Project done on Behalf of the
Zitholele Consulting

Environmental Noise Impact Evaluation of the Proposed 60 Year Ash Disposal Facility at Kusile Power Station

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1 INTRODUCTION

Kusile Power Station is a coal-fired power generation facility at which construction started in 2008 with completion expected in 2016. The power station is located in the Nkangala District of Mpumalanga, approximately 20 km north-west of the existing Kendal Power Station (near the town of Ogies). Kusile Power Station will dispose boiler and fly ash in a dry format, which will be conditioned and transported by means of conveyors to one of two site alternatives, that is, Site A or B, as identified through the scoping phase process.

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Zitholele Consulting (Pty) Ltd (Zitholele) to study the potential for environmental noise impacts as a result of the disposal of ash at either of these sites.

2 NOISE DEFINED

As background to a noise impact study, the reader should take note of some definitions and conventions used in the measurement, calculation and assessment of environmental noise.

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

Noise is reported in decibels (dB). "dB" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in Equation 1:

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

Equation 1

Where:

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

2.1 Perception of Sound

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

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

2.2 Frequency Weighting

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

2.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot just simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using Equation 2.

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

Equation 2

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

2.4 Environmental Noise Propagation

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

- The type of source and its sound power;
- The distance between the source and the receiver;
- The extent of atmospheric absorption (attenuation);
- Wind speed and direction;
- Temperature and temperature gradient;
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption;
- Reflections;
- Humidity; and
- Precipitation

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

2.5 Environmental Noise Indices

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

- **L_{Aeq} (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). The International Finance Corporation (IFC) provides guidance with respect to L_{Aeq} (1 hour), the A-weighted equivalent sound pressure level, averaged over 1 hour.
- **L_{AIeq} (T)** – The A-weighted impulse corrected equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **L_{A90} (T)** – The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor because it provides an indication of what the L_{Aeq} could have been in the absence of noisy single events.
- **$L_{Req,d}$** – The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
- **$L_{Req,n}$** – The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
- **L_{Rdn}** – The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10 dB in order to account for the additional disturbance caused by noise during the night.

3 METHODOLOGY

The conveying and disposal of ash has the potential to cause environmental noise impacts. The main objective of the noise assessment is to provide an estimate of potential impacts from the proposed ash disposal facility on the surrounding environment. Based on the overall objective the following were included in the study:

- A review of South African guidelines pertaining to environmental noise impacts.
- A review of available project documentation and information.
- The assessment of existing environmental noise levels in the vicinity of the project and nearby residences as well as other sensitive receptors.
- The identification of sources of environmental noise associated with the operational phase of the ash disposal facility.
- The preparation of meteorological data and site specific acoustic parameters for use in the calculation of noise propagation.
- Noise propagation calculations.
- The evaluation of estimated noise impacts against legislation and (or) guidelines.
- A review of mitigation measures pertaining to environmental noise management.
- The compilation of a noise impact assessment report and rating of sites.

The assessment included a study of the legal requirements pertaining to noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels (noise ‘emissions’) and sound pressure levels (noise impacts) associated with the transport and disposal of ash at either Site A or B. The findings of the assessment components informed recommendations of management measures, including mitigation and monitoring. Individual aspects of the noise impact assessment methodology followed in the study are discussed in more detail below.

A site visit was conducted on the 30th of May 2013. The purpose of the visits was to familiarize the consultant with the project environment and to conduct representative sampling measurements of the existing ambient noise levels. The impact of the proposed project's noise emissions will be assessed in terms of the effect that they may have on communities or human settlements. In order to assess the proposed project's noise impact, knowledge of the typical present ambient noise levels is essential. For practical reasons, it is not possible to measure the ambient noise level at all the affected points in the study area. Consequently, sampling measurements were undertaken at locations deemed to be representative of noise sensitive receptors within the study area. Noise measurements were taken in accordance with the methods stipulated by SANS 10103 (SANS 10103, 2008).

Sound power levels (noise "emissions") (L_W's) from activities associated with the transport of ash via conveyor were estimated based on data published for overland conveyors whereas L_W's of ash stackers were determined from measurements conducted at Kendal Power Station's ash disposal facility. Reference was also made to data published by the European Commission (EC) Working Group Assessment of Exposure to Noise (WG-AEN) and general sound power data obtained from Francois Malherbe Acoustic Consulting cc.

The propagation of noise from proposed activities was calculated according to 'The calculation of sound propagation by the Concawe method' (SANS 10357, 2004). The Concawe method makes use of the International Organisation for Standardization's (ISO) air absorption parameters and equations for noise attenuation as well as the factors for barriers and ground effects. In addition to the ISO method, the Concawe method facilitates the calculation of sound propagation under a variety of meteorological conditions. Meteorological data obtained from South African Weather Service (SAWS) for eMalahleni were applied in calculations.

Predicted noise impacts were calculated both in terms of total ambient noise levels as a result of proposed activities as well as the effective increase in ambient noise levels. Impacts were assessed according to guidelines published in SANS 10103 (SANS 10103, 2008) and the International Finance Corporation (IFC) (IFC, 2007).

4 Environmental Noise Regulations

Prior to assessing baseline noise levels and potential noise impacts, reference needs to be made to guidelines and standards regulating noise within communities.

The National Environmental Management Air Quality Act (NEMAQA) (Act No. 39 of 2004) makes provision for the control of noise. The Act states that:

1. The minister may prescribe essential national standards –
    a. For the control of noise, either in general or by specified machinery or activities or in specified places or areas; or
    b. For determining –
        i. A definition of noise; 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.

Sample noise regulations were circulated to provinces in 1997, which could be adopted unchanged or adapted to provincial requirements. To date, only three provinces, i.e. the Free State, Gauteng and Western Cape have adopted these. These sample noise regulations are in the process of being reviewed and will be published under the NEMAQA.

It is anticipated that, in terms of the setting of standards, the new regulations will make direct and extensive reference to SANS 10103, thus giving it legal status instead of only being a guideline document. It successfully addresses the manner in which environmental noise measurements and assessments are to be conducted and assessed in South Africa. The values given in Table 1 are typical rating levels that should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be considered to be annoying to the community (SANS 10103, 2008). The levels given in Table 1 may also be used as a guide for zoning purposes.

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

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

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

Table 1: Typical rating levels for outdoor noise in districts

Type of district	Equivalent Continuous Rating Level ($L_{Req,T}$) for Outdoor Noise (SANS 10103, 2008)		
	Day/night L_{Rdn} (dBA)	Day-time $L_{Req,d}$ (dBA)	Night-time $L_{Req,n}$ (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40
Urban districts	55	55	45
Urban districts with one or more of the following; business premises; and main roads	60	60	50
Central business districts	65	65	55
Industrial districts	70	70	60

The IFC provides guidance on the assessment of noise impacts beyond the property boundaries of industrial facilities in its General Environmental, Health and Safety (EHS) Guidelines. The IFC states that noise impacts should not exceed the levels presented in Table 2, or result in a maximum increase in background levels of 3 dBA at the nearest receptor location off-site (IFC, 2007).

For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

Table 2: IFC noise level guidelines

Noise Level Guidelines (IFC, 2007)		
Area	One Hour L_{Aeq} (dBA) 07:00 to 22:00	One Hour L_{Aeq} (dBA) 22:00 to 07:00
Residential; institutional and educational receptors	55	45

After careful consideration of the above, use was made of the following in assessing noise impacts:

- IFC noise guidelines for residential areas:
  - Day-time – **55 dBA**
  - Night-time – **45 dBA**
- An increase of **5 dBA** above the baseline when 'little' reaction and 'sporadic' complaints can be expected (SANS 10103, 2008).

5 THE EFFECTED NOISE ENVIRONMENT

5.1 Distance to Communities/Residences

Both Sites A and B are surrounded by several farmsteads and residences, with some as close as a 100 m from the footprint/laydown areas and overland conveyor routes. These are likely to be most affected by disposal activities. The towns of Ogies, Phola and Bronkhorstspruit are too far away to be affected by noise generated by the disposal of ash at either Site A or B.

5.2 Atmospheric Absorption and Meteorology

Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation on noise from source to receiver (Section 2.4). Meteorological parameters affecting the propagation of noise, when calculated using the Concawe method, include wind speed, wind direction, temperature, relative humidity, air pressure, solar radiation and cloud cover.

Average day and night-time wind speed, wind direction, temperature, relative humidity, pressure and solar radiation as obtained from the SAWS for eMalahleni and applied in calculations are provided in Table 3.

It is well known that wind speed increases with altitude. This results in the 'bending' of the path of sound to 'focus' it on the downwind side and creating a 'shadow' on the upwind side of the source. Depending on the wind speed, the downwind level may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

Wind roses indicating prevailing wind directions in the area during the day and night are provided in Figure 1. Wind roses represent wind frequencies for the 16 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated. The average day-time wind field is characterised by frequent moderate winds (2 to 4 m/s) from the east-south-east and north-western sector.

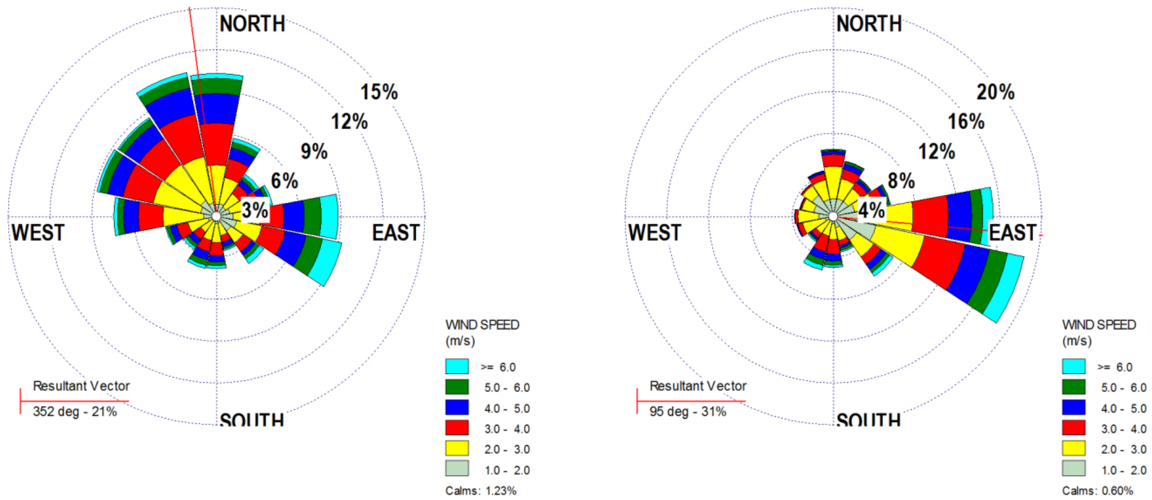

Figure 1: Day (left) and night-time (right) wind roses generated from SAWS eMalahleni (2008 to 2012)

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a ‘shadowing’ effect for sounds. On a clear night, temperatures may increase with altitude thereby ‘focusing’ sound on the ground surface. Noise impacts are therefore generally more significant during the night.

Table 3: Average annual meteorological data applied in calculations

Average Meteorological Data Applied in Calculations		
Meteorological Parameter	**Day-time (06:00 – 22:00)**	**Night-time (22:00 – 06:00)**
Average wind speed (m/s)	3	2.4
Wind direction from (°)	352	95
Average temperature (°C)	18.1	12.8
Average relative humidity (%)	59.2	77.7
Air pressure (kPa)	85	85
Solar radiation (W/m²)	700	Not applicable
Cloud cover (octas)	3.3	2.5

5.3 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (natural terrain or installed acoustic barrier) feature depends on two factors namely the path difference of the sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise. Low frequency noise is difficult to reduce with barriers (Brüel

& Kjær Sound & Vibration Measurement A/S, 2000). Natural topographical features, tall vegetation, waste rock dumps, topsoil stockpiles and pit walls may all act as noise barriers.

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g., concrete or water), soft (e.g., grass, trees or vegetation) and mixed surfaces. Ground attenuation is often calculated in frequency bands to take into account the frequency content of the noise source and the type of ground between the source and the receiver barriers (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Ground cover consists of dense vegetation and is considered acoustically soft i.e. conducive to noise attenuation.

6 BASELINE ENVIRONMENTAL NOISE LEVELS

Noise measurements were conducted at three representative baseline locations around Site A in May 2013 (Figure 2). KMP1 and KMP3 were on the eastern and southern edges of Site A respectively. KMP2 was approximately 3.5 km west of Site A. Pictures of these locations and surrounding areas are presented in Figure 3. From observations in the project area, baseline noise levels at Site B are expected to be similar to those at Site A. Measurements were conducted in accordance with SANS 10103, *'The measurement and rating of noise and speech communication'* (SANS 10103, 2008). Existing sources of noise and the physical environment, including weather conditions, were noted during measurements. A summary of measurement results is provided in Table 4.

To facilitate comparison with SANS Guidelines in Table 1, measured L_{Aleq} levels were used to determine equivalent continuous day-time ($L_{Req,d}$), night-time ($L_{Req,n}$) and day-night (L_{Rdn}) ratings that includes specified adjustments for tonal character and time of day (Table 5).

As is typical of rural areas, sampled environmental noise levels were mostly affected by the wind (specifically during the day), traffic on local roads and distant highway traffic, birds and insects. Sampled night-time noise levels correspond with the equivalent continuous night-time rating for rural areas ($L_{Req,n}$ of 35 dBA). Sampled day-time noise levels were notably higher than what is reported for rural areas because of moderate to strong wind conditions. Levels corresponded with the equivalent continuous day-time rating for rural areas ($L_{Req,d}$ of 45 dBA) during times when wind died down momentarily

Based on the sampling results, baseline equivalent continuous day-time and night-time ratings of 47.4 dBA and 37.4 dBA were applied in calculations and the assessment of cumulative noise impacts

Table 4: Summary of baseline noise level measurement results

Time of Day	Location	Start Time	L_{AIeq} (10 min) (dBA)	L_{Aeq} (10 min) (dBA)	L_{90} (dBA)	Notes
Day-time	KMP1	30-May-13 14:53	53.6	48.0	35.6	Moderate to strong wind, wind rustling grass, birds, aircraft and frequent traffic.
	KMP2	30-May-13 14:24	55.9	51.0	38.0	Moderate to strong wind, grass rustling, birds and insects.
	KMP3	30-May-13 13:49	57.2	52.0	39.9	Moderate to strong wind, wind rustling grass, birds and frequent traffic.
Night-time	KMP1	30-May-13 22:53	21.5	19.4	18.6	Slight wind, wind rustling grass, insects.
	KMP2	30-May-13 22:32	36.2	32.7	20.2	Slight wind, wind rustling grass, insects. Passing car.
	KMP3	30-May-13 22:07	40.8	37.9	34.1	Moderate wind, wind rustling grass, insects and distant traffic.

Table 5: Equivalent continuous ratings calculated from sampled noise levels

Location	$L_{Req,d}$ (dBA)	$L_{Req,n}$ (dBA)	$L_{R,dn}$ (dBA)
1	53.6	21.5	51.9
2	55.9	36.2	54.4
3	57.2	40.8	55.9
Average	**55.8**	**37.4**	**54.3**

Figure 2: Kusile Power Station 60 year ash disposal facility site options A and B and baseline noise measurement locations

Location KMP1

Location KMP2

Location KMP3

Figure 3: Pictures of baseline noise measurement locations

7 IMPACT ASSESSMENT AND ZONES OF INFLUENCE

7.1 Sources of Noise

The most significant sources of noise associated with ash include conveyor transfer and ash stacking. The following routine sources of noise were therefore included in the assessment:

- A bottom and top ash stacker;
- Conveyor transfer houses; and
- Overland conveying.

A noise sample was taken at a distance of 10 m from stacking operations on the existing Kendal Power Station ash disposal facility. At such small distances from a noisy source, the effect of wind direction and time of day on sampled noise levels is immaterial The stacker/conveyor system's sound power levels (noise 'emissions') were subsequently calculated and are presented in Table 6. It was assumed that the stackers proposed for the Kusile 60 year ash disposal facility will make use of equipment similar to those used at Kendal.

Transfer house noise and overland conveyor sound power levels were obtained from the database of Francois Malherbe Acoustic Consulting cc. These are also provided in Table 6.

Table 6: Source sound power levels

Source	Octave Band Sound Power Levels, L_{Wi} (dB)							
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Unit
Stacker	108.1	103.4	102.3	103.1	99.9	97.3	89.6	dB
Transfer House	80.0	90.0	98.8	97.6	100.7	101.4	95.4	dB
Overland Conveyor	103.0	105.0	100.0	101.0	97.0	93.0	85.0	dB/100m

7.2 Noise Propagation Modelling and Predicted Noise Levels

The propagation of noise was calculated in accordance with SANS 10103. Meteorological and site specific acoustic parameters as discussed in Section 5 along with source data discussed in Section 7.1, were applied in the model.

Due to the extent of operations and variable nature in the positioning of ash stackers on the facility, results are presented as transects i.e. noise level/impact as a function of perpendicular downwind distance from the stackers, transfer houses and conveyors. The propagation of noise was calculated over a distance of 2 km at 25 m intervals. To facilitate comparison with selected criteria, results are presented as:

- Cumulative day and night-time noise levels where the impact of the stackers, transfer houses and conveyors are superimposed on baseline noise levels; and
- The increase in day and night-time noise levels over the baseline.

7.2.1 *Predicted Day-time Noise Levels*

Cumulative day-time noise levels as a function of downwind distance from the operation of one stacker, two stackers, a transfer house and the overland conveyor is shown in Figure 4. The day-time guideline of 55 dBA considered acceptable for residences is exceeded up to ~100 m from these sources.

A 5 dBA increase in day-time noise level above the baseline of 47.4 dBA (shown in Figure 5) can be expected up to 150 m from areas of operation. At an increase of 5 dBA 'little' community reaction with 'sporadic' complaints may be expected.

7.2.2 *Predicted Night-time Noise Levels*

Cumulative night-time noise levels as a function of downwind distance from the operation of one stacker, two stackers, a transfer house and the overland conveyor is shown in Figure 6. The day-time guideline of 45 dBA considered acceptable for residences is exceeded up to ~375 m from the ash disposal facility and ~750 m from the overland conveyor.

A 5 dBA increase in night-time noise level above the baseline of 37.4 dBA (shown in Figure 7) can be expected up to 500 m from the ash disposal area and 1150 m from the conveyor. At an increase of 5 dBA 'little' community reaction with 'sporadic' complaints may be expected.

Night-time impacts will therefore be more significant as anticipated.

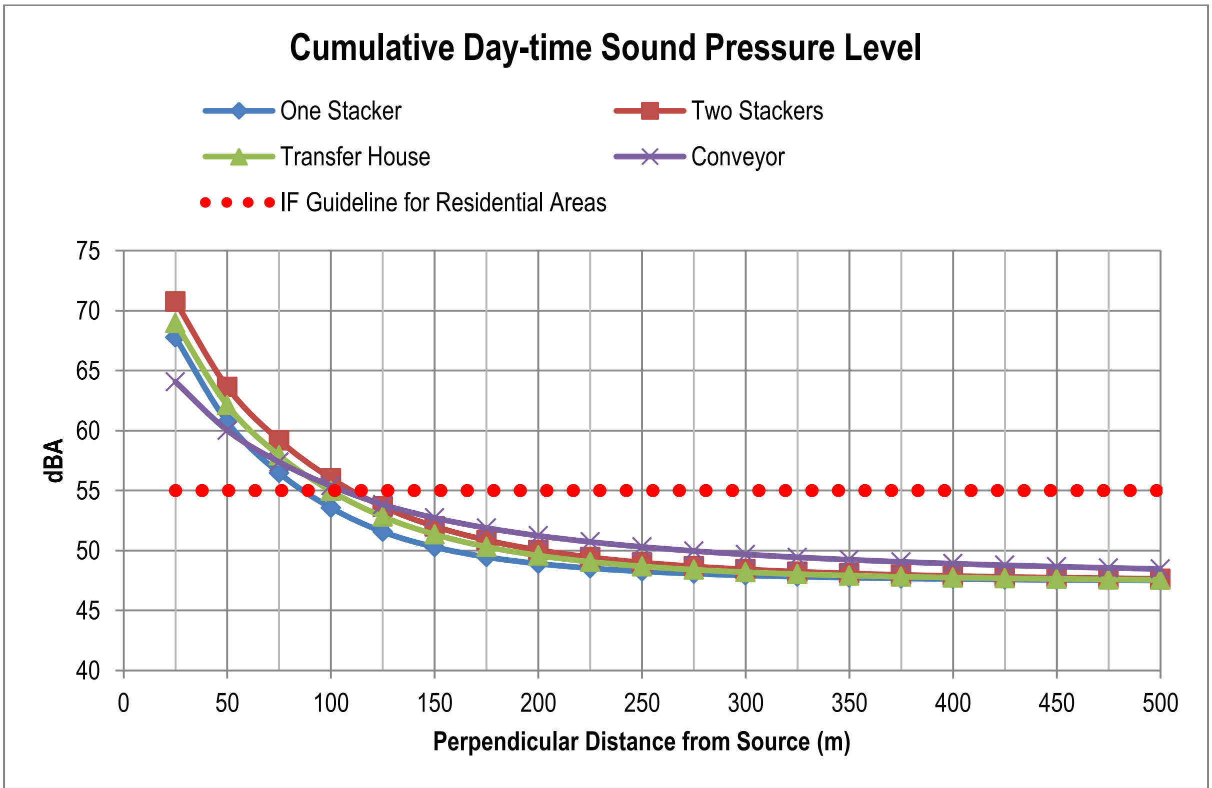

Figure 4: Cumulative day-time sound pressure levels

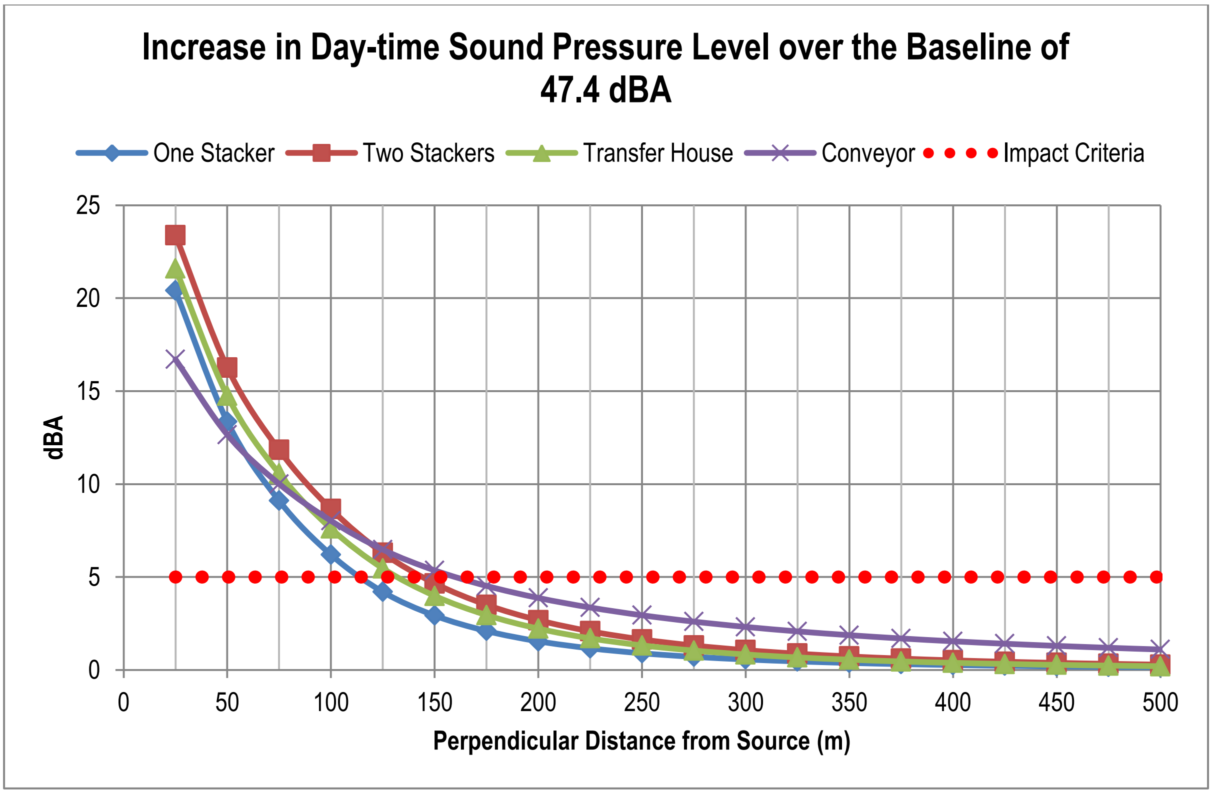

Figure 5: Increase in day-time sound pressure levels over the baseline of 47.4 dBA

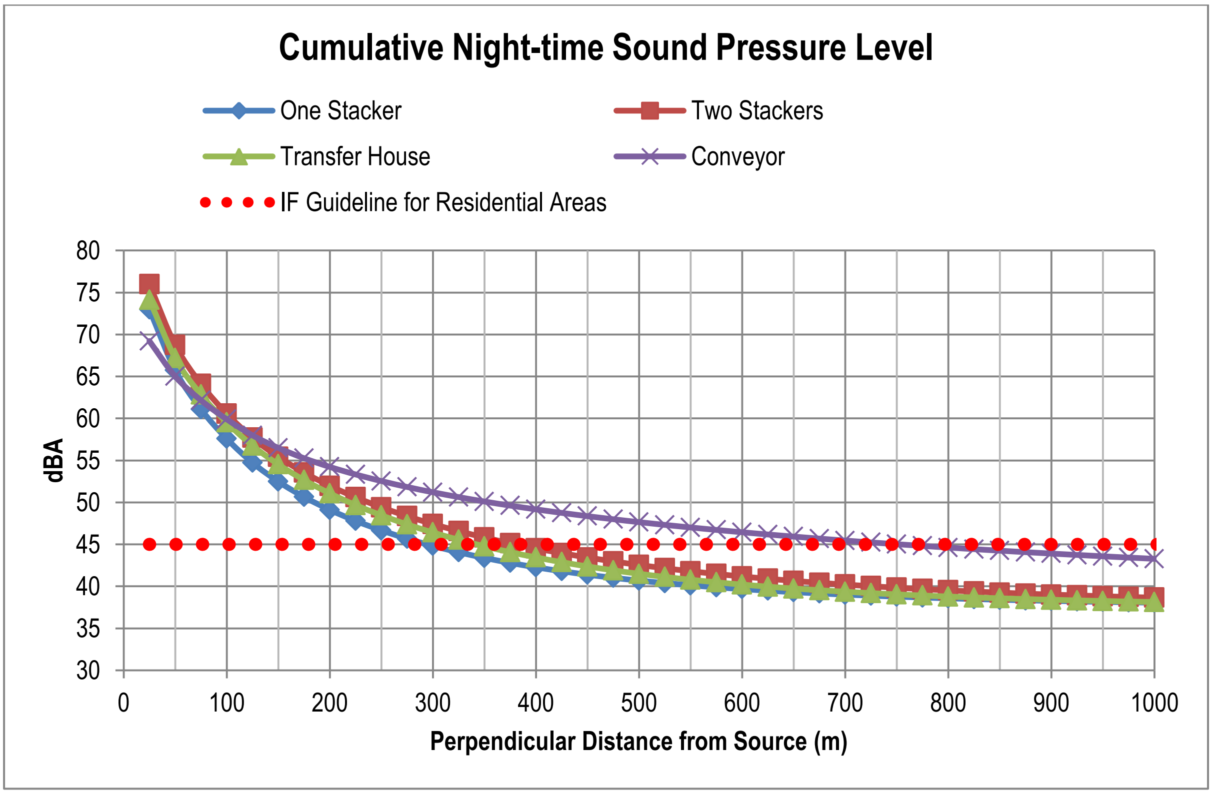

Figure 6: Cumulative night-time sound pressure levels

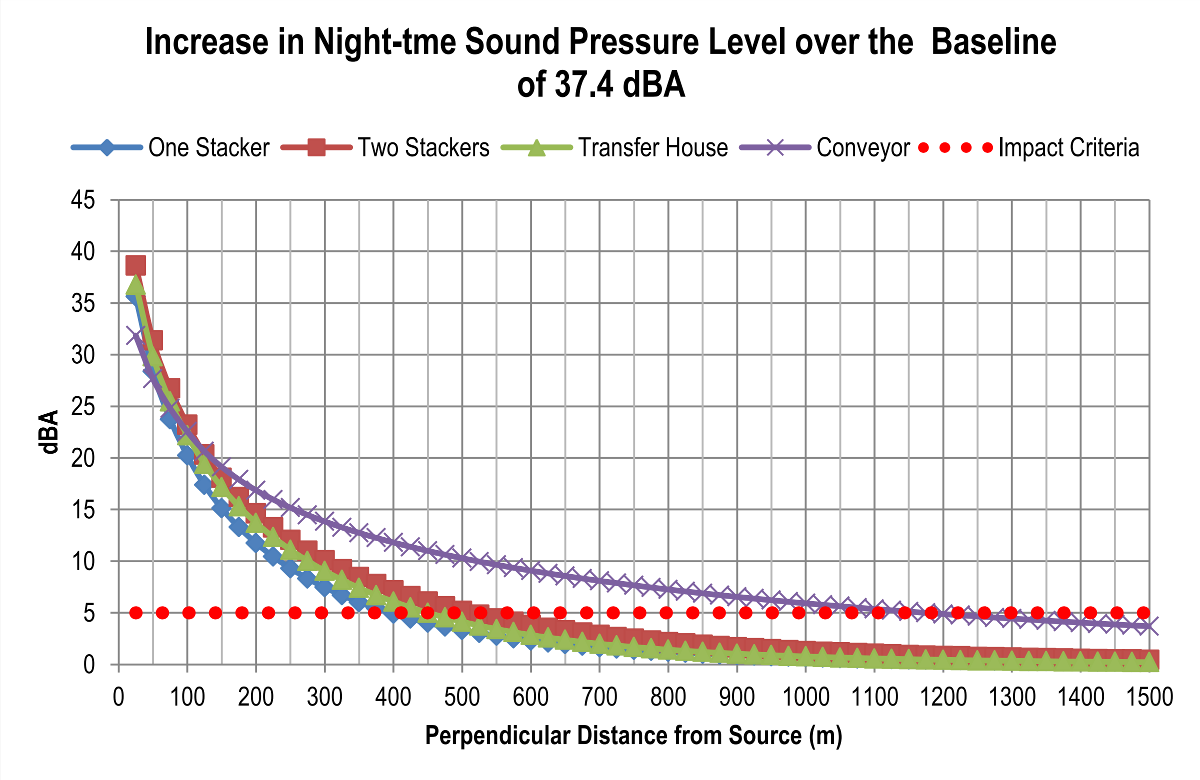

Figure 7: Increase in night-time sound pressure levels over the baseline of 34.7 dBA

8 MITIGATION AND MANAGEMENT

8.1 General Mitigation and Management Measures

For ***general construction, operational and decommissioning activities*** the following good engineering practice should be applied:

- All diesel powered equipment must be regularly maintained and kept at a high level of maintenance. This must particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment must serve as trigger for withdrawing it for maintenance.
- All mechanical and electrical equipment i.e. drive units, idlers, pulleys etc. must be regularly maintained and kept at a high level of maintenance. This must particularly include the regular inspection and, if necessary, replacement of noisy elements.
- To minimise noise generation, vendors can be required to guarantee optimised equipment design noise levels.
- During the planning and design stages of the project, possibly related noise aspects should always be kept in mind. The enclosure of major sources of noise, such transfer houses, must be included in the design process, since they represent basic good engineering practice.
- All vibrating equipment must be installed on vibration isolating mountings.
- By enclosing the tipper discharge and lowering the conveyor drop height, noise emissions may be reduced. Mechanical and electrical design also influences the amount of noise from stacking operations.
- Re-locate noise sources to less sensitive areas to take advantage of distance and shielding.
- Site permanent facilities away from community areas if possible.

- Develop a mechanism to monitor noise levels, record and respond to complaints and mitigate impacts.

8.2 Operational Hours

It is recommended that, as far is as practicable, noise generating activities such as maintenance, construction and decommissioning be limited to day-time hours since noise impacts are most significant during the night.

8.3 Noise Management Zone

It is recommended that a noise management zone be considered around the operations. This area should correspond to the area over which noise levels may result in sporadic complaints and occasional community action that is ~1 km from operations. Complaints and noise levels in this area should be recorded and monitored and corrective actions taken communicated to interested and affected parties.

8.4 Noise Monitoring

It is recommended that, ambient noise measurements be conducted during all project phases to assess and confirm the impact area. Specific attention should be paid to noise levels at noise sensitive receptors within the 1 km noise management zone. Noise measurements should be conducted in accordance with SANS 10103 (2008).

A summary of the proposed noise monitoring plan as well as the parameters that should be sampled are summarised in Table 7.

In addition to the measurement of sound pressure levels, the octave band frequency spectra should also be recorded. Frequency spectrum data can provide useful insight into the nature of recorded sound pressure levels and assist with distinguishing between potential sources of noise that contribute to noise levels at a certain location. Source noise measurements could be conducted to confirm equipment manufacturer sound power data and assumed sound power data used in the current study.

Table 7: Proposed monitoring plan

Parameters to be Measured	Frequency
L_{Aeq}(1 hour) between 06:00 and 22:00[1]	One campaign during the construction/closure/de-commissioning phases. One campaign per year of operation
L_{Aeq}(1 hour) between 22:00 and 06:00	One campaign during the construction/closure/de-commissioning phases (if applicable). One campaign per year of operation.
Octave band frequency spectrum	During every campaign.

[1] SANS 10103 specifies day-time to be from 06:00 to 22:00 and night-time from 22:00 to 06:00. The IFC specifies day-time to be from 07:00 to 22:00 and night-time from 22:00 to 07:00.

9 ENVIRONMENTAL IMPACT STATEMENT

The environmental impact statement that follows applies to the construction, operational and closure phases of the Ash Disposal Facility located at the site alternatives A or B. All noise impacts are considered **negative** and **probable**.

All noise impacts will have ceased after the closure phase. There will therefore be no post-closure impacts.

9.1 Status Quo

The most notable sources of intrusive noise in the vicinity of alternative Sites A and B include Kusile Power Station and national/regional roads. Kusile Power Station will affect environmental noise levels in the vicinity of Site A most notably.

The impact of Kusile Power Station's operational phase on Site A is considered *low* in magnitude, limited to the *study area*, of *medium duration* (i.e. will last for the duration of the power station's operation) and will definitely *occur,* resulting in a **negative moderate** impact risk. The impact of traffic noise (the most notable source of intrusive noise) on Site B is considered *very low* in magnitude, limited to the *isolated areas*, of *medium duration* and is already *occurring,* resulting in a **negative low** impact risk.

The status quo is similar for all project phases.

9.2 Unmitigated Project Impact

During the construction and closure phases of the ash disposal facility, noise impacts are considered *low* in magnitude, limited to the *isolated areas of construction*, *short in duration* and *likely to occur,* resulting in a **negative low** impact risk. Operational phase impacts are considered *low* in magnitude, limited to the *study area*, of *medium duration* (project life) and *likely to occur,* resulting in a **negative low** impact risk. There are no distinguishing differences between unmitigated noise impacts associated with ash disposal Site A or B.

9.3 Unmitigated Cumulative Impact

During the construction and closure phases of the ash disposal facility, cumulative noise impacts are considered *low* in magnitude, limited to the *isolated areas of construction*, *short in duration* and *likely to occur,* resulting in a **negative low** impact risk. Operational phase impacts are considered *low* in magnitude, limited to the *study area*, of *medium duration* (project life) and *likely to occur,* resulting in a **negative low** impact risk. There are no distinguishing differences between unmitigated cumulative noise impacts associated with ash disposal Site A or Site B.

9.4 Mitigation Measures

Effective noise management and mitigation measures can be summarised as:

- Regular maintenance of all construction equipment, conveyors and conveyor elements, and stacker equipment to minimise noise generation.
- Restricting all construction, closure and maintenance activities to day-time since impacts are most

significant at night.

- Monitoring noise levels at noise sensitive receptors within 1 km from any activity.

9.5 Residual Impact

During the construction and closure phases of the ash disposal facility, residual noise impacts are considered *low* in magnitude, limited to the *isolated areas of construction*, *short in duration* and *could occur,* resulting in a **negative very low** impact risk. Operational phase impacts are considered *low* in magnitude, limited to the *study area*, of *medium duration* (project life) and *could occur,* resulting in a **negative low** impact risk. There are no distinguishing differences between residual noise impacts associated with ash disposal Site A or Site B.

9.6 Impact Matrix

The impacts identified and discussed above have been rated according to the impact assessment methodology prescribed by Zitholele for the construction, operational and closure phases (Table 8, Table 9 and Table 10 respectively).

9.7 Environmental Management Planning

The identified impacts should be mitigated through the implementable actions proposed in Section 8. These mitigation measures are presented in the proposed Environmental Management Planning (Table 11).

9.8 Concluding Remarks

From an environmental noise impact perspective neither Site A or B are considered 'fatally flawed'. There are also no distinguishing differences between noise impacts associated with ash disposal Site A or Site B.

Table 8: Construction phase impact risk

Impact Description		Direction of Impact	Degree of Certainty	Magnitude	Spatial Scale	Temporal Scale	Probability	Impact Risk
The Disposal of Ash at Alternative Site A								
Status Quo	Initial baseline environmental noise impacts	Negative	Definite	2	2	3	5	**-2.3**
				LOW	STUDY	MED	OCCUR	**MOD**
Project Impact	Environmental noise impacts as a result of the project.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	ISO	SHORT	VLIKE	**LOW**
Cumulative Impact	Impact from project in addition to initial baseline environmental noise impacts before mitigation.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	ISO	SHORT	VLIKE	**LOW**
Residual Impact	Impact from project in addition to initial baseline environmental noise impacts after mitigation.	Negative	Probable	2	1	2	3	**-1**
				LOW	ISO	SHORT	COULD	**VLOW**
The Disposal of Ash at Alternative Site B								
Status Quo	Initial baseline environmental noise impacts	Negative	Definite	1	1	3	5	**-1.7**
				VLOW	ISO	MED	OCCUR	**LOW**
Project Impact	Environmental noise impacts as a result of the project.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	STUDY	SHORT	VLIKE	**LOW**
Cumulative Impact	Impact from project in addition to initial baseline environmental noise impacts before mitigation.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	STUDY	SHORT	VLIKE	**LOW**
Residual Impact	Impact from project in addition to initial baseline environmental noise impacts after mitigation.	Negative	Probable	2	1	2	3	**-1**
				LOW	STUDY	SHORT	COULD	**VLOW**

Table 9: Operational phase impact risk

Impact Description		Direction of Impact	Degree of Certainty	Magnitude	Spatial Scale	Temporal Scale	Probability	Impact Risk
The Disposal of Ash at Alternative Site A								
Status Quo	Initial baseline environmental noise impacts	Negative	Definite	2	2	3	5	-2.3
				LOW	STUDY	MED	OCCUR	MOD
Project Impact	Environmental noise impacts as a result of the project.	Negative	Probable	2	2	3	4	-1.9
				LOW	STUDY	MED	VLIKE	LOW
Cumulative Impact	Impact from project in addition to initial baseline environmental noise impacts before mitigation.	Negative	Probable	2	2	3	4	-1.9
				LOW	STUDY	MED	VLIKE	LOW
Residual Impact	Impact from project in addition to initial baseline environmental noise impacts after mitigation.	Negative	Probable	2	2	3	3	-1.4
				LOW	STUDY	MED	COULD	LOW
The Disposal of Ash at Alternative Site B								
Status Quo	Initial baseline environmental noise impacts	Negative	Definite	1	1	3	5	-1.7
				VLOW	ISO	MED	OCCUR	LOW
Project Impact	Environmental noise impacts as a result of the project.	Negative	Probable	2	2	3	4	-1.9
				LOW	STUDY	MED	VLIKE	LOW
Cumulative Impact	Impact from project in addition to initial baseline environmental noise impacts before mitigation.	Negative	Probable	2	2	3	4	-1.9
				LOW	STUDY	MED	VLIKE	LOW
Residual Impact	Impact from project in addition to initial baseline environmental noise impacts after mitigation.	Negative	Probable	2	2	3	3	-1.4
				LOW	STUDY	MED	COULD	LOW

Table 10: Closure phase impact risk

Impact Description		Direction of Impact	Degree of Certainty	Magnitude	Spatial Scale	Temporal Scale	Probability	Impact Risk
The Disposal of Ash at Alternative Site A								
Status Quo	Initial baseline environmental noise impacts	Negative	Definite	2	2	3	5	**-2.3**
				LOW	STUDY	MED	OCCUR	**MOD**
Project Impact	Environmental noise impacts as a result of the project.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	ISO	SHORT	VLIKE	**LOW**
Cumulative Impact	Impact from project in addition to initial baseline environmental noise impacts before mitigation.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	ISO	SHORT	VLIKE	**LOW**
Residual Impact	Impact from project in addition to initial baseline environmental noise impacts after mitigation.	Negative	Probable	2	1	2	3	**-1**
				LOW	ISO	SHORT	COULD	**VLOW**
The Disposal of Ash at Alternative Site B								
Status Quo	Initial baseline environmental noise impacts	Negative	Definite	1	1	3	5	**-1.7**
				VLOW	ISO	MED	OCCUR	**LOW**
Project Impact	Environmental noise impacts as a result of the project.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	STUDY	SHORT	VLIKE	**LOW**
Cumulative Impact	Impact from project in addition to initial baseline environmental noise impacts before mitigation.	Negative	Probable	2	1	2	4	**-1.3**
				LOW	STUDY	SHORT	VLIKE	**LOW**
Residual Impact	Impact from project in addition to initial baseline environmental noise impacts after mitigation.	Negative	Probable	2	1	2	3	**-1**
				LOW	STUDY	SHORT	COULD	**VLOW**

Table 11: Environmental management planning - Noise

Management / Environmental Component:	EMPr Reference Code:		
Environmental Noise	EMPr-Noise		
Primary Objective:			
Reduce noise generated by activities associated with the construction, operation and closure of an overland ash conveyor and ash disposal facility.			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
1. Regular maintenance and inspection of ALL noise generating equipment.	Environmental manager	Sound Level Meter	Weekly
2. Limiting construction, closure and maintenance activities to day-time hours.	Environmental and operations manager	-	Daily
3. Environmental noise level and complaint monitoring at noise sensitive receptors within 1 km of any activity.	Environmental manager	Sound Level Meter	Construction/closure – one campaign or as required by complaints Operational phase – annually or as required by complaints
Existing management plans/procedures:			
Unknown			

10 REFERENCES

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