53	46.8	60.7	38.1	70	Yes
KR02 (on-site)	13:14	41.4	64.6	27.6	70	Yes
KR03 (on-site)	13:34	51.1	67.9	36.4	70	Yes
KR04 (on-site)	14:08	46.8	68.7	24.7	70	Yes
KR05 (off-site)	16:21	44.6	57.4	35.1	55	Yes
KR06 (off-site)	15:54	39.5	65.8	25.4	55	Yes
KR07 (off-site)	15:18	34.9	57.8	21.9	50	Yes

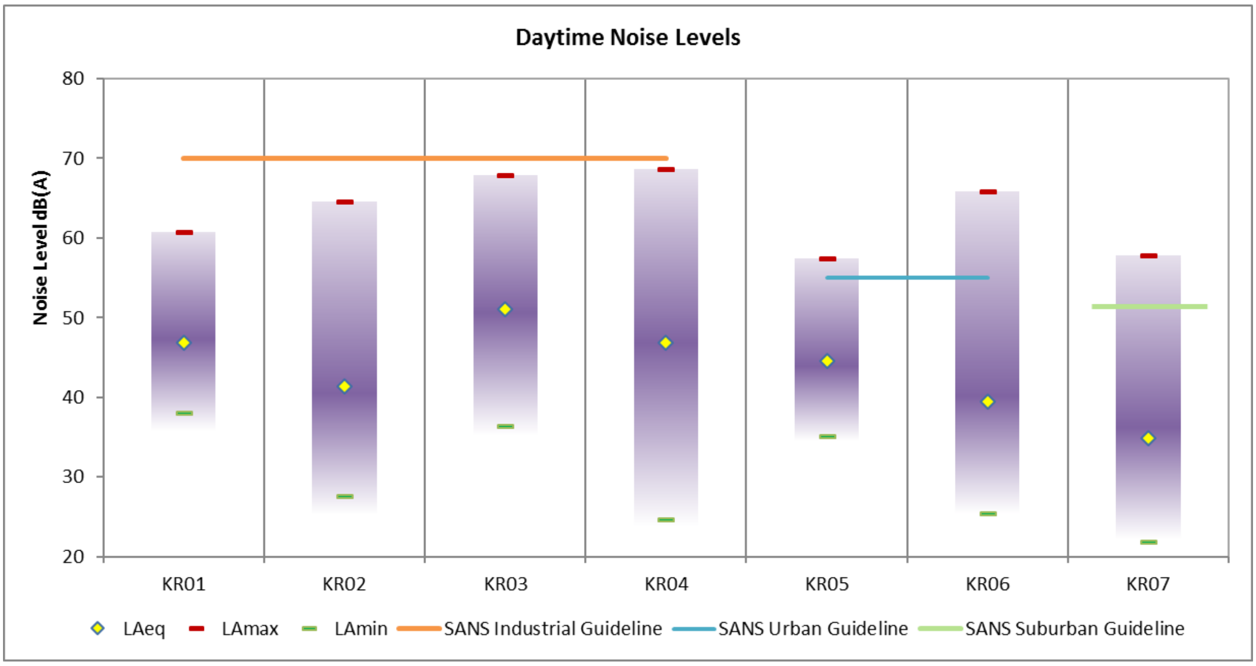

Figure 4: Day-time monitored noise levels. L_{Aeq} (yellow diamond) is compared with the SANS guideline.

7.1.2 NIGHT-TIME

The results from the night-time noise monitoring campaign conducted on 10 August 2017 are presented in **Table 11** and **Figure 5**. Noise levels at the on-site locations were compared to the typical night-time rating level for noise in industrial areas (60 dB(A)), while noise levels at the hostel (since demolished) and Khuma Town were assessed against the urban guideline level (45 dB(A)). Noise levels at the residential area to the south of the TSF was assessed against the suburban guideline level of 40 dB(A).

Due to safety concerns at night, monitoring could not be undertaken at KR05 (Khuma Town) and KR06 (Hostel) and as such there is no night-time data to present for these locations. Noise levels at all other locations remained well below their respective guideline levels. The highest L_{Aeq} noise level was recorded at KR01 (on-site). Dominant noise sources on-site included pumps and intermittent vehicles, while livestock and the S643 road were the dominant sources at the residential area south of the TSF (KR07).

Table 11: Night-time noise monitoring results

Location	Time	L_{Aeq} (dB(A))	L_{Amax} (dB(A))	L_{Amin} (dB(A))	SANS Guideline (dB(A))	Compliant
KR01 (on-site)	22:49	49.1	56.2	42.5	60	Yes
KR02 (on-site)	23:07	40.5	62.5	30.9	60	Yes
KR03 (on-site)	23:24	40.3	56.9	33.5	60	Yes
KR04 (on-site)	23:49	32.1	52.4	26.5	60	Yes
KR05 (off-site)	-	-	-	-	45	-
KR06 (off-site)	-	-	-	-	45	-
KR07 (off-site)	22:00	34.5	52.3	22.8	40	Yes

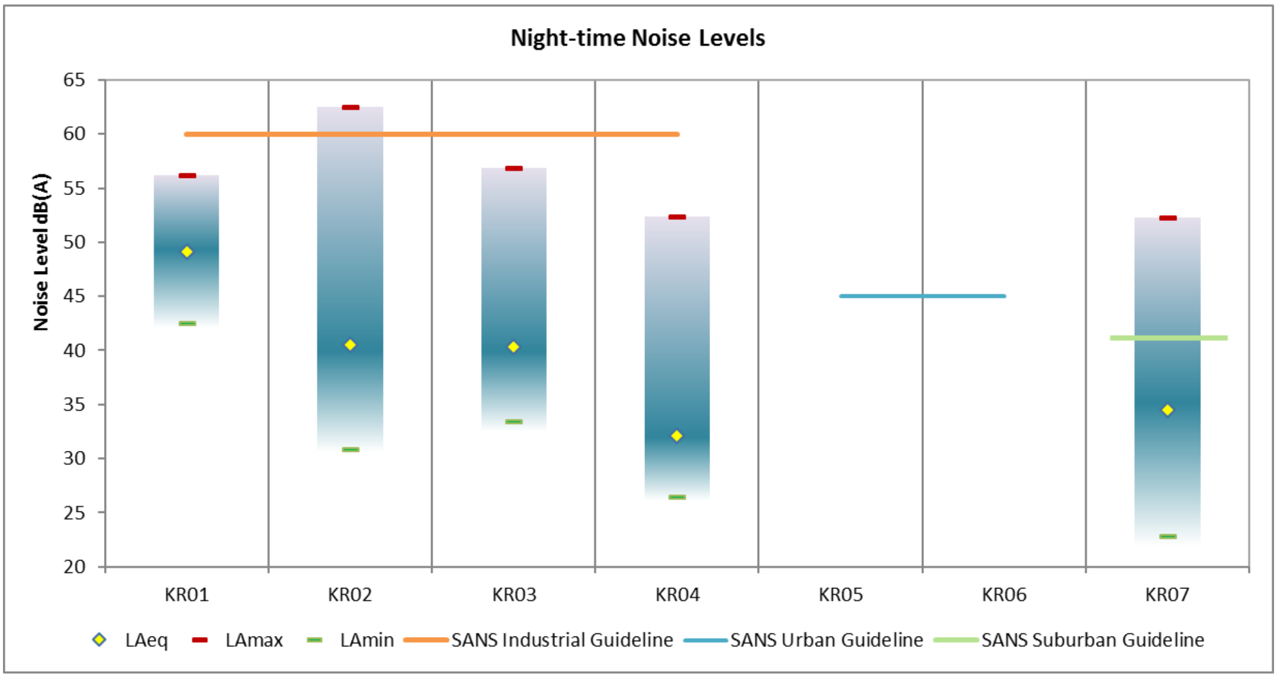

Figure 5: Night-time monitored noise levels. L_{Aeq} (yellow diamond) is compared with the SANS guideline.

7.2 PREDICTED NOISE CLIMATE

7.2.1 CONSTRUCTION PHASE

Based on a worst-case cumulative sound power level of 122.8 dB(A) stemming from all construction equipment operational during the construction phase, as outlined in **Table 7**, the resultant noise levels at specified distances from the source are presented in **Figure 6**. Noise levels in the immediate vicinity of the construction activities are predicted to be high, as would be expected. From 50 m from the source, noise levels will reduce considerably, with noise levels at 165 m from the source dropping below the industrial guideline rating level of 70 dB(A).

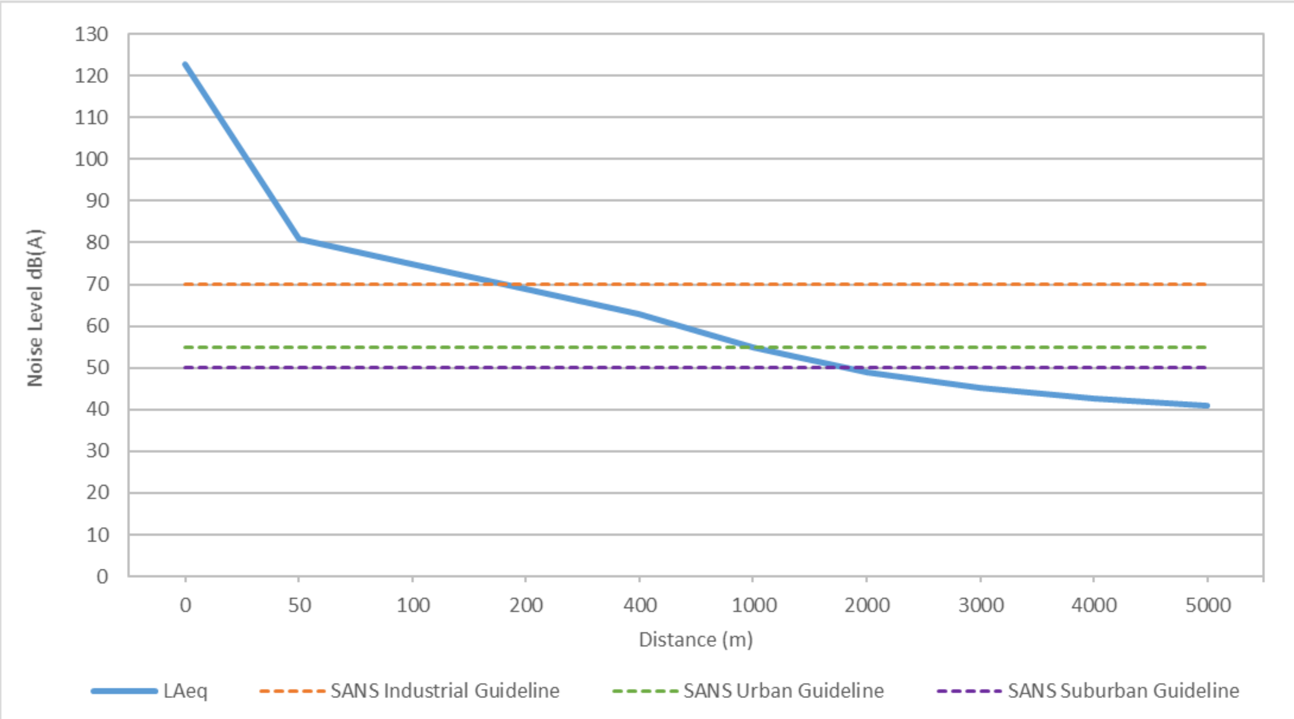

Figure 6: Worst-case predicted noise levels associated with the construction phase

Resultant noise levels and predicted impacts at the receptor locations are presented in **Table 12**. This includes baseline (monitored) noise levels in order to assess changes in noise levels at each location. These changes are assessed using the classifications presented in **Table 4**. It must be noted that these results represent a worst-case scenario when construction activities are occurring on the closest TSF boundary to the receptor in question and do not represent noise levels that will occur all the time. Since sound levels are represented in logarithmic units, simple addition cannot be applied to obtain the cumulative sound levels, but rather logarithmic addition.

Increases in noise levels at the on-site receptor locations as a result of the construction activities will range from 5.5 to 25.4 dB(A). Such increases will result in "little" to "very strong" response at the on-site receptor locations. It must be noted that these receptors are merely on-site locations utilised to match historical monitoring locations and do not represent sensitive receptors. Increases in noise levels at the off-site receptor locations as a result of the construction activities will range from 6.7 to 10.0 dB(A). Such increases will result in "little" to "medium" community response when the construction activities are occurring in closest proximity to each of the receptors. These increases are above the 7 dB(A) threshold for annoyance as per the South African Noise Control Regulations. Such a situation represents a worst-case scenario, which in unlikely to occur in reality.

Table 12: Predicted day-time noise levels at the receptors during the construction phase

Receptor	Predicted noise level dB(A)	Baseline Noise Level dB(A)	Cumulative Noise Level dB(A)	Change in Noise Level dB(A)	Estimated Community Response
KR01 (on-site)	59.0	46.8	59.2	+12.4	Medium to Strong
KR02 (on-site)	57.8	41.4	57.9	+16.5	Strong
KR03 (on-site)	55.2	51.1	56.6	+5.5	Little to Medium
KR04 (on-site)	72.2	46.8	72.2	+25.4	Very Strong
KR05 (off-site)	50.2	44.6	51.3	+6.7	Little to Medium
KR06 (off-site)	45.5	39.5	46.4	+6.9	Little to Medium
KR07 (off-site)	44.4	34.9	44.9	+10.0	Little to Medium

Based on a sound power level of 128.0 dB(A) stemming from a blasting event, the resultant noise levels at specified distances from the source are presented in **Figure 7**. Noise levels in the immediate vicinity of the blasting activities are predicted to be high, as would be expected. From 50 m from the source, noise levels will reduce considerably, with noise levels at 300 m from the source dropping to below the industrial guideline rating level of 70 dB(A). Noise levels will, however, only drop to below the suburban guideline some 3000 m from the source.

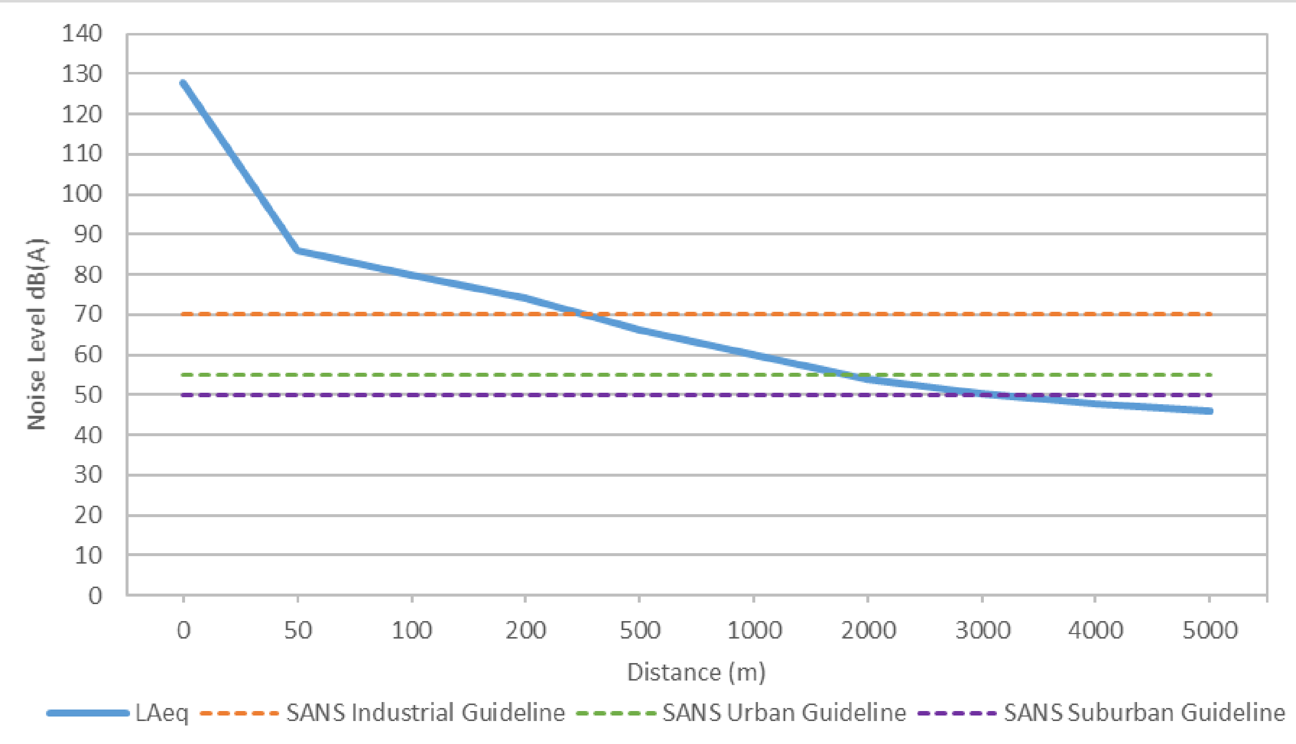

Figure 7: Worst-case predicted noise levels associated with the construction phase during a blasting event

Resultant noise levels and predicted impacts at the receptor locations are presented in **Table 13**. This includes baseline (monitored) noise levels in order to assess changes in noise levels at each location. These changes are assessed using the classifications presented in **Table 4**. It must be noted that these results represent a worst-case scenario when blasting activities are occurring on the closest TSF boundary to the receptor in question and does not represent noise levels that will occur all the time. Since sound levels are represented in logarithmic units, simple addition cannot be applied to obtain the cumulative sound levels, but rather logarithmic addition.

Increases in noise levels at the on-site receptor locations during a blasting event will range from 9.7 to 30.6 dB(A). Such increases will result in "medium" to "very strong" community response at the on-site receptor locations. It must be noted that these receptors are merely on-site locations utilised to match historical monitoring locations and do not represent sensitive receptors. Increases in noise levels at the off-site receptor locations during a blasting event will range from 11.1 to 14.8 dB(A). Such increases will result in "medium" to "strong" community response when a blast occurs in closest proximity to each of the receptors. These increases are above the 7 dB(A) threshold for annoyance as per the South African Noise Control Regulations. It must be noted that blasting is instantaneous and intermittent and will not occur every day.

It must be noted that in addition to the noise impacts of a blasting event, air over pressure and ground-borne vibration impacts may also be noted. Such impacts were beyond the scope of this Environmental Acoustic Impact Assessment and as such were not assessed.

Table 13: Predicted day-time noise levels at the receptors during the construction phase during a blasting event

Receptor	Predicted noise level dB(A)	Baseline Noise Level dB(A)	Cumulative Noise Level dB(A)	Change in Noise Level dB(A)	Estimated Community Response
KR01 (on-site)	64.2	46.8	64.2	+17.4	Strong to Very Strong
KR02 (on-site)	63.0	41.4	63.0	+21.6	Very Strong
KR03 (on-site)	60.4	51.1	60.8	+9.7	Little to Medium
KR04 (on-site)	77.4	46.8	77.4	+30.6	Very Strong
KR05 (off-site)	55.4	44.6	55.7	+11.1	Medium to Strong
KR06 (off-site)	50.6	39.5	51.0	+11.5	Medium to Strong
KR07 (off-site)	49.6	34.9	49.7	+14.8	Medium to Strong

7.2.2 OPERATIONAL PHASE

DAY-TIME

The predicted day-time noise levels at the specified receptor locations associated with the TSF expansion are presented in **Table 14**. The predicted noise levels were compared with the current baseline noise levels (monitored) to assess any changes and the resultant impacts on the surrounding receptors. A visual output of the modelled results is presented in **Figure 8**. It must be noted that the visual output is associated with the proposed TSF expansion alone and is not cumulative (i.e. taking the existing background noise levels into account).

Predicted day-time noise levels at all four of the on-site receptor locations are predicted to increase with the operation of the TSF expansion. Noise levels will increase by between 2.0 and 10.8 dB(A) resulting in "little" to "strong" community response. It must be noted that such receptors are not residential in nature and hence are not classified as sensitive. Assessment of noise levels at these locations are provided for on-site management purposes and to match the historical monitoring locations.

Predicted day-time noise levels at one of the sensitive (off-site) receptor locations (KR05) are predicted to increase marginally with the operation of the TSF expansion. Noise levels will increase by 0.2 dB(A) at this location resulting in "little" community response. Such an increase is well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

Based on the low predicted day-time noise levels and resultant minimal increases at all sensitive receptors, no buffers or areas to be avoided have been identified in this assessment.

Table 14: Predicted day-time noise levels at specified receptor locations during the operation of the Kareerand TSF expansion

Receptor	Predicted Noise Level (dB(A))	Current Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Estimated Community Response
KR01 (on-site)	46.9	46.8	49.9	+3.1	Little
KR02 (on-site)	51.8	41.4	52.2	+10.8	Medium to Strong
KR03 (on-site)	48.8	51.1	53.1	+2.0	Little
KR04 (on-site)	50.4	46.8	52.0	+5.2	Little to Medium
KR05 (off-site)	30.5	44.6	44.8	+0.2	Little
KR06 (off-site)	0.0	39.5	39.5	0.0	Little
KR07 (off-site)	0.0	34.9	34.9	0.0	Little

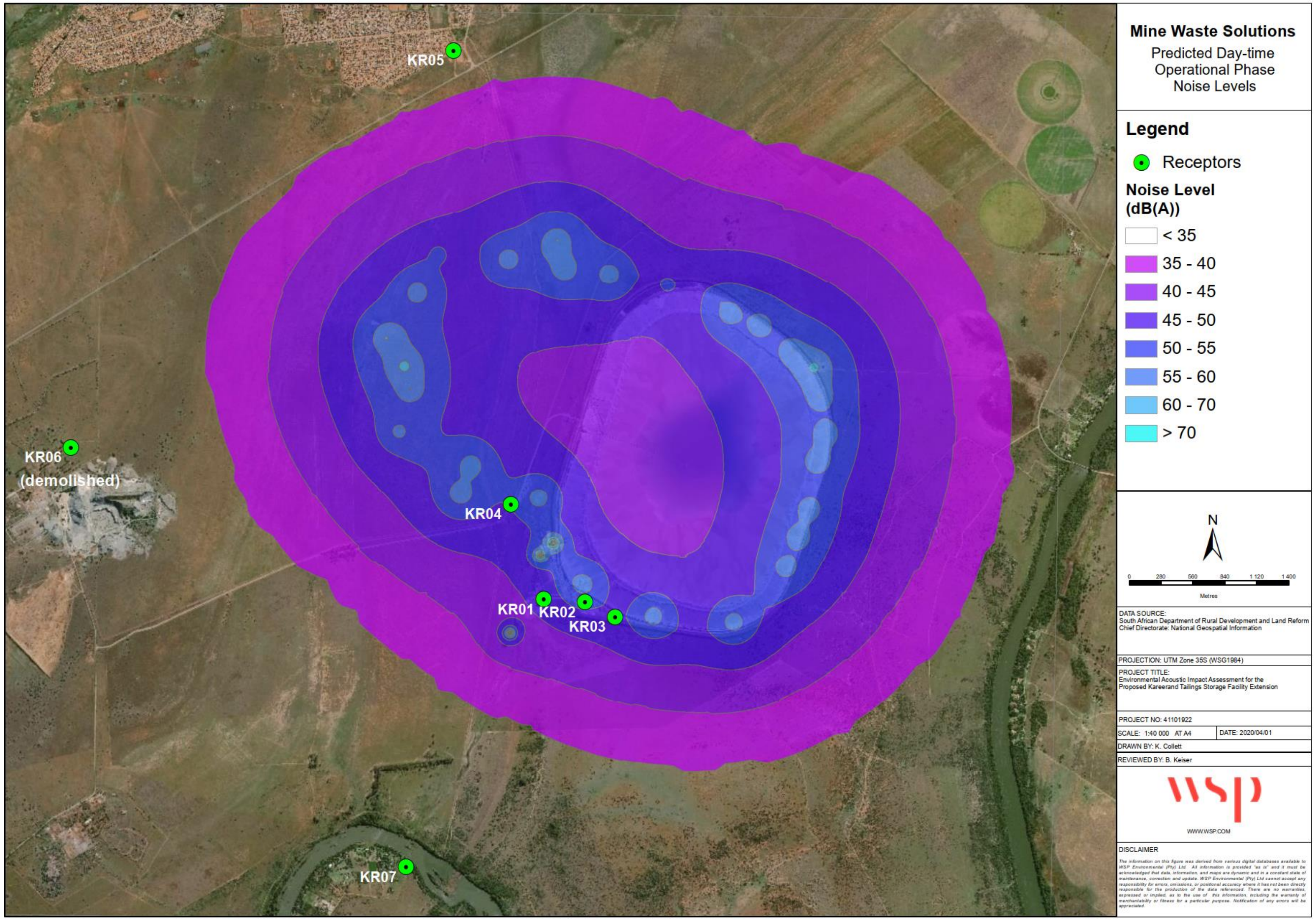

Figure 8: Predicted day-time noise levels during the operational phase of the Kareerand TSF expansion

NIGHT-TIME

The predicted night-time noise levels at the specified receptor locations associated with the TSF expansion are presented in **Table 15**. The predicted noise levels were compared with the current baseline noise levels (monitored) to assess any changes and the resultant impacts on the surrounding receptors. A visual output of the modelled results is presented in **Figure 9**. It must be noted that the visual output is associated with the proposed TSF expansion alone and is not cumulative (i.e. taking the existing background noise levels into account).

Predicted night-time noise levels at all four of the on-site receptor locations are predicted to increase with the operation of the TSF expansion. Noise levels will increase by between 0.5 and 10.1 dB(A) resulting in "little" to "strong" community response. It must be noted that such receptors are not residential in nature and hence are not classified as sensitive. Assessment of noise levels at these locations are provided for on-site management purposes and to match the historical monitoring locations.

With reference to the off-site residential receptors, it is noted that the predicted night-time noise levels at KR06 and KR07 during the operation of the TSF expansion are undetectable (0.0 dB(A)) and as such, no negative impacts are envisaged at these receptors. With the absence of monitored data at KR05, an assessment of the increase in noise levels at this location could not be undertaken. Based on the generally low baseline (monitored) noise levels at all other receptors, it is envisaged that the impact at this location will also be minimal.

Based on the low predicted night-time noise levels and resultant minimal increases at all receptors, no buffers or areas to be avoided have been identified in this assessment.

Table 15: Predicted night-time noise levels at specified receptor locations during the operation of the Kareerand TSF expansion

Receptor	Predicted Noise Level (dB(A))	Current Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Estimated Community Response
KR01 (on-site)	40.0	49.1	49.6	+0.5	Little
KR02 (on-site)	41.8	40.5	44.2	+3.7	Little
KR03 (on-site)	41.3	40.3	43.8	+3.5	Little
KR04 (on-site)	41.7	32.1	42.2	+10.1	Medium to Strong
KR05 (off-site)	18.7	-	-	-	-
KR06 (off-site)	0.0	-	-	0.0	Little
KR07 (off-site)	0.0	34.5	34.5	0.0	Little

7.2.3 MITIGATION RECOMMENDATIONS

CONSTRUCTION PHASE

In order to minimise the acoustic impacts from the construction phase of the proposed project, various mitigation techniques can be employed. These options include both management and technical options:

— Planning construction activities in consultation with local communities so that activities with the greatest potential to generate noise are planned during periods of the day that will result in least disturbance. Information regarding construction activities should be provided to all local communities. Such information includes:

  — Proposed working times;

  — Anticipated duration of activities;

  — Explanations on activities to take place and reasons for activities; and

  — Contact details of a responsible person on site should complaints arise.

- When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible;
- Using noise control devices, such as temporary noise barriers and deflectors for high impact activities, and exhaust muffling devices for combustion engines;
- Selecting equipment with the lowest possible sound power levels; and
- Ensuring equipment is well-maintained to avoid additional noise generation.

OPERATIONAL PHASE

Since acoustic impacts during the operational phase will be minimal, as well as the fact that noise associated with the current operations is negligible, no specific mitigations recommendations are provided.

REHABILITATION PHASE

Since similar equipment will be utilised during the rehabilitation phase (which runs concurrently with the operational phase), the same mitigation recommendations provided for the construction phase above are applicable to the rehabilitation phase.

DECOMMISSIONING PHASE

Since similar equipment will be utilised during the decommissioning phase, the same mitigation recommendations provided for the construction phase above are applicable to the decommissioning phase.

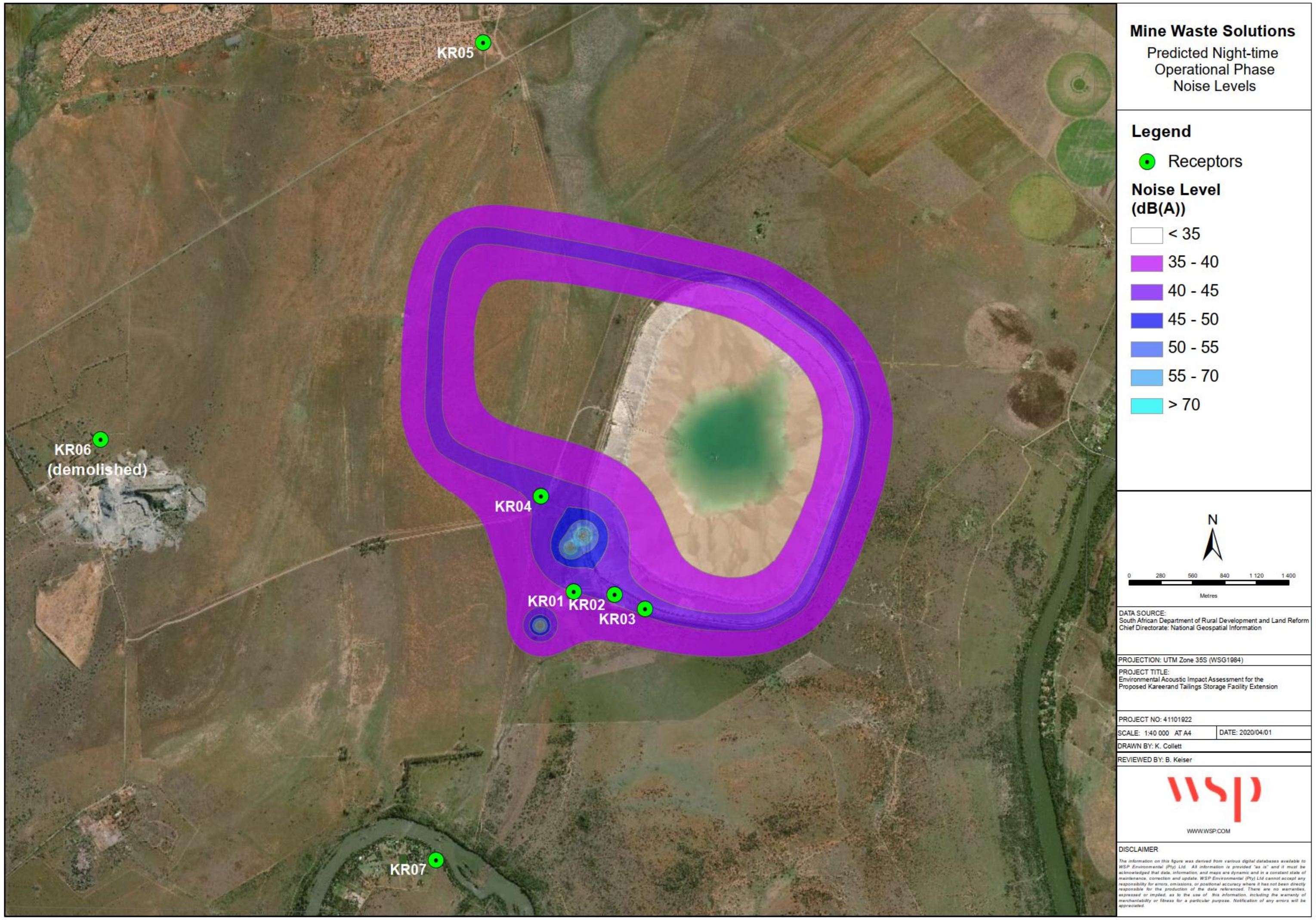

Figure 9: Predicted night-time noise levels during the operational phase of the Kareerand TSF expansion

8 ASSESSMENT OF IMPACTS

The purpose of this acoustic impact assessment is to identify the potential impacts and associated risks posed by the construction and operation of the proposed expansion to the Kareerand TSF on the noise climate of the area. The outcomes of the impact assessment will provide a basis to identify the key risk drivers and make informed decisions on the way forward in order to ensure that these risks do not result in unacceptable social or environmental risk.

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the extent, duration, potential intensity and probability of potentially significant impacts. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix C**. Key localised acoustic impacts associated with the TSF expansion include:

— Construction phase impacts of noise on residential receptors;
— Future operational phase impacts of noise on residential receptors; and
— Decommissioning phase impacts of noise on residential receptors.

Inclusion of monitored data that is presented alongside the predicted (modelled) data enables an assessment in the change in noise levels as a result of the TSF expansion. Such comparison essentially accounts for the cumulative impact of the project, taking the existing, background noise climate into consideration. As such, the impacts presented here are cumulative.

Outcomes of the acoustic impact assessment are contained within **Table 16** outlining the impact of each parameter and the resulting risk level. The resultant environmental acoustic risks for residential receptors were ranked "low" during both the construction and operational phases.

Table 16: Impact assessment of risks associated with the construction and future operation of the Kareerand TSF expansion

	Without Mitigation						With Mitigation					
Description	Extent	Duration	Potential Intensity	Probability	Significance	**Risk Level**	Extent	Duration	Potential Intensity	Probability	Significance	**Risk Level**
Construction phase impacts of noise on residential receptors	2	1	2	0.5	2.5	**Low**	2	1	2	0.2	1	**Low**
Future operational phase impacts of noise on residential receptors	1	3	1	0.1	0.5	**Low**	1	3	1	0.1	0.5	**Low**
Decommissioning phase impacts of noise on residential receptors	2	1	2	0.5	2.5	**Low**	2	2	2	0.2	1	**Low**

9 PROJECT AUTHORISATION

With such minimal increases in noise levels during the operational phase, it is envisaged that the operation of the facility can be authorised without any major impacts or complaints. The facility is adequately positioned away from sensitive receptors and will not negatively impact the noise climate at the receptors. The only major changes in noise levels are predicted during the construction phase. Should complaints arise, it is recommended that the mitigation and management techniques detailed in **Section 7.2.3** be implemented. No special conditions or additional monitoring requirements need to be included in the environmental authorisation.

10 CONCLUSIONS

This Environmental Acoustic Impact Assessment investigated noise associated with the construction and operation of the expansion to the Kareerand TSF. The construction phase of the project will include soil reclamation via excavators and dump trucks; trench construction with possible blasting; earthen wall construction via excavators, dump trucks and rollers; pipeline laying and construction of access roads. During the operational phase, similar operations will occur at the proposed TSF expansion that are currently occurring at the TSF. Slurry will be pumped continuously to the TSF and soil for rehabilitation will be obtained from three different borrow pit areas around the TSF. Placement of soil for rehabilitation will occur during day-time hours (06:00 to 18:00). An additional ten light duty vehicles will be put into operation around the TSF perimeter and on the TSF walls.

In order to assess the existing noise climate in the area surrounding the TSF facility, ambient noise monitoring was conducted at four on-site locations (historical monitoring locations) and at three residential receptor locations surrounding the site. An acoustic inventory was developed to identify all potential sources of noise associated with the construction and operational phases of the TSF expansion. The acoustic impacts of the proposed facility were then assessed through the use of the CadnaA acoustic model.

Baseline monitoring indicated current day-time noise levels at all seven monitoring locations are compliant with the SANS guideline rating levels. The main sources of noise identified at the on-site locations were pumps, trucks and activity of people. The R502 road is currently the main source of noise identified at both KR05 (Khuma Town) and KR06 (Hostel - since demolished), while very quiet conditions were noted at KR07 (house south of the TSF site).

Due to safety concerns at night, monitoring could not be undertaken at KR05 (Khuma Town) and KR06 (Hostel) and as such there is no night-time data to present for these locations. Night-time noise levels at all other locations remained well below their respective guideline levels. The highest L_{Aeq} noise level was recorded at KR01 (on-site). Dominant noise sources on-site included pumps and intermittent vehicles, while livestock and the S643 road were the dominant sources at the residential area south of the TSF (KR07).

During the construction phase, noise levels at the on-site receptor locations are predicted to increase by between 5.5 and 25.4 dB(A). Such increases will result in "little" to "very strong" community response at the on-site receptor locations. It must be noted that these receptors are merely on-site locations utilised to match historical monitoring locations and do not represent sensitive receptors. Increases in noise levels at the off-site receptor locations as a result of the construction activities will range from 6.7 to 10.0 dB(A). Such increases will result in "little" to "medium" community response when the construction activities are occurring in closest proximity to each of the receptors. These increases are above the 7 dB(A) threshold for annoyance as per the South African Noise Control Regulations. It must be noted that these results represent a worst-case scenario when construction activities are occurring at the closest TSF boundary to the receptor in question and do not represent noise levels that will occur all the time. Such a scenario is unlikely to occur in reality.

Should complaints arise during the construction phase, various mitigation techniques can be employed. These options include both management and technical options. Such techniques include planning construction activities in consultation with local communities; limiting the number of simultaneous activities when in close proximity to a receptor; using temporary acoustic barriers for high impact activities; selecting equipment with the lowest possible sound power levels; and ensuring equipment is well-maintained to avoid additional noise generation.

During the operational phase, predicted day-time noise levels at all four of the on-site receptor locations are predicted to increase. Noise levels will increase by between 2.0 and 10.8 dB(A) resulting in "little" to "strong" community response. It must be noted that such receptors are not residential in nature and hence are not classified as sensitive. Assessment of noise levels at these locations are provided for on-site management purposes and to match the historical monitoring locations. The predicted day-time noise levels at one of the off-site sensitive receptor locations (Khuma Town) are predicted to increase marginally with the operation of the TSF expansion. Noise levels at this location will increase by 0.2 dB(A) resulting in “little” community response.

At night, when the reclamation activities cease, noise levels at all four on-site receptor locations are predicted to increase with the operation of the TSF expansion. Noise levels will increase by between 0.5 and 10.1 dB(A) resulting in “little” to “strong” community response. It must be noted that such receptors are not residential in nature and hence are not classified as sensitive. Assessment of noise levels at these locations are provided for on-site management purposes and to match the historical monitoring locations.

With reference to the off-site residential receptors, it is noted that the predicted night-time noise levels at KR06 (Hostel) and KR07 (residential area to the south) during the operation of the TSF expansion are undetectable (0.0 dB(A)) and as such, no negative impacts are envisaged at these receptors. With the absence of monitored data at KR05, an assessment of the increase in noise levels at this location could not be undertaken. Based on the generally low baseline (monitored) noise levels at all other receptors, it is envisaged that the impact at this location will also be minimal. Based on the low predicted noise levels and resultant minimal increases at all receptors, no buffers or areas to be avoided have been identified in this assessment.

With such minimal increases in noise levels during the operational phase, no mitigation recommendations for the operation of the proposed TSF expansion are proposed and it is envisaged that the operation of the facility can be authorised without any major impacts or complaints. With rehabilitation occurring simultaneously with the operational phase, the same mitigation recommendations provided for the construction phase can be applied to the rehabilitation phase.

11 REFERENCES

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- World Health Organisation (WHO) (1999): Guidelines for Community Noise. Available online at: http://www.who.int/docstore/peh/noise/guidelines2.html.

APPENDIX

A

CURRICULUM VITAE

APPENDIX

KIRSTEN COLLETT, M.Sc. (Pr.Sci.Nat)

Senior Consultant (Air Quality & Acoustics), Environment & Energy

Years with the firm

8

Years of experience

10

Professional qualification

Pri.Sci.Nat

Areas of expertise

Air Quality Impact Assessments

Air Quality Management

Ambient Air Quality and Acoustic Monitoring

Environmental Acoustic Assessments

CAREER SUMMARY

Kirsten is a Senior Air Quality and Acoustic Consultant with a Master of Science (Atmospheric Sciences) degree obtained from the University of the Witwatersrand. She is currently employed at the Johannesburg branch of WSP Environmental and has worked on various air quality and acoustic impact assessments; air quality management plans; air quality and acoustic monitoring projects; and air quality and acoustic modelling projects for a variety of clients over the past eight years. She has provided consulting support to various client industries including petrochemical, mining, metallurgical, manufacturing and local government bodies among others. She is also a registered Professional Natural Scientist (Pr.Nat.Sci.) with the South African Council for Natural Scientific Professions (SACNASP).

EDUCATION

Master of Science, Atmospheric Sciences, University of Witwatersrand, Johannesburg, South Africa	2009
Bachelor of Science (Honours) Geography and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa	2006
Bachelor of Science, Geography and Environmental Studies, University of Witwatersrand, Johannesburg, South Africa	2005

ADDITIONAL TRAINING

Business-focussed Project Management	2013
Snake Awareness Training	2016

PROFESSIONAL MEMBERSHIPS

South African Council for Natural Scientific Professions	SACNASP
National Association for Clean Air	NACA

PROFESSIONAL EXPERIENCE

Air Quality Impact Assessments (AQIAs)

— AQIA for a Proposed Expansion to an Iron Ore Loading Port, Saldanha (2019): Lead Consultant. WSP was contracted to undertake an air quality impact assessment to determine the impacts of a proposed increase in iron ore storage and handling capacity at the Saldanha Port. The project included a baseline assessment, compilation of a comprehensive emissions inventory and dispersion modelling using the CALPUFF dispersion model to assess the impacts of emissions on the surrounding communities. Client: Transnet Port Terminals Saldanha Bay.

— AQIA for a proposed coal stockpile at an underground mine, Ogies, Mpumalanga, South Africa (2018): Project Manager and Lead Consultant. WSP was appointed to conduct an Air Pollution Assessment in the form of an Atmospheric Impact Report for a proposed coal stockpile at the underground section of the Zibulo Colliery. The assessment consisted of the compilation of a comprehensive emissions inventory to account for emissions from the proposed stockpile as well as dispersion modelling using the AERMOD dispersion model to assess the impacts of emissions on any surrounding receptors. Client: Anglo American Coal SA.

- AQIA for a Proposed Waste to Energy Facility, Kuwait (2017-2018): Lead Consultant. WSP was contracted to undertake an air quality impact assessment to determine the impacts of a proposed waste to energy facility in Kuwait. The project included assessment of baseline monitoring data (conducted by a local partner), a baseline assessment, emissions inventory, dispersion modelling using CALPUFF and comparison of the predicted concentrations against the Kuwait and International ambient air quality guidelines/standards. A preliminary screening assessment was undertaken using SCREEN3 to determine the monitoring locations for the baseline monitoring campaign. Client: WSP Middle East.
- AQIA for a Chemical Manufacturer, New Germany, KwaZulu-Natal, South Africa (2015): Project Manager and Lead Consultant. WSP was appointed to conduct an Air Pollution Assessment in the form of an Atmospheric Impact Report for the proposed Polyol Blending Plant at the Dow Advanced Materials site in New Germany. The assessment consisted of the compilation of a comprehensive emissions inventory to account for emissions from both the existing and proposed operations as well as dispersion modelling using the AERMOD dispersion model to assess the impacts of emissions on the surrounding communities. Client: The Dow Chemical Company (Rohm and Haas) - Advanced Materials.
- AQIA for Remediation of a Smelter, Richards Bay, KwaZulu-Natal, South Africa (2015-2016): Lead Consultant. WSP was contracted to undertake an air quality impact assessment to determine the impacts of remediating the legacy landfill sites at the Bayside Aluminium Smelter in Richards Bay. Kirsten was responsible for the development of a comprehensive emissions inventory; and determination of the impact of the proposed project on the surrounding communities using the AERMOD dispersion modelling software. Client: South32 Aluminium SA Limited.
- AQIA for a Smelter Decommissioning, Richards Bay, KwaZulu-Natal, South Africa (2014-2015): Lead Consultant. WSP was contracted to undertake a screening-level air quality impact assessment for the decommissioning of the Bayside Aluminium Smelter in Richards Bay. Kirsten was responsible for the development of a comprehensive emissions inventory; and determination of the impact of the proposed project on the surrounding communities using the AERSCREEN Tier 1 dispersion modelling software. Client: South32 Aluminium SA Limited.
- AQIA for a Biodiesel Plant, Coega IDZ, Eastern Cape, South Africa (2011-2015): Lead Consultant. As part of a larger Environmental Impact Assessment for a proposed biodiesel production plant in Coega, WSP Environmental was commissioned to conduct a specialist air quality impact assessment for the facility. Kirsten was responsible for compiling the air quality impact assessment which was initially a screening-level assessment and later upgraded to a Tier 2 full air quality impact assessment. The project involved a baseline review of the area; baseline meteorological and pollutant data analysis; emission inventory compilation; dispersion modelling; reporting; and atmospheric emission licence (AEL) compilation. Client: First in Spec Biofuels Ltd.
- AQIA for a Proposed Mine, Wakkerstroom, Mpumalanga, South Africa (2012-2014): Lead Consultant. WSP Environmental was commissioned to undertake an air quality impact assessment for a proposed underground coal mine near Wakkerstroom, Mpumalanga as part of a comprehensive environmental and social impact assessment for the mine. Kirsten was responsible for conducting the air quality assessment. The assessment comprised on-site ambient air quality monitoring in order to assess the existing air quality in the region as well as dispersion modelling (using the ADMS (v5) software) to determine the predicted impacts that the proposed mine will have on the existing air quality. Client: Atha-Africa Ventures (Pty) Ltd.
- AQIA for a Tyre Manufacturer, Durban, KwaZulu-Natal, South Africa (2012-2013): Consultant. WSP Environmental was commissioned to perform an air

quality impact assessment for a tyre manufacturer to determine the changes in emissions should they replace their existing heavy fuel oil fired boiler with two coal fired boiler equipped with bag filters. Kirsten was responsible for conducting this screening-level air quality assessment through a baseline review of the site; emissions inventory compilation; and determination of the impact of the boiler emissions on the surrounding communities using the SCREEN3 screening-level dispersion modelling software. Client: Apollo Tyres South Africa (Pty) Ltd.

— AQIA for Ferrochrome Production Facility, Rustenburg, North West, South Africa (2012): Lead Consultant. WSP Environmental was commissioned to perform an air quality impact assessment of a proposed ferrochrome production facility in Zinniaville, Rustenburg as part of a larger environmental impact assessment. Kirsten was responsible for conducting the air quality assessment through a baseline review of the site; compilation of a detailed site specific emissions inventory; determination of the impact of the proposed facility on the surrounding communities using the ADMS dispersion modelling software; and compilation of the atmospheric emission licence (AEL) application. Client: Ferrochrome Furnaces (Pty) Ltd.

— AQIA for a Fuel Depot Recommissioning, Western Cape, South Africa (2012): Consultant. WSP Environmental was commissioned as part of a broader environmental impact assessment, to conduct an air quality impact assessment of the recommissioning of the Total Paarden Island fuel storage and distribution terminal near Cape Town. The air quality impact assessment investigated emissions generated as a result of both the construction phase and operational phase of the facility. Kirsten was responsible for the assessment which comprised a baseline review of the site; compilation of a detailed site specific emissions inventory; estimation of emissions generated from each of the onsite storage tanks through the use of the TANKS 4.0.9 model; and determination of the impact of the proposed facility on the surrounding communities using the SCREEN3 dispersion modelling software. Client: SIVEST SA (Pty) Ltd.

— AQIA for a Proposed Oilseeds Processing Plant, Standerton, Mpumalanga, South Africa (2011-2012): Consultant. Noble Resources proposed to construct an oilseeds processing plant in Standerton and required an air quality assessment to determine what impacts the activity would have in the region. Kirsten performed this assessment through a baseline assessment of the site; development of a comprehensive emissions inventory; and determination of the proposed impacts through the use of a Tier 2 atmospheric dispersion model (ADMS) Client: Noble Resources Ltd.

— Ambient Air Quality Assessment during Car Free Day, Johannesburg, South Africa (2007-2008): Consultant. This project monitored vehicular emissions from a mobile monitoring station placed alongside the M1 highway in Johannesburg. This was done to evaluate the effectiveness of car free day and to assess whether there was a reduction in emissions on the day. Kirsten was involved in the assessment, analysis and reporting in this specific project. Client: City of Johannesburg.

Air Quality Management

— Mafube Colliery Integrated Air Quality Management Plan, Mpumalanga, South Africa (2015-2016): Lead Consultant. Anglo American Coal SA requested the compilation of an integrated Air Quality Management Plan (AQMP) for the Mpumalanga Colliery in the Mpumalanga province. The AQMP was aimed at improving air quality at the colliery through the identification of main sources of emissions and recommendations to reduce emissions from these sources. Kirsten was responsible for the compilation of the AQMP which was performed through a baseline assessment of activities at the colliery; identification of key emission sources; compilation of a detailed site specific emissions inventory; determination of the impact of emissions from the colliery on surrounding communities using the AERMOD dispersion modelling software; review of current management and mitigation techniques at the colliery; and development of strategies to minimise any impacts of emissions from the colliery going forward. Client: Anglo American Coal SA.

- Air Quality Management Reports, White River, Mpumalanga, South Africa (2011-2015): Consultant. WSP Environmental has been continuously monitoring formaldehyde, suspended particulate matter (PM_{10}) and dust deposition (fallout) concentrations in and around the Sonae Novobord White River plant since 2008. Kirsten was responsible for analysing and assessing the ambient monitoring data and drafting the air quality management reports. Client: Sonae Novobord (Pty) Ltd.
- Combined Integrated Air Quality Management Plan for the Greenside, Kleinkopje and Landau Collieries, Mpumalanga, South Africa (2013-2014): Lead Consultant. Anglo American Coal SA requested the compilation of a combined integrated Air Quality Management Plan (AQMP) for the Greenside, Kleinkopje and Landau Collieries in the Mpumalanga province. The AQMP was aimed at becoming a management tool for the collieries going forward Kirsten was responsible for the compilation of the combined AQMP which was performed through a baseline assessment of activities at each colliery; identification of key emission sources; compilation of a detailed site specific emissions inventory for each colliery; determination of the impact of emissions from each colliery (as well as the combined impact) on surrounding communities using the CALPUFF dispersion modelling software; review of current management and mitigation techniques at each colliery; and development of strategies to minimise any impacts of emissions going forward. Client: Anglo American Coal SA.
- Fugitive Dust Suppression Plan for a Steel Producer, Middelburg, Mpumalanga, South Africa (2013): Lead Consultant. WSP Environmental was commissioned to compile a fugitive dust suppression plan in order to assess the fugitive dust emanating from a stainless steel plant in Middelburg. Kirsten was responsible for compiling the fugitive dust suppression plan through on-site dust fallout monitoring; analysis of all historical particulate matter, dust fallout and meteorological data for the site; identification of key emission sources; and provision of mitigation and management measures in order to limit the impact of fugitive dust going forward. Client: Columbus Stainless (Pty) Ltd.
- Greenside Colliery Integrated Air Quality Management Plan, Mpumalanga, South Africa (2012-2013): Lead Consultant. Anglo American Coal SA requested the compilation of an integrated Air Quality Management Plan (AQMP) for the Greenside Colliery in the Mpumalanga province. The AQMP was aimed at improving air quality at the colliery through the identification of main sources of emissions and recommendations to reduce emissions from these sources. Kirsten was responsible for the compilation of the AQMP which was performed through a baseline assessment of activities at the colliery; identification of key emission sources; compilation of a detailed site specific emissions inventory; determination of the impact of emissions from the colliery on surrounding communities using the ADMS dispersion modelling software; review of current management and mitigation techniques at the colliery; and development of strategies to minimise any impacts of emissions from the colliery going forward. Client: Anglo American Coal SA.
- Landau Colliery Integrated Air Quality Management Plan, Mpumalanga, South Africa (2012): Lead Consultant. Anglo American Coal SA requested the compilation of an integrated Air Quality Management Plan (AQMP) for the Landau Colliery in the Mpumalanga province. The AQMP was aimed at improving air quality at the colliery through the identification of main sources of emissions and recommendations to reduce emissions from these sources. Kirsten was responsible for the compilation of the AQMP which was performed through a baseline assessment of activities at the colliery; identification of key emission sources; compilation of a detailed site specific emissions inventory; determination of the impact of emissions from the colliery on surrounding communities using

the ADMS dispersion modelling software; review of current management and mitigation techniques at the colliery; and development of strategies to minimise any impacts of emissions from the colliery going forward. Client: Anglo American Coal SA.

- Strategic Overview of Air Quality Conditions at the Sonae Novobord Plant, White River, Province, South Africa (2008-2011): Consultant. WSP Environmental has been monitoring various air quality aspects in and around the Sonae Novobord White River plant since 2008. Concentrations of formaldehyde, suspended particulate matter (PM_{10}) and dust deposition (fallout) have been continually monitored in terms of the requirements of the NEMA Section 24G Environmental Management Plan. Kirsten was involved in performing a strategic assessment of conditions at the plant, to ascertain whether the air quality has improved over time and whether the conditions set out in the Record of Decision and the Air Quality Management Plan are being met. Client: Sonae Novobord (Pty) Ltd.

Ambient Monitoring

- Dust Fallout and Particulate Matter Monitoring for nine Collieries, Mpumalanga, South Africa (2016-present): Project Manager. WSP was appointed to manage Anglo American Coal SA's air quality monitoring requirements at nine of their collieries. The contract includes dust fallout monitoring at all nine collieries, while continuous particulate matter (PM_{10} and $PM_{2.5}$) monitoring is conducted at seven collieries using mobile custom-designed solar system trailers. Kirsten is responsible for project management and quality control for the project. Client: Anglo American Coal SA.
- Dust Fallout and Particulate Matter Monitoring for a Phosphate Mine, Phalaborwa, Limpopo, South Africa (2016-2019): Project Manager. WSP was commissioned to manage and maintain a dust monitoring network for Foskor Phalaborwa's phosphate rock operations in the Limpopo Province. The monitoring network comprises 37 dust fallout samplers, and a real-time particulate matter (PM_{10}) monitor. Kirsten is responsible for project management and quality control for the project. Client: Foskor (Pty) Ltd.
- Leak Detection and Repair Programs for Ten Fuel Depots, South Africa (2016-2017): Project Manager. WSP was appointed to conduct leak detection and repair programs at ten of Total South Africa's bulk fuel storage depots as part of their atmospheric emission licence conditions. Kirsten was responsible for project management, data analysis and reporting for the project. Client: Total South Africa (Pty) Ltd.
- Dust Fallout Monitoring for Kendal Power Station, Kendal, Mpumalanga, South Africa (2016): Project Manager. WSP was commissioned to monitor dust fallout at the Kendal Power Station in Mpumalanga for a six month period. Kirsten was responsible for project management, data analysis and reporting for the project. Client: Eskom Holdings SOC Limited.
- Dust Fallout Monitoring for a Steel Facility, Mpumalanga, South Africa (2012-2015): Project Manager. As part of Evraz Highveld Steel's on-going monitoring program for the assessment of dust generated by the steelworks and associated activities, WSP Environmental was commissioned to conduct dust fallout monitoring both on and off site. Monitoring has been performed over time at the site on a monthly basis in accordance with the ASTM D1739 reference method. Kirsten was responsible for data analysis, interpretation and reporting during the 2012 monitoring period. Most recently, Kirsten was responsible for project management during the 2014 and 2015 campaign. Client: Evraz Highveld Steel and Vanadium.
- Particulate Matter Monitoring for a Steel Facility, Mpumalanga, South Africa (2014-2015): Project Manager. WSP Environmental was commissioned to monitor particulate matter concentrations at three locations in and around the Evraz Highveld Steel facility using E-sampler monitoring equipment. Kirsten was

responsible for project management and reporting for the project. Client: Evraz Highveld Steel & Vanadium Corporation Ltd.

- Dust Fallout Monitoring for Majuba Power Station, Volksrust, Mpumalanga, South Africa (2013-2015): Project Manager. WSP Environmental was commissioned to monitor dust fallout at the Majuba Power Station in Mpumalanga for a two year period. Kirsten was responsible for project management, data analysis and reporting for the project. Client: Eskom Holdings SOC Limited.
- Dust Fallout Monitoring, Kendal, Mpumalanga, South Africa (2013-2014): Project Manager. WSP Environmental was commissioned to monitor dust fallout and meteorological conditions at the Tubular Holdings workers' living quarters near Kendal, Mpumalanga. The project was initiated to determine the source of dust at this location. Kirsten was responsible for project management; data analysis; and reporting for the project. Client: Tubular Holdings (Pty) Ltd.
- Dust Monitoring Program for a Foundry, Atlantis, Western Cape, South Africa (2011): Data Analyst. WSP Environmental has been commissioned to provide specialist air quality support and monitoring services to Atlantis Foundries (Pty) Ltd, situated within Atlantis near Cape Town. The project included: dust deposition monitoring, the compilation of an Atmospheric Emission Licence (AEL) for the facility and the development of site-specific dust mitigation and management strategies. Kirsten has been involved in assisting with data analysis and interpretation of the results obtained from the monthly monitoring campaigns at the site. Client: Atlantis Foundries (Pty) Ltd.
- Air Quality Monitoring for a Proposed Power Plant, Ressano Garcia, Mozambique, Africa (2011): Field Consultant. WSP Environmental was commissioned by Sasol New Energy Holding (Pty) Ltd to undertake an integrated environmental and social impact assessment (ESIA) and bankable environmental, social and health impact assessment (ESHIA) for the proposed gas engine power plant that is to be constructed in Ressano Garcia, Mozambique. As part of this assessment, a specialist air quality study was conducted to assess what impacts the proposed plant may have on air quality in the region. Kirsten was responsible in assisting with the set-up of passive monitoring equipment, dust buckets and a meteorological station at the site. Client: Sasol New Energy Holding (Pty) Ltd.
- European Integrated Project on Aerosol, Cloud, Climate and Air Quality Interactions, Mpumalanga, South Africa (2007-2010): Technical Consultant. This was an international aerosol project focusing on four developing countries, namely South Africa, India, Brazil and China. It was initiated to provide a comparative set of aerosol emission data between the four countries. Kirsten was involved in the setup and maintenance of the monitoring instrumentation at the South African site. For this, Kirsten was also involved in an aerosol training course in Hyytiälä, Finland as well as technical training in Leipzig, Germany for the SMPS (Scanning Mobility Particle Sizer) instrument.
- Ambient Air Monitoring at the Point of Highest Impact Resulting from Kriel and Matla Power Stations, Mpumalanga, South Africa (2009): Consultant. This study was conducted on the Mpumalanga Highveld in order to increase our understanding of the sources and diurnal variations of various atmospheric species as well as the effects of local meteorology on the concentration of these species. The study included ambient monitoring using a mobile monitoring station. Kirsten was involved in the data analysis, statistical manipulation and reporting. Client: Eskom Holdings SOC Limited.

Acoustics

- Environmental Acoustic Impact Assessment for the proposed expansion to a paper mill, KwaZulu-Natal, South Africa (2018): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for the proposed expansion to the Sappi Saiccor Mill, near Umkomaas. Kirsten was responsible for conducting the assessment which included baseline acoustic monitoring; development of a comprehensive acoustic inventory for the proposed expansion activities; and determination of the impact of the proposed expansion on the surrounding sensitive receptors through the use of attenuation-over-distance acoustic calculations. Client: Sappi Southern Africa Limited.

- Environmental Acoustic Impact Assessment for a proposed timber handling facility, Umkomaas, KwaZulu-Natal, South Africa (2017): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for a proposed timber handling facility near Umkomaas. Kirsten was responsible for conducting the assessment which included baseline acoustic monitoring; development of a comprehensive acoustic inventory; and determination of the impact of the proposed facility on the surrounding sensitive receptors (specifically, a newly proposed retirement village) using the Computer Aided Noise Abatement (CadnaA) acoustic modelling software. Client: Sappi Southern Africa Limited.
- Environmental Acoustic Impact Assessment for the proposed rehabilitation of the Sekoma-Morwamosu road section, Botswana (2017): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for the proposed rehabilitation of a section of road within the southern part of Botswana. Kirsten was responsible for conducting the assessment. Current operational noise levels in the vicinity of the road section where determined using an acoustic modelling platform, with current (2017) traffic count data as input. The acoustic impacts of the proposed rehabilitation were determined using attenuation-over-distance calculations (construction phase) and acoustic modelling (operational phase). Changes in noise levels at specific receptor locations were then assessed for each phase and the resultant community responses were evaluated. Client: Loci Environmental.
- Environmental Acoustic Impact Assessment for the expansion to a tailings storage facility, North West Province, South Africa (2017): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for the proposed extension of the Kareerand Tailings Storage Facility. Kirsten was responsible for conducting the assessment which included baseline acoustic monitoring; development of a comprehensive acoustic inventory for both the construction and operational phases of the project; and determination of the impact of the proposed project on the surrounding sensitive receptors using the Computer Aided Noise Abatement (CadnaA) acoustic modelling software. Client: AngloGold Ashanti.
- Environmental Acoustic Impact Assessment for three wind energy facilities, Northern and Western Cape, South Africa (2016-2017): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for three proposed wind energy facilities located between Sutherland and Matjiesfontein in the Northern and Western Cape provinces. Kirsten was responsible for conducting the assessments which included baseline acoustic monitoring; development of a comprehensive acoustic inventory for both the construction and operational phases of the project; and determination of the impact of the proposed wind energy facilities on the surrounding sensitive receptors (farm houses) using the Computer Aided Noise Abatement (CadnaA) acoustic modelling software. Client: BioTherm Energy.
- Environmental Acoustic Impact Assessment for the Redevelopment of the Athlone Power Station, Cape Town, Western Cape, South Africa (2016-2017): Lead Consultant. WSP was contracted to undertake an environmental acoustic impact assessment for redevelopment of the Athlone Power Station site to determine the noise impacts of a) the surrounding activities on the redevelopment site; and b) the proposed site activities on the surrounding communities. Kirsten was responsible for conducting the assessment which included baseline acoustic monitoring; development of a comprehensive noise source inventory; and determination of the impact of the current noise climate on the Athlone site as well

as the impact of the proposed redevelopment activities on the surrounding communities. Client: City of Cape Town.

- Environmental Acoustic Monitoring for a Gas Engine Power Plant, Ressano Garcia, Mozambique (2016): Project Manager. WSP was commissioned to undertake acoustic monitoring at the Central Termica De Ressano Garcia gas engine power plant site in order to assess the noise associated with the operation of the plant. Kirsten was responsible for project management, technical input and reporting for this project. Client: Central Termica Da Ressano Garcia.
- Community Environmental Acoustic Monitoring Survey, Vereeniging, Gauteng, South Africa (2016): Project Manager. WSP was appointed to conduct community-based noise monitoring in a region adjacent to the New Vaal Colliery in order to assess the acoustic impacts of the colliery on the surrounding communities. Kirsten was responsible for project management, data analysis and reporting for the project. Client: Anglo American Coal SA.
- Screening Level Environmental Acoustic Impact Assessment for a New Ventilation Shaft, Rustenburg, North West, South Africa (2016): Lead Consultant. WSP was appointed to investigate the acoustic impacts associated with the construction and operation of an additional ventilation shaft at the Siphumelele 1 Mine near Rustenburg. Kirsten was responsible for conducting the assessment through baseline acoustic monitoring and acoustic propagation calculations. Client: Anglo American Platinum Limited.
- Environmental Acoustic Impact Assessment for a Proposed Paper Mill, Frankfort, Free State, South Africa (2013-2015): Lead Consultant. WSP was contracted to undertake an environmental acoustic impact assessment for a proposed paper mill in Frankfort in the Free State Province. Kirsten was responsible for conducting the assessment which included baseline acoustic monitoring; development of a comprehensive noise source inventory; and determination of the impact of the proposed project on the surrounding communities using the Computer Aided Noise Abatement (CadnaA) acoustic model. Client: Industrial Development Corporation of SA (Pty) Ltd.
- Environmental Acoustic Impact Assessment for the Decommissioning of a Smelter, Richards Bay, KwaZulu-Natal, South Africa (2014-2015): Lead Consultant. WSP was contracted to undertake a screening-level environmental acoustic impact assessment for the decommissioning of the Bayside Aluminium Smelter in Richards Bay. Kirsten was responsible for conducting the assessment which included the development of a comprehensive noise source inventory; and determination of the impact of the proposed project on the surrounding communities using noise propagation calculations. Client: South32 Aluminium SA Limited.
- Environmental Acoustic Monitoring for a Gas Engine Power Plant, Ressano Garcia, Mozambique, Africa (2014-2015): Project Manager and Lead Consultant. WSP Environmental was commissioned by Sasol New Energy Holding (Pty) Ltd to undertake acoustic monitoring at the Central Termica De Ressano Garcia gas engine power plant site in order to assess the noise associated with the construction and operational phases of the plant. Kirsten was responsible for technical input, acoustic data analysis and reporting for this project. Client: Sasol New Energy Holding (Pty) Ltd.
- Environmental Noise Survey for a Wood Producer, White River, Mpumalanga, South Africa (2012-2015): Consultant. WSP Environmental has been conducting environmental noise monitoring at the Sonae Novobord White River plant since 2009. The project includes day and night time monitoring in accordance with the SANS 10103:2008 methodology, data analysis, compliance assessment and reporting. Kirsten was involved in the data analysis, interpretation and reporting for the project. Client: Sonae Novobord (Pty) Ltd.

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Senior Consultant (Air Quality & Acoustics), Environment & Energy

- Environmental Acoustic Impact Assessment for a Proposed Mine, Wakkerstroom, Mpumalanga, South Africa (2012-2014): Lead Consultant. WSP Environmental was commissioned to undertake an environmental acoustic impact assessment for a proposed underground coal mine near Wakkerstroom, Mpumalanga as part of a comprehensive environmental and social impact assessment for the mine. Kirsten was responsible for conducting the environmental acoustic assessment. The assessment comprised on-site environmental noise monitoring in order to obtain a baseline noise climate for the region as well as acoustic modelling to determine the predicted impacts that the proposed mine will have on the existing noise climate. An inventory of all noise sources during the construction and operational phases was compiled with associated sound power levels for each source. These sources were then input into the Computer Aided Noise Abatement (CadnaA) acoustic model. Results were compared with the monitored (existing) noise levels as well as the SANS day and night-time guidelines to assess compliance. Client: Atha-Africa Ventures (Pty) Ltd.
- Environmental Noise Survey for a Wood Producer, Panbult, Mpumalanga, South Africa (2013): Project Manager. WSP Environmental was commissioned to do a once of environmental acoustic compliance monitoring survey at the Sonae Novobord Panbult site in Mpumalanga. Kirsten was responsible for project management and reporting for the project. Client: Sonae Novobord (Pty) Ltd.
- Environmental Noise Impact Assessment for the Amandelbult Mine, Limpopo, South Africa (2013): Lead Consultant. As part of an environmental impact assessment, WSP Environmental was commissioned to conduct an environmental noise assessment for the sinking of a new shaft at the Tumela mine in the Limpopo Province. Kirsten conducted this environmental noise impact assessment through a baseline review of the site; compilation of a detailed site specific noise inventory; determination of the impact of the proposed project on the surrounding communities using the CadnaA acoustic model; interpretation of modelled results; compliance assessment; and reporting. Client: Rustenburg Platinum Mines Limited.
- Environmental Noise Impact Assessment for SAPREF Cleaner Fuels Phase Two, Durban, KwaZulu-Natal, South Africa (2013): Lead Consultant. WSP Environmental was contracted to perform the environmental noise impact assessment of the Cleaner Fuels Phase Two Project for the SAPREF Refinery in South Durban. The project investigated the noise associated with undertaking the required modifications to the refinery in order to meet the pending fuel specifications published by the South African Department of Energy. Kirsten was responsible for analysis and interpretation of on-site acoustic monitoring; compilation of a detailed site specific noise inventory; determination of the impact of the proposed project on the surrounding communities through the use of the CadnaA acoustic model; interpretation of modelled results; compliance assessment; and reporting. Client: Shell and BP South Africa Petroleum Refineries (SAPREF).
- Environmental Monitoring Assessment for a Manganese Mine, Hotazel, Northern Cape, South Africa (2012-2013): Consultant. WSP Environmental was commissioned to conduct environmental monitoring for their underground manganese mining venture at Black Rock in the Northern Cape Province. The environmental monitoring consisted of both environmental noise monitoring and particulate monitoring. Vehicle noise and emissions testing was also performed on various Assmang owned vehicles onsite. Kirsten was responsible for analysis of all monitored data, interpretation, compliance assessment and reporting. Client: Assmang Black Rock Mine Operations.
- Environmental Noise Surveys, Vaal River and West Wits Operations, North West, South Africa (2012): Consultant. WSP Environmental was commissioned by Anglo Gold Ashanti to perform environmental noise surveys of their Vaal River and West Wits mining operations in the North West Province, as part of their commitment to minimise negative impacts on the environment. The project

included day and night time monitoring in accordance with the SANS 10103:2008 methodology, data analysis, compliance assessment and reporting. Kirsten was responsible for assisting with data analysis, interpretation and reporting. Client: AngloGold Ashanti (Pty) Ltd.

— Environmental Acoustic Impact Assessment for a proposed Power Plant, Ressano Garcia, Mozambique (2011): Field Consultant. WSP Environmental was commissioned by Sasol New Energy Holding (Pty) Ltd to undertake an integrated environmental and social impact assessment (ESIA) and bankable environmental, social and health impact assessment (ESHIA) for the proposed gas engine power plant that is to be constructed in Ressano Garcia, Mozambique. As part of this assessment, a specialist environmental acoustic study was conducted to assess what impacts the proposed plant may have on the noise climate of the region. Kirsten was responsible in assisting with on-site acoustic monitoring for the project. Client: Sasol New Energy Holding (Pty) Ltd.

MSC Thesis

— The Atmospheric Nitrogen Budget over the South African Highveld, Mpumalanga, South Africa (2007-2009). This project was Kirsten's MSc thesis and was performed in collaboration with Eskom. The project aimed to assess the atmospheric nitrogen cycle in the industrialised Highveld region. The project investigated the various atmospheric nitrogen compounds on the South African Highveld and looked at the dominant sources, the transport and conversion of the species in the atmosphere and in what form they are deposited to the ground. From this it was confirmed that the majority of emitted nitrogen remains in the atmosphere, confirming the trends depicted by satellite technology. Client: Eskom Holdings SOC Limited.

Honours Project

— NOx or Not: Nitrogen Oxide Levels over the South African Highveld, Mpumalanga, South Africa (2006). This was Kirsten's honours project and was performed in collaboration with Eskom. This project aimed to validate the nitrogen dioxide hotspot over the South African Highveld as identified by satellite technology. The prevalent sources of nitrogen dioxide were investigated as well as the diurnal and seasonal distributions. Client: Eskom Holdings SOC Limited.

Third Year Project

— The Monitoring of Aerosol Concentrations over the South African East Coast, Natal, South Africa (2015). This project formed part of Kirsten's BSc degree and investigated aerosol concentrations along the east coast of South Africa using a research aircraft equipped with various aerosol and condensation nuclei instruments. It aimed to investigate whether the high aerosol concentrations were a direct result of industries in the south Durban area and also investigated transport of aerosols in the region.

AWARDS

Best presentation for paper entitled "The Atmospheric Nitrogen Budget over the South African Highveld". National Association for Clean Air (NACA) conference	2008
MSc Distinction	2009

PUBLICATIONS AND PRESENTATIONS

Publications

— Collett, K.S., Piketh, S.J. and Ross, K.E. "An assessment of the atmospheric nitrogen budget on the South African Highveld." *South African Journal of Science*, 2010, pp. #106, 5/6, Article# 220.

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- Laakso, L., Vakkari, V., Laakso, H., Virkkula, A., Kulmala, M., Beukes, J.P., van Zyl, P.G., Pienaar, J.J., Chiloane, K., Gilardoni, S., Vignati, E., Wiedensohler, A., Tuch, T., Birmili, W., Piketh, S., Collett, K., Fourie, G.D., Komppula, M., Lihavainen, H., de Leeuw, G. and Kerminen, V.-M. "South African EUCAARI – measurements: a site with high atmospheric variability, "*Atmospheric Chemistry and Physics Discussion*. Month 2010, 10, 30691 – 30729.
- Ross, K., Broccardo, S., Heue, K-P., Collett (nee Ferguson), K. and Piketh, S. "Nitrogen oxides on the South African Highveld." *Clean Air Journal*, Month 2007. 16, 2, 6 – 15.

Presentations

- Collett, Kirsten. "The Atmospheric Nitrogen Budget over the South African Highveld." National Association for Clean Air Conference, Nelspruit, Mpumalanga, 2009.

APPENDIX

B

FIELD LOG SHEETS

APPENDIX

Project Number: 48941

Project Name: AGA Kareerand Noise Monitoring

Location: Stilfontein

Consultant: K. Privett & P. Kgashane

Date: 10 August 2017

wsp

Daytime Monitoring Sheet

ID	Description	Coordinates	Calibration (Y/N)	Calibration Level	Date (dd/mm)	Start Time	People Talking	People Walking	Vehicle Traffic ONSITE	Vehicle idling	Vehicle Traffic OFFSITE	Nr. of Vehicles	Ind. noise from Client	Ind. Noise external	Dogs	Cattle	Insects or birds	Wind noise	Water noise	Aircraft overhead	Quiet	Client audible?	End Time	Calibration (Y/N)	Calibration Level	Comments
KR01	On-site	26.899894°S; 26.879584°E	Y	114	10/08	12:53							✓				✓					✓	13:08	Y	114	water pump buzzing
KR02	On-site	26.900083°S; 26.883211°E	Y	114	10/08	13:14	✓		✓		✓	1	✓				✓					–	13:38	Y	114	trucks onsite, truck drove past
KR03	On-site	26.901203°S; 26.885895°E	Y	114	10/08	13:34			✓	✓		3	✓				✓	✓					13:49	Y	114	Trucks digging up sand, wind
KR04	On-site	26.892398°S; 26.876556°E	Y	114	10/08	14:08	✓	✓	✓	✓		4	✓									–	14:23	Y	114	people walking and talking, cars idling
KR05	Khuma Town	26.856546°S; 26.870875°E	Y	114	10/08	16:21	✓	✓			✓	3			✓		✓						16:36	Y	114	cars passing on R502
KR06	Hostel	26.888428°S; 26.837603°E	Y	114	10/08	15:54					✓						✓						16:09	Y	114	cars on R502, truck driving nearby
KR07	House to South	26.921099°S; 26.867744°E	Y	114	10/08	15:18					✓	1		✓	✓	✓	✓			✓			15:33	Y	114	machine noise

Meteorological Summary:

Sunny, few clouds, light wind - 2 m/s

KR02 - person shouting in the distance, cars on R502

KR03 20m high, Truck driving past with squeaking breaks, Truck reverse alarm, insects, truck idling

KR04 cars driving - [illegible] huge gust of wind, hooter

KR05 power line cables vibrating, car playing music [illegible]

Project Number: 48941

Project Name: AGA Kareerand Noise Monitoring

Location: Stilfontein

Consultant: K. Privett & P. Kgashane

Date: 10 August 2017

wsp

Night-time Monitoring Sheet

ID	Description	Coordinates	Calibration (Y/N) - Level		Date (dd/mm)	Start Time	People Talking	People Walking	Vehicle Traffic ONSITE	Vehicle idling	Vehicle Traffic OFFSITE	Nr. of Vehicles	Ind. noise from Client	Ind. Noise external	Dogs	Cattle	Insects or birds	Wind noise	Water noise	Aircraft overhead	Quiet	Client audible?	End Time	Calibration (Y/N) - Level		Comments
							Type of noise																			
KR01	On-site	26.899894°S; 26.879584°E	Y	114	10/08	22:19	✓		✓			2	✓				✓	✓					23:04	Y	114	~~Pop~~ pump noise, alarm noise pump
KR02	On-site	26.900083°S; 26.883211°E	Y	114	10/08	23:07			✓			1	✓				✓	✓					23:22	Y	114	noise from pump //
KR03	On-site	26.901203°S; 26.885895°E	Y	114	10/08	23:24			.		✓		✓				✓	✓					23:39	Y	114	grumbling noise, cars on RSO2
KR04	On-site	26.892398°S; 26.876556°E	Y	114	10/08	23:49							✓				✓						00:04	Y	114	Security gate closing, noise from [illegible]
KR05	Khuma Town	26.856546°S; 26.870875°E																								unsafe at night
KR06	Hostel	26.888428°S; 26.837603°E																								unsafe at night
KR07	House to South	26.921099°S; 26.867744°E	Y	114	10/08	22:00			✓				✓		✓	✓	✓						22:15	Y	114	cars on RSO2, cars, dogs.

Meteorological Summary:

clear sky, full moon slight breeze

KR01 - car drove past. - car reverse alarm - drove past again, unknown whistling noise onsite

KR02 - car drove past

KR03 - noise from pump, Jackals

KR04 - ~~N~~ Noise from Pump, cars on RSO2, Noise from security box

APPENDIX

APPENDIX

C

IMPACT ASSESSMENT METHODOLOGY

APPENDIX

The impacts were assessed using the risk matrix defined in tables that follow.

Impact Assessment Parameters – Extent

Extent Descriptors	Definitions	Rating
Site	The impact footprint remains within the cadastral boundary of the site.	1
Local	The impact footprint extends beyond the cadastral boundary of the site, to include the immediately adjacent and surrounding areas.	2
Regional	The impact footprint includes the greater surrounding area within which the site is located.	3
National	The scale / extent of the impact is applicable to Botswana.	4
Global	The extent / scale of the impact is global.	5

Impact Assessment Parameters – Duration

Duration Descriptors	Definitions	Rating
Construction Period Only	The impact endures for only as long as the Construction period of the proposed activity. This implies the impact is fully reversible.	1
Short Term	The impact continues to manifest for a period of between 3 – 10 years. The impact is reversible.	2
Medium Term	The impact continues to manifest for a period of 10 – 30 years. The impact is reversible with relevant and applicable mitigation and management actions.	3
Long Term	The impact continues for a period in excess of 30 years. However, the impact is still reversible with relevant and applicable mitigation and management actions.	4
Permanent	The impact will continue indefinitely and is irreversible.	5

Impact Assessment Parameters – Potential Intensity

Descriptors: Potential Negative Consequence	Rating	Score
Human health – morbidity / mortality. Loss of species.	High	16
Reduced faunal populations, loss of livelihoods, individual economic loss.	Moderate-high	8
Reduction in environmental quality – air, soil, water. Loss of habitat, loss of heritage, amenity.	Moderate	4
Nuisance.	Moderate-low	2
Negative change – with no other consequences.	Low	1

APPENDIX

Impact Assessment Parameters – Probability

Likelihood / Probability Descriptors	Definitions	Rating
Improbable	The possibility of the impact occurring is negligible and only under exceptional circumstances.	0.1
Unlikely	The possibility of the impact occurring is low with less than 10% chance of occurring. The impact has not occurred before.	0.2
Probable	The impact has a 10 – 40% chance of occurring. Only likely to happen once every three or more years.	0.5
Highly Probable	It is most likely that the impact will occur. A 41 – 75% chance of occurring.	0.75
Definite	More than 75% chance of occurring. The impact occurs regularly.	1

From the tables above, the significance of the impacts is then calculated using the following equation:

(Extent + Duration + Potential Intensity) x Probability = Significance

The significance level of the risks, as weighted by the above equation, identifies the risk rating that each impact triggers and the associated authorisation implications as outlined in the table below:

Impact Assessment Parameters – Significance

Descriptors	Definitions	Rating
Low	The project can be authorised with a low risk of environmental degradation.	**> 5**
Medium	The project can be authorised but with conditions and routine inspections.	**5 – 8**
High	The project can be authorised but with strict conditions and high levels of compliance and enforcement in respect of the impact in question.	**9 – 15**
Fatally Flawed	The project cannot be authorised.	**>15**