ENVIRONMENTAL NOISE IMPACT ASSESSMENT FOR THE PROPOSED BALAMA GRAPHITE MINE

COASTAL & ENVIRONMENTAL SERVICES

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This document has been prepared by **Digby Wells Environmental**.

Report Title:	**Environmental Noise Impact Assessment for the proposed Balama Graphite Mine**
Project Number:	**COA2029**

Name	Responsibility	Signature	Date
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Bradly Thornton	1st review		05/06/2013

EXECUTIVE SUMMARY

Syrah Resources Ltd (Syrah) is an Australian resource company listed on the Australian Stock Exchange (ASX: SYR). The head office of Syrah is in Melbourne, Australia. In December 2011, Syrah acquired 100% ownership of the Balama Graphite Project (Balama), located in northern Mozambique and has since conducted a large diamond drilling resource definition program to establish a graphite resource with very strong potential to be developed into a mining operation.

Syrah commenced a Scoping Study in July 2012 and anticipates that this study will be complete in April/May 2013. Syrah then proposes to conduct a Bankable Feasibility Study BFS), which is proposed to be complete by the end of calendar 2013.

Digby Wells Environmental (Digby Wells) was commissioned by Coastal & Environmental Services (PTY) Ltd (CES) to conduct an environmental noise impact assessment in support of the Environmental Impact Assessment (EIA) for the proposed Balama Graphite Mine in the Balama District of the Cabo Delgado Province, Mozambique. The purpose of the study is to assess the potential impact of the proposed project on the ambient noise climate of the area, which is primarily rural agricultural.

The approach used in investigating the noise impacts is based on the International Finance Corporation's (IFC) Environmental Health and Safety (EHS) guidelines.

This environmental noise impact assessment report forms part of the BFS and entails the following tasks:

- Identification of noise sources and potential noise sensitive receptors;
- Establishment of the existing noise climate at various locations in the project area and directly adjacent areas; and
- Assessment of the anticipated noise impacts associated with the project activities during the construction, operational, decommissioning and post-closure phases.

In terms of the baseline conditions, it is gathered that the existing ambient day and night time noise levels in the surrounding villages are mostly below the IFC EHS noise rating limit for residential districts.

The overall pre-mitigation significance of the noise impact from the proposed Balama Graphite Mine is moderate to high during the construction and operational phase and drops to a low significance during the decommissioning phase.

The post- mitigation significance of the noise impacts is moderate to low. The noise contributions can be reduced through the implementation of the recommended mitigation measures, especially the construction of the earth berms around the pits, which will help with the noise attenuating towards the villages. Depending on the general construct of the earth berms, an effective noise contribution decrease of between 5dBA and 10dBA can be achieved.

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1 INTRODUCTION

Syrah Resources Ltd (Syrah) is an Australian resource company listed on the Australian Stock Exchange (ASX:SYR). The head office of Syrah is in Melbourne, Australia. In December 2011, Syrah acquired 100% ownership of the Balama Graphite Project (Balama), located in northern Mozambique and has since conducted a large diamond drilling resource definition program to establish a graphite resource with very strong potential to be developed into a mining operation.

Syrah commenced a Scoping Study in July 2012 and anticipates that this study will be complete in April/May 2013. Syrah then proposes to conduct a Bankable Feasibility Study (BFS), which is proposed to be complete by the end of calendar 2014. This environmental noise impact report is compiled in support of the EIA.

The local subsidiary of Syrah, Twigg Exploration & Mining Ltd., has received a license for prospecting and exploration of graphite, base and precious metals in Balama district, Cabo Delgado Province.

The activities related to Balama, for the construction, operational phases include:

- Two mining areas
- Process plant
- Tailings Storage Facility (TSF);
- Rock dump;
- Haul road; and
- Water station.

This report serves to inform about the noise impacts on the surrounding ambient noise levels of the area with regard to the construction, operational and decommissioning phases of the proposed Balama Graphite Mine.

2 TERMS OF REFERENCE

Digby Wells Environmental (Digby Wells) was commissioned by Coastal & Environmental Services (PTY) Ltd (CES) to conduct an environmental noise impact assessment in support of the BFS for the proposed Balama Graphite Mine in the Balama District of the Cabo Delgado Province, Mozambique. The purpose of the study is to assess the potential impact of the proposed project on the ambient noise climate of the area, which is primarily rural agricultural.

The approach used in investigating the noise impacts is based on the International Finance Corporation's (IFC) Environmental Health and Safety (EHS) guidelines.

Environmental Noise Impact Assessment report will include a baseline study, predicted noise impacts on the identified noise sensitive receivers, during the various project phases as well as recommendations and mitigation measures for potential impacts.

3 STUDY AREA

Balama is located on a 106km^2 granted Prospecting Licence in the Cabo Delgado province in the District of Namuno of northern Mozambique. The project is approximately 265km by road (3.5 hours' drive) west of the port town of Pemba. Pemba is a deep water container port and is the third largest port in Mozambique.

Balama is accessed by an excellent sealed road from Pemba to Montepuez, a regional township, and then via 45 km of unsealed road which is in the process of being upgraded by the Government. The project area is only 7 km east of the small regional township of Balama. Please refer to Plan 1 for the regional setting of the project.

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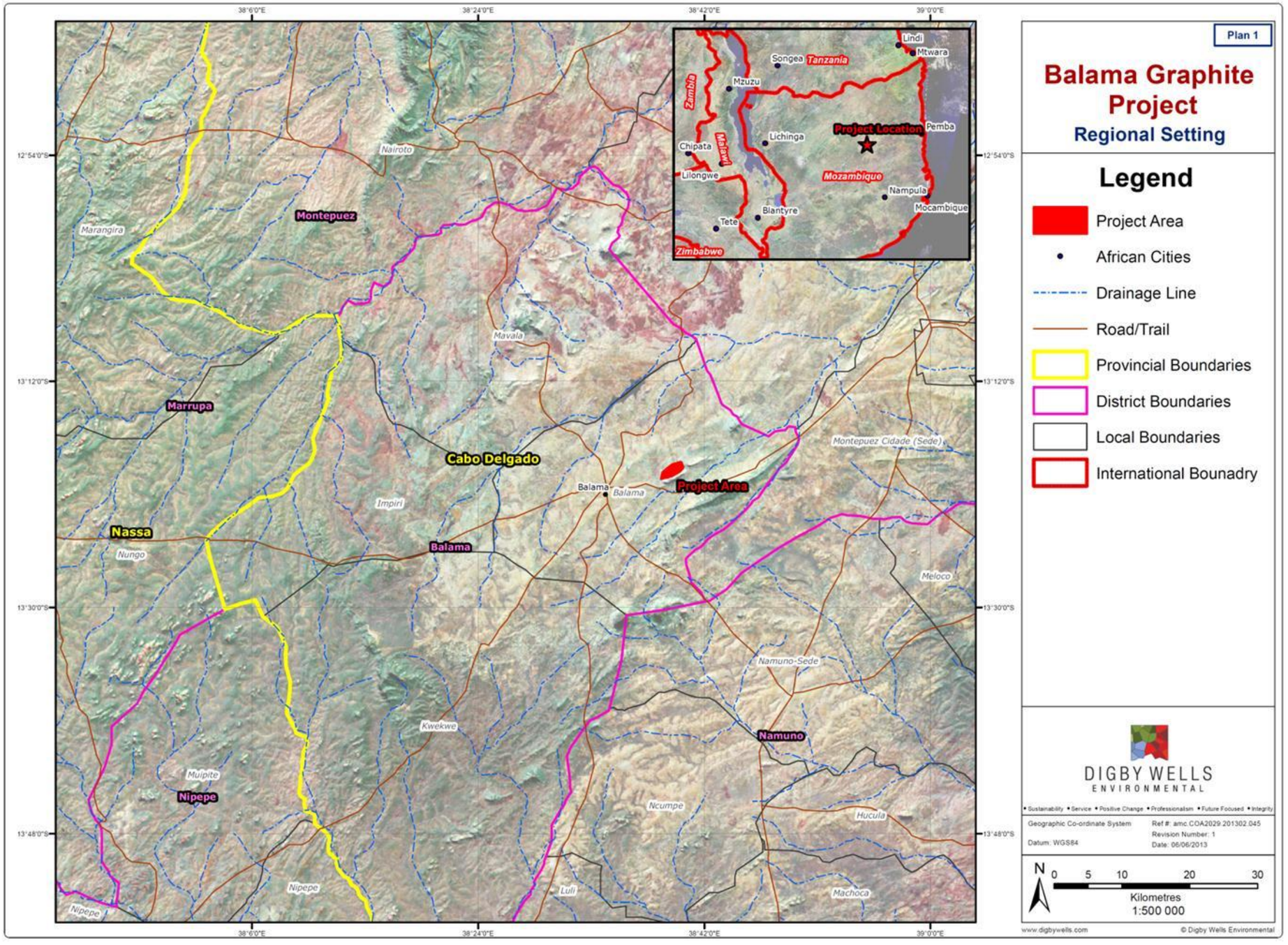


Plan 1: Regional Setting

4 EXPERTISE OF THE SPECIALIST

Lukas Sadler has a B.COM degree in Geography and Environmental Management, including short courses in Environmental Noise Assessments, Environmental Noise Control and Air Quality Management as well as local and international work experience in the environmental sciences field. This includes experience working with projects in accordance with the International Finance Corporation (IFC) and World Bank standards. Lukas has also gained experience working in Africa namely Mali, Senegal, Ghana, Sierra Leone, DRC, Liberia, Mozambique and Namibia. At Digby Wells, Lukas' core focus is working on Environmental Noise impact assessments, which includes baseline noise monitoring surveys, noise dispersion modelling and noise management programmes.

5 AIMS AND OBJECTIVES

The aim of the study is to provide a level of significance for the impact on the ambient noise levels, especially at the noise sensitive receiver surrounding the proposed Balama Graphite Mine.

The objectives are to assess, via predictive noise dispersion modelling, the potential impact of the noise emissions from the proposed Balama Graphite Mine on the surrounding environment. The study will include baseline noise measurements and also provide recommendations in terms of the mitigation and monitoring measures.

6 METHODOLOGY

As previously mentioned, the approach used in investigating noise impacts for this project is based on the IFC's EHS guidelines. According to these guidelines noise from the proposed project should not exceed the levels presented in Table 6-1, or result in a maximum increase in background levels of 3 decibels adjusted (dBA) at the nearest receptor location off-site.

Table 6-1: Acceptable rating levels for noise in districts (IFC EHS, 2007)

Noise level guidelines	**One Hour LAeq (dBA)**	
Receptor	**Daytime** **07:00-22:00**	**Night time** **22:00-07:00**
Residential; institutional; educational	55	45
Industrial; commercial	70	70

A baseline assessment was undertaken to determine the current ambient noise levels at the surrounding areas of the proposed project.

6.1 Locations

The criteria that were used for the siting of the measurement locations were:

- The locations were the nearest noise sensitive receptors surrounding the proposed project and subsequently the most likely to be impacted on by the proposed mining activities; and

- That they served as suitable reference points for the measurement of ambient sound levels surrounding the proposed project area. The noise measurement locations cover locations that represent a comprehensive soundscape of the area.

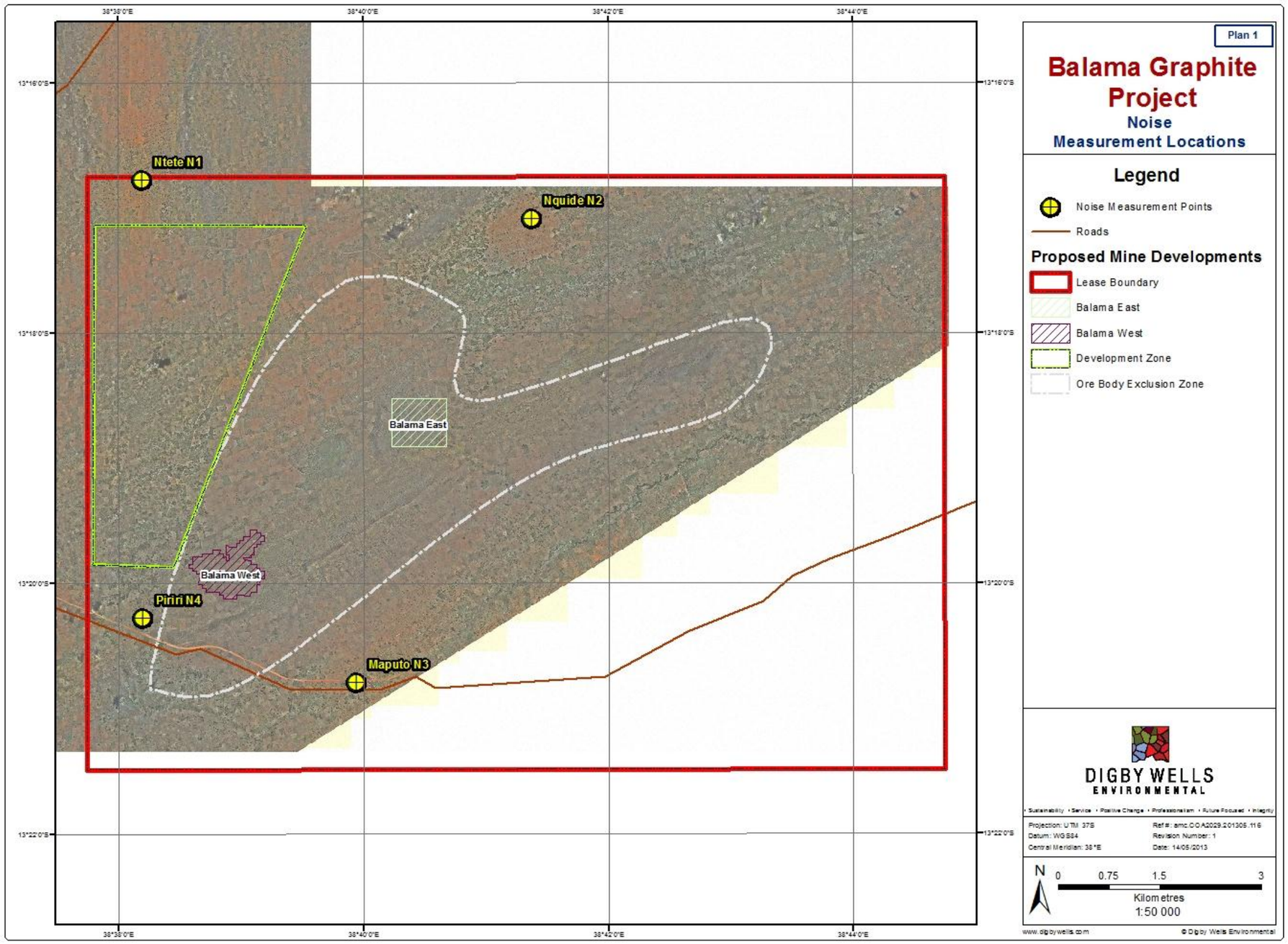
The list of noise measurement locations can be seen in Table 6-2 and the physical locations are illustrated on Plan 2 below.

A Cirrus, Optimus Green, precision integrating sound level meter was used for the measurements. The instrument was field calibrated with a Cirrus, sound level calibrator. Photos of the measurement locations are presented in Figure 6-1 to Figure 6-4.

Table 6-2: Noise measurement locations

Site ID	Location	Category of receiver	GPS coordinates
N1	Ntete	Village	13°16'52.39"S & 38°38'16.05"E
N2	Nquide	Village	13°17'5.24"S & 38°41'22.78"E
N3	Maputo	Village	13°20'47.18"S & 38°39'56.29"E
N4	Piriri	Village	13°20'16.38"S & 38°38'11.97"E

Please note that the village of Maputo (4km from site) should not be confused with the city of Maputo, the capital of Mozambique (2700km from site).



Plan 2: Noise measurement locations

Figure 6-1: Location of N1 at Ntete Village

Figure 6-2: Location of N2 at Nquide village

Figure 6-3: Location of N3 at Maputo village

Figure 6-4: Location of N4 at Piriri village

6.2 Predictive modelling

Predictive modelling was performed for the proposed mining activities through the use of the modelling software SoundPlan. The software specializes in computer simulations of noise pollution dispersion. Estimates of the cumulative mining noise levels from the study were derived from the noise emissions from all the major noise-generating components and activities of the proposed project.

The models were run as a conservative scenario with worst case assumptions, so the following should be noted:

- The average yearly temperature was used;
- The average yearly humidity was used;
- Calm wind conditions were assumed; and
- The decommissioning phase should be undertaken during daylight hours
- The mitigation effect of vegetation was not taken into account.

The following table indicates the noise power levels used in the model simulations. The sound power levels were derived from a number of previous studies.

Table 6-3: Sound power levels from main noise causing sources

Noise source	**Sound power levels dB**						
Octave band frequencies, Hz	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***
Haul Truck	108	118	115	114	110	106	102
Excavators	113	117	107	108	106	101	95
Front end Loader	108	116	107	108	105	99	95
Dozer	110	122	113	114	110	108	104
Processing plant	108	106	107	103	99	94	86

The existing background noise levels are compared with the outcome of the model, to specifically determine the significance of the impact. It is assumed that the decommissioning activities will only take place during daylight hours.

7 RESULTS AND DISCUSSIONS

The results from the noise meter recordings for all the sampled points as well as the rating limits according to the IFC EHS guidelines are presented in Table 7-1. The noise level time history graph per noise measurement location can be seen in Figure 7-1 to Figure 7-4.

Table 7-1: Results of the baseline noise measurements

Sample ID	IFC EHS rating limit					
	Type of district	**Period**	**Acceptable rating level dBA**	**$L_{Areq,T}$ dBA**	**Maximum/Minimum dBA**	**Date**
N1	Ntete (Residential)	Daytime	55	52	88 / 34	15/04/2013
		Night time	45	45	83 / 28	15/04/2013
N2	Nquide (Residential)	Daytime	55	48	90 / 28	16/04/2013
		Night time	45	42	80 / 25	16/04/2013
N3	Maputo (Residential)	Daytime	55	54	82 / 32	17/04/2013
		Night time	45	48	85 / 25	17/04/2013
N4	Piriri (Residential)	Daytime	55	50	89 / 30	18/04/2013
		Night time	45	43	83 / 21	18/04/2013
	Indicates current $L_{Aeq,T}$ levels above either the daytime rating limit or the night time rating limit					

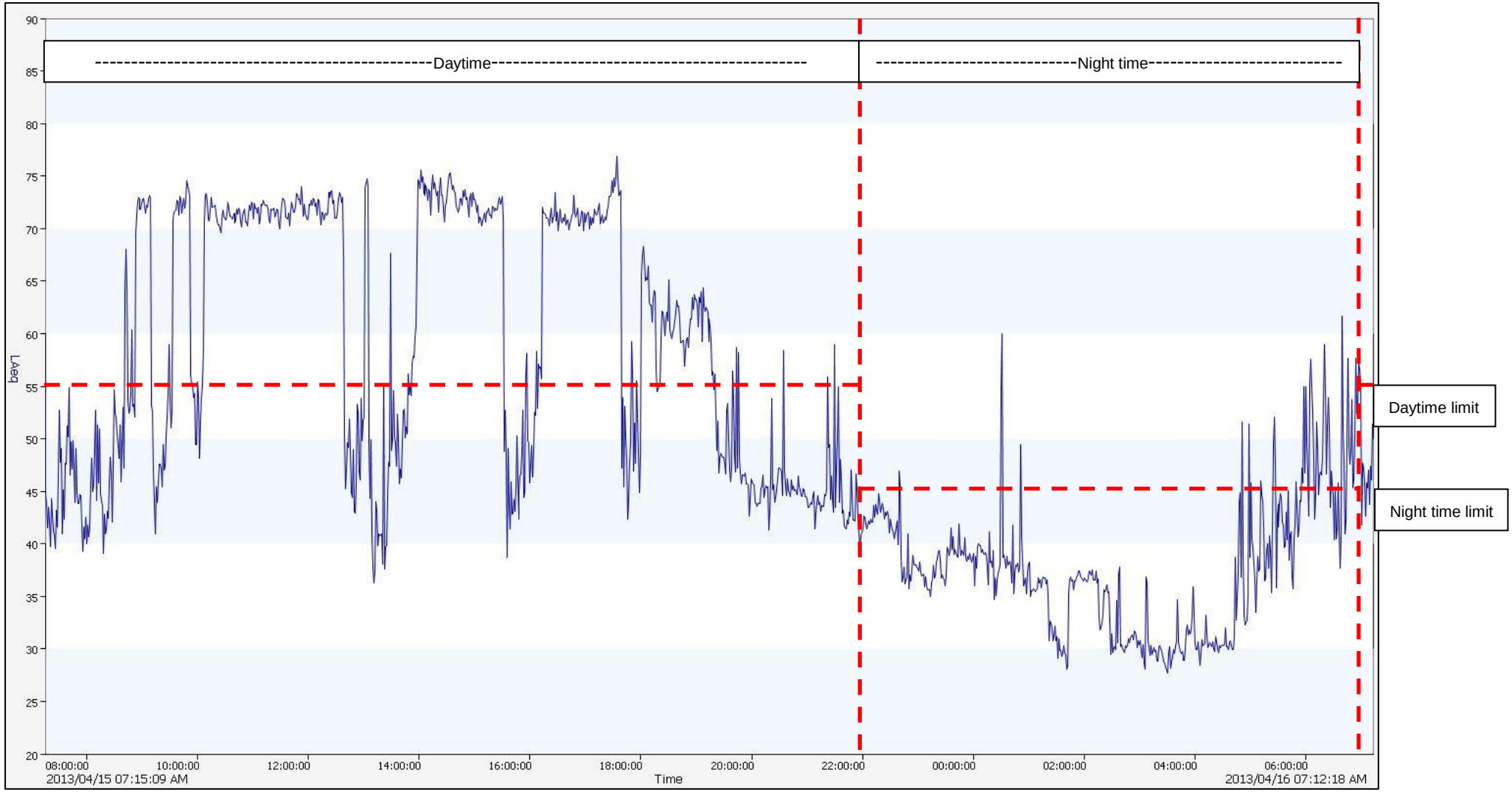


Figure 7-1: Noise graph for Ntete village

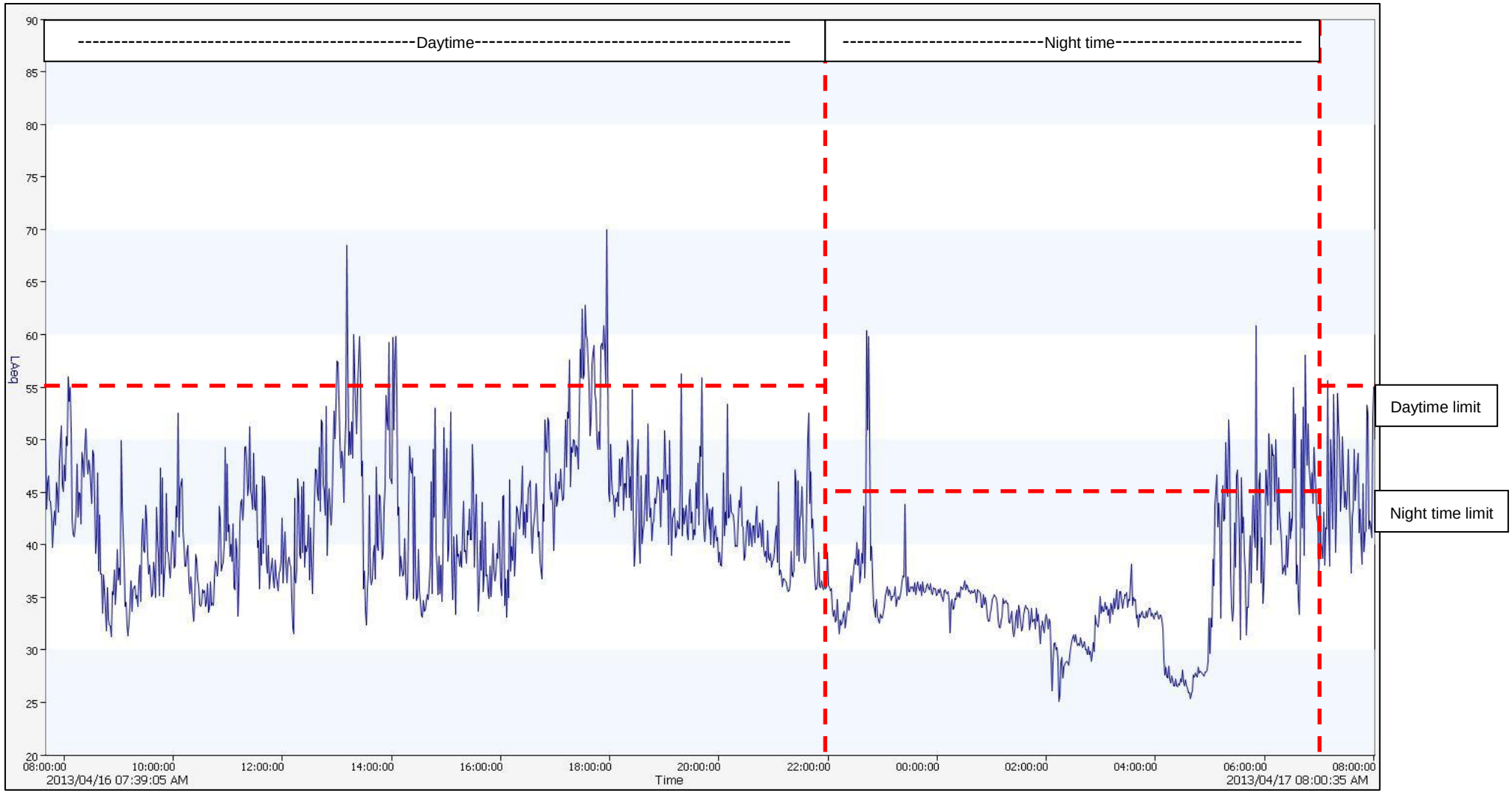


Figure 7-2: Noise graph for Nquide village

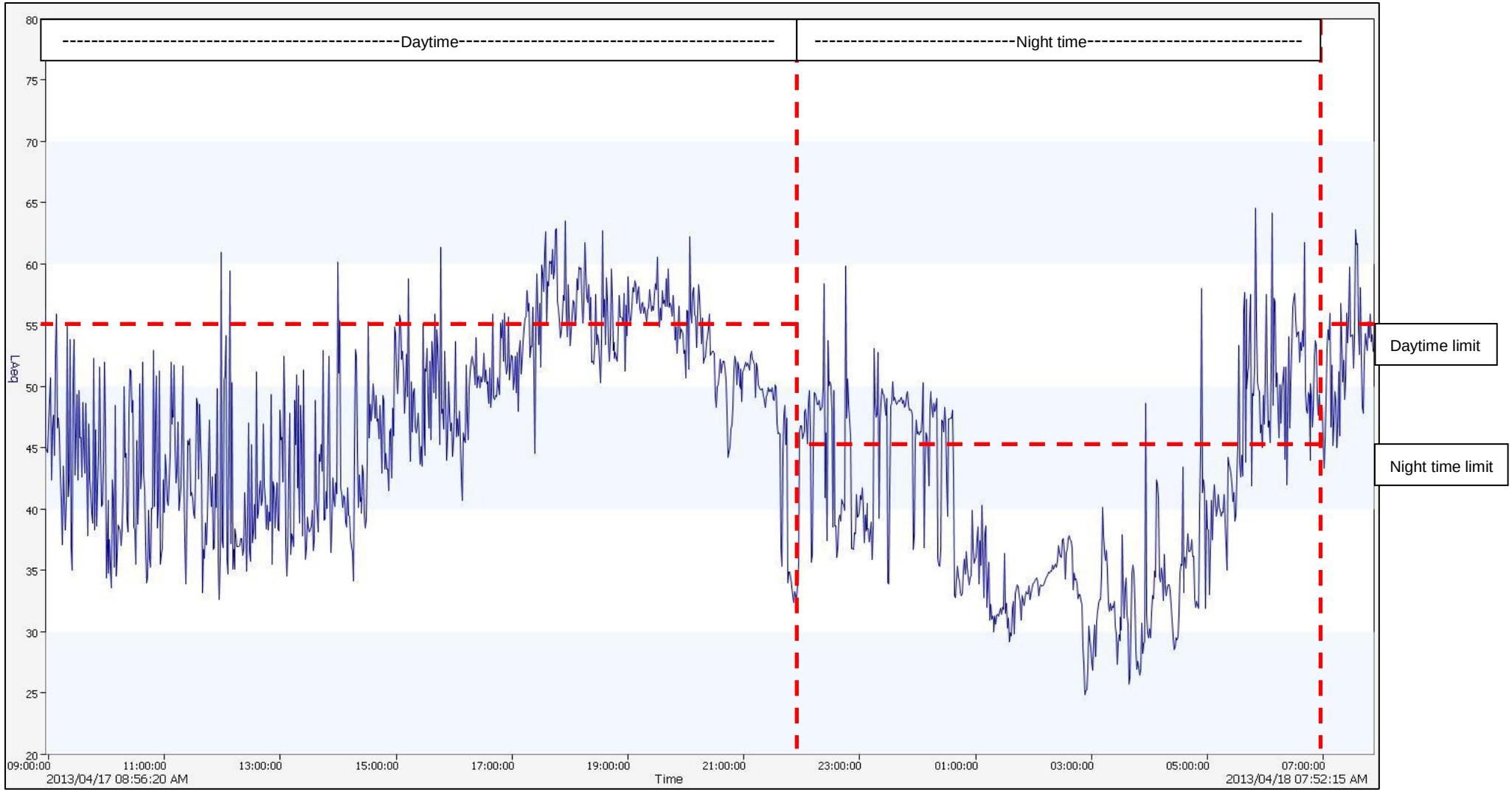


Figure 7-3: Noise graph for Maputo village

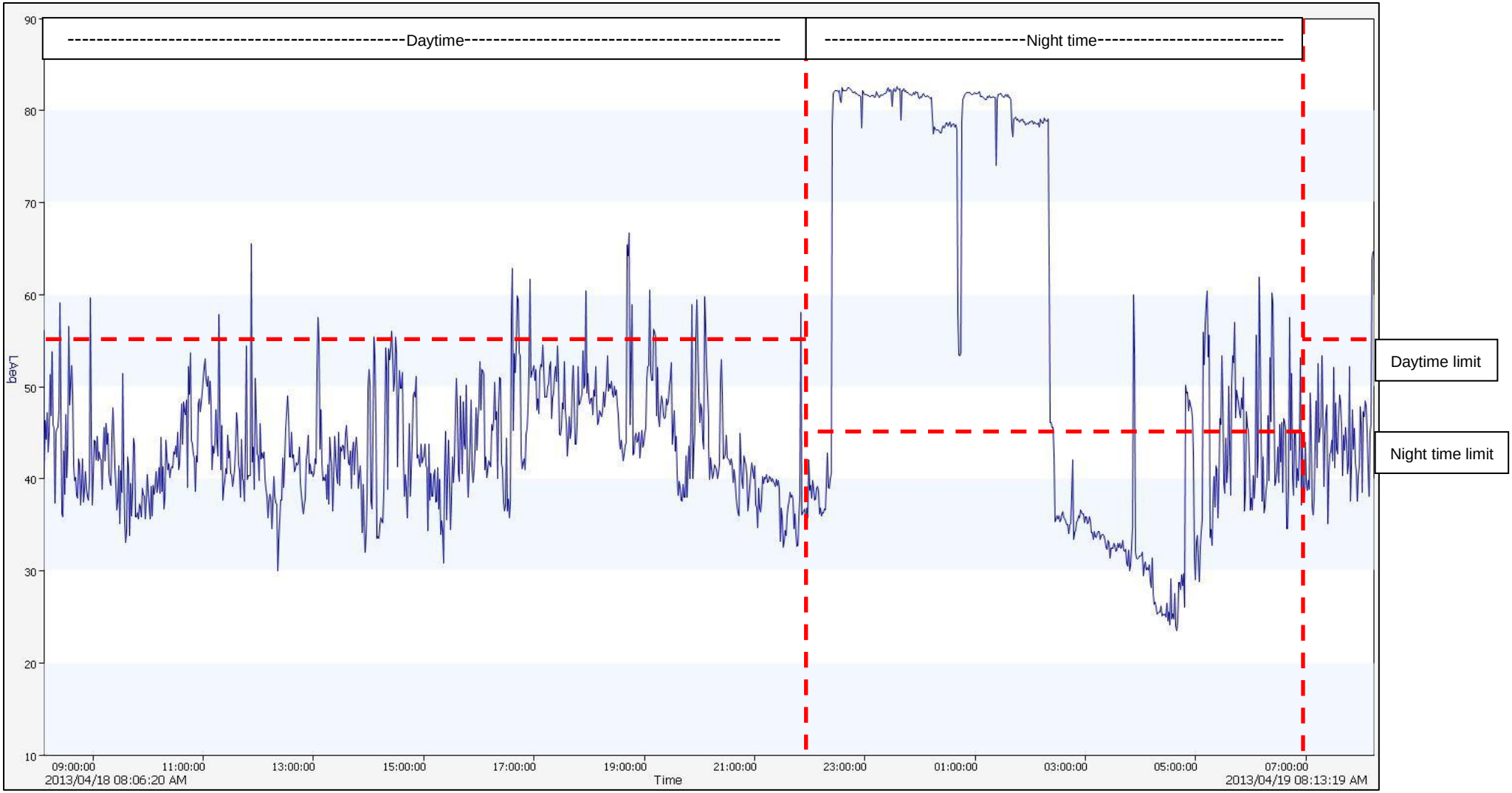


Figure 7-4: Noise graph for Piriri village

7.1 Daytime results

Based on the daytime results measured at the rural receivers, the general existing ambient noise levels are mostly below the IFC's guideline rating limits for the maximum allowable outdoor daytime limit for ambient noise in residential districts. Overall the ambient noise levels at the rural receivers are at the level of what is expected of rural villages according to IFC guidelines. The high peaks on Ntete's graph (Figure 7-1), during the morning and afternoon was due to a maize milling machine in operation. The operation of a maize milling machine, during the morning and afternoon, near the measurement location at Ntete caused the average to increase to 69 dBA. The average noise levels, not taking the maize milling machine into account, is 52 dBA. The baseline level at Ntete is set at the lower level of 52 dBA because of the fact that the maize milling machine is not always in operation and causes skewing of the more representative baseline level.

7.2 Night time results

The night time noise levels indicate that the ambient night time levels are mostly below the IFC's residential guideline limit. The high peaks on Piriri's graph (Figure 7-4) during the night time period was due to a Cicada that set itself on top of the windscreen covered microphone and the noise it produced caused the baseline level to measure at 77 dBA, which distorts the more representative baseline level. The more representative level, excluding the Cicada's noise contribution, is 43 dBA.

The noise sources that were audible during the baseline measurements at the time of the noise survey and that were responsible for the day/night time level are summarised in Table 7-2.

Table 7-2: General noise sources during baseline measurements

Noise source description			
Day	**Duration**	**Night**	**Duration**
Maize milling machine at Ntete	Intermittent	*Gryllidae* (crickets)	Continuous
Socializing activities	Intermittent	*Cicadidae* Cicada	Continuous
Vehicular activities on gravel roads passing through the villages as well as main road passing through Maputo	Intermittent	Vehicular activities on main road passing through Maputo	Intermittent

8 FINDINGS

8.1 The findings for the various phases

SoundPlan noise dispersion modelling software was used to assess whether the noise from the mining activities will have an impact on the relevant noise sensitive receptors. This was done by comparing the predicted propagating noise levels with the current ambient baseline noise levels.

8.1.1 Construction phase

It is assumed that the construction activities will only take place during daylight hours.

The following activities during the construction phase are identified as possible noise sources and may impact on the ambient noise level of the area:

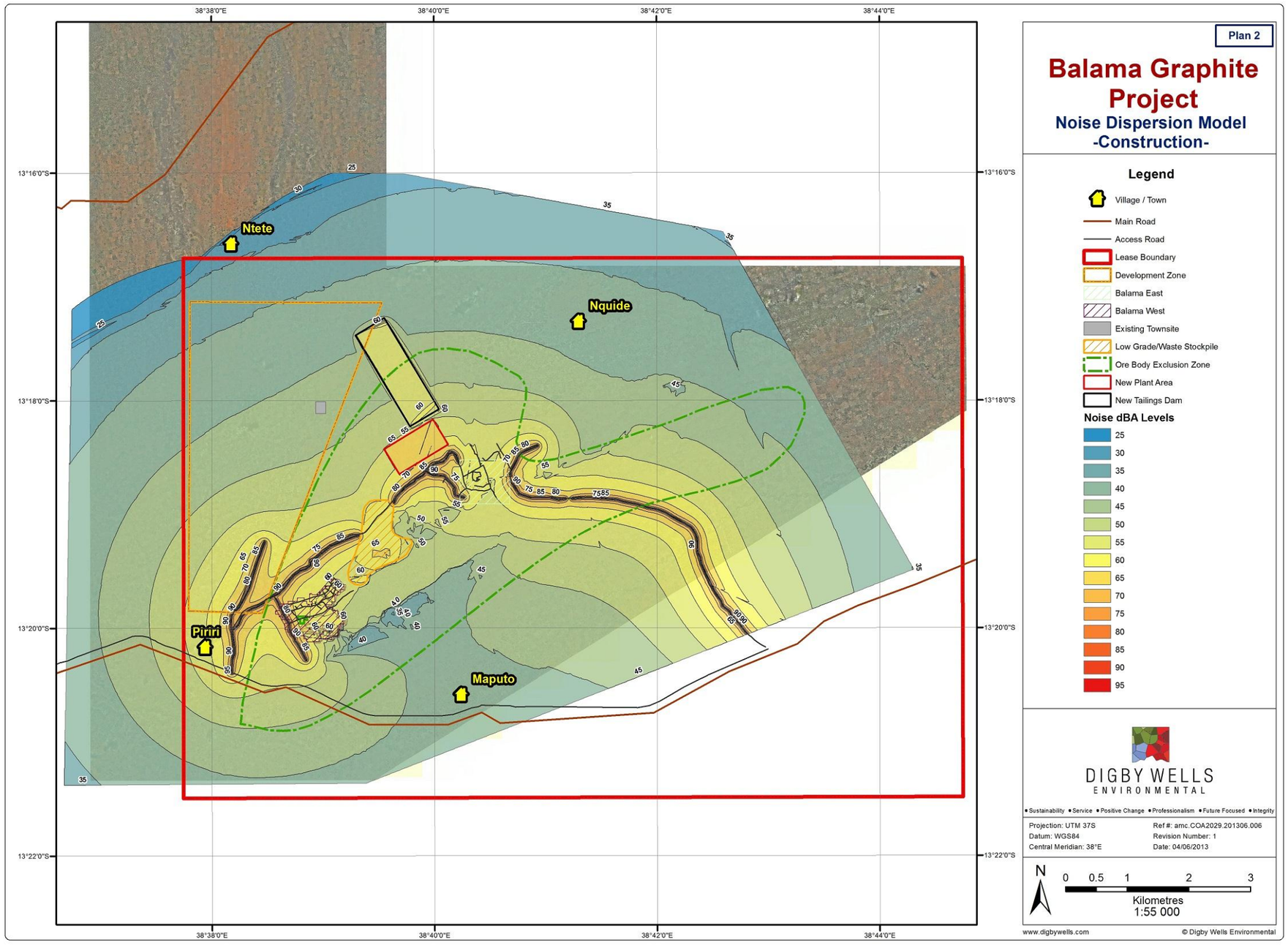
- Site clearing: Removal of topsoil and vegetation and stockpiling of overburden and topsoil; and
- Construction of any surface infrastructure e.g haul roads, processing plant and water station.
- Site establishment
- Increase in number of labourers

Potential impact: The construction machinery will be a source of continuous noise throughout the construction phase.

The grid noise map, shown in Plan 2, presents the noise contour lines and visually indicates the noise propagation during the construction phase.

According to the noise dispersion model for the construction phase, the noise from the proposed mining activities will measure below that of the IFC daytime guidelines as well as below that of the current ambient noise levels at the villages of Ntete, Nquide and Maputo.

The noise generated from the proposed construction of the haul roads is expected to measure above the existing baseline at Piriri. The noise levels from the construction of the haul roads are expected to measure 60dBA at Piriri, which is an increase of 10dBA. The expected noise from the haul road construction will therefore not be in compliance with the IFC EHS guidelines.



Plan 3: Noise dispersion from the construction phase.

8.1.2 Operational phase

The mining and processing activities will be operational for 24 hours a day and may impact on the existing ambient day and night time levels at the surrounding villages.

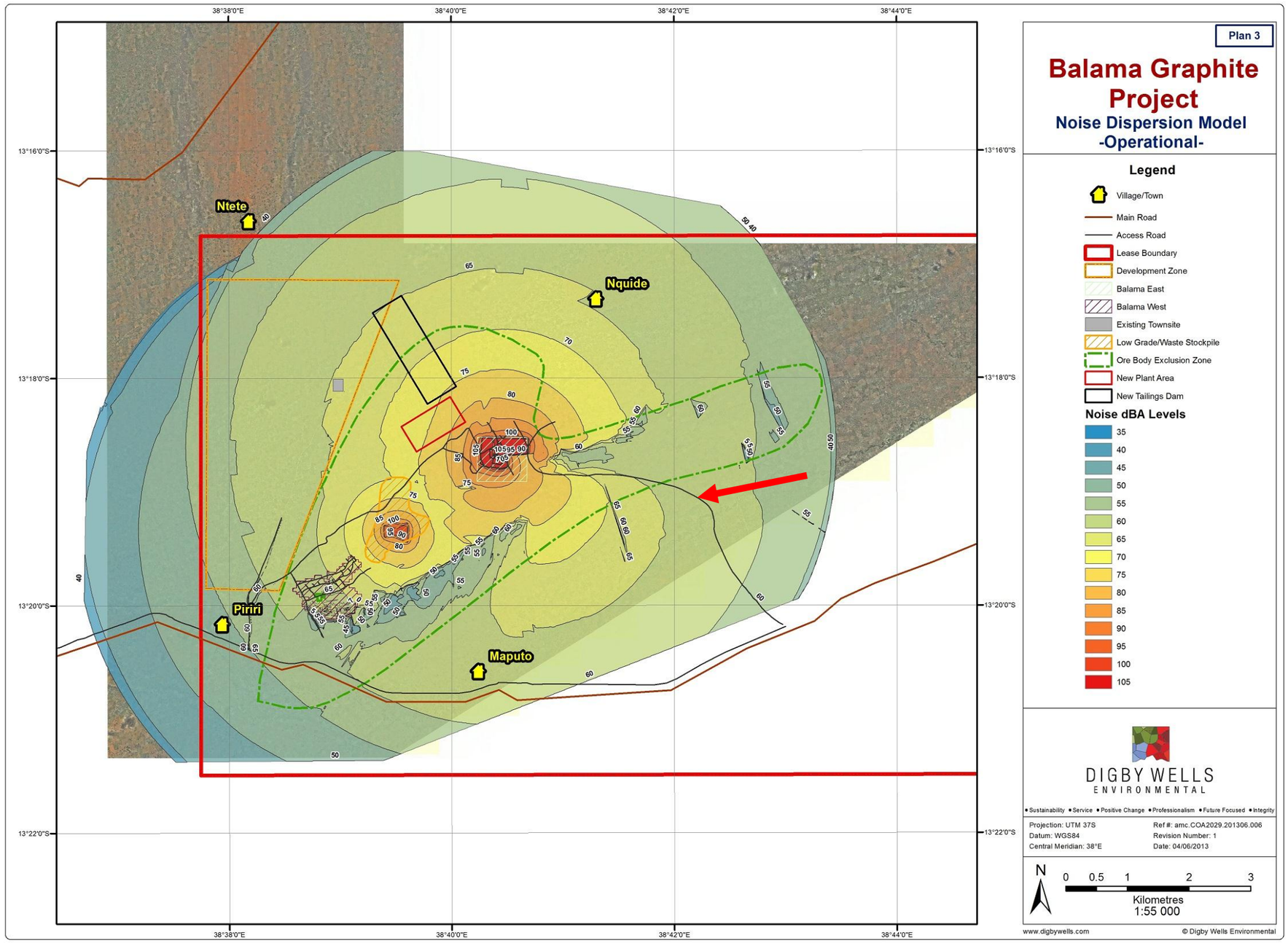
- Operation of surface infrastructure such as the operation of the processing plant; and
- Mining of the east and west pit.

Potential impact: The machinery involved with the above mentioned activities will be a source of continuous noise throughout the operational phase.

The grid noise map, shown in Plan 3, presents the noise contour lines and visually indicates the noise propagation of the operational phase for the day and night time.

According to the noise dispersion model for the operational phase, the noise from the proposed mining activities will measure above the day and night time baseline levels at the surrounding villages of Maputo and Nquide, but only above the night time baseline level at Piriri. The expected noise from the operation will therefore not be in compliance with the IFC EHS guidelines.

The haul trucks hauling the processed graphite off site may impact on villages adjacent to the haul route, depending on the specific haul route.



Plan 4: Noise dispersion from the operational phase.

8.1.3 Decommissioning phase

The following activities during the decommissioning phase are identified as possible noise sources and may impact on the ambient noise level at the relevant noise sensitive receptors:

- Demolition and removal of all infrastructure; and
- Rehabilitation activities (spreading of soil, re-vegetation & profiling/contouring).

Potential impact: The machinery involved with the above mentioned activities will be a source of continuous noise throughout the decommissioning phase.

The expected noise levels during this phase will be lower than that of the construction and operational phases because less machinery will be involved during the decommissioning phase. It is therefore expected that the noise from the proposed mining activities will be lower to that of the current ambient noise levels at the surrounding villages.

9 IMPACT ASSESSMENT

To ensure a direct comparison between various specialist studies, a standard rating scale has been defined and will be used to assess and quantify the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed.

The **environmental significance** scale evaluates the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the assessor/s making the judgement. Four factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.
2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.
3. The severity of the impact - the **severity/beneficial** scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party. The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word ‘mitigation’ means not just ‘compensation’, but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.
4. The **likelihood** of the impact occurring - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss or clearance of vegetation), but other impacts are not as likely to occur (e.g. vehicle accidents), and may or may not result from the project operations. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

Table 9.1 below summarises the above described factors’ categorical limits and criteria.

Table 9-1: Impact Significance Rating Criteria

Effect	**Temporal scale**		
	Short term	Less than 5 years	
	Medium term	Between 5 and 20 years	
	Long term	Between 20 and 40 years (a generation) and from a human perspective almost permanent.	
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there	
	Spatial Scale		
	Localised	At localised scale and a few hectares in extent	
	Study area	The proposed site and its immediate environs	
	Regional	District and provincial level	
	National	Country	
	International	Internationally	
	Severity		**Benefit**
	Slight / Slightly Beneficial	Slight impacts on the affected system(s) or party(ies)	Slightly beneficial to the affected system(s) or party(ies)
	Moderate / Moderately Beneficial	Moderate impacts on the affected system(s) or party(ies)	An impact of real benefit to the affected system(s) or party(ies)
	Severe / Beneficial	Severe impacts on the affected system(s) or party(ies)	A substantial benefit to the affected system(s) or party(ies)
	Very Severe / Very Beneficial	Very severe change to the affected system(s) or party(ies)	A very substantial benefit to the affected system(s) or party(ies)
Likelihood	**Temporal scale**		
	Unlikely	The likelihood of these impacts occurring is slight	
	May Occur	The likelihood of these impacts occurring is possible	
	Probable	The likelihood of these impacts occurring is probable	
	Definite	The likelihood is that this impact will definitely occur	

A four-point impact significance scale is then applied to the project impacts (Table 9.2 below).

Table 9-2: Environmental Significance Rating Scale

Significance rating	Description
Very High	VERY HIGH impacts would constitute a major and usually permanent change to the (natural and/or social) environment, and usually result in severe or very severe effects, or beneficial or very beneficial effects.
High	These impacts will usually result in long term effects on the social and/or

Significance rating	Description
	natural environment. Impacts rated as HIGH will need to be considered by the project decision makers as constituting an important and usually long term change to the (natural and/or social) environment. These would have to be viewed in a serious light.
Moderate	These impacts will usually result in medium to long term effects on the social and/or natural environment. Impacts rated as MODERATE will need to be considered by the project decision makers as constituting a fairly important and usually medium term change to the (natural and/or social) environment. These impacts are real but not substantial.
Low	These impacts will usually result in medium to short term effects on the social and/or natural environment. Impacts rated as LOW are generally fairly unimportant and usually constitute a short term change to the (natural and/or social) environment. These impacts are not substantial and are likely to have little real effect.

9.1 Construction phase

Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the construction phase.

Cause and Comment

The equipment and machinery involved such as excavators, pneumatic tools, bulldozers and haul trucks may impact on the surrounding ambient noise levels at the noise sensitive receptors near the project area.

Mitigation and Management

Standard mitigation measures to ensure vehicle noise is kept within acceptable limits:

- Keep vehicles in good repair and use standard exhaust and silencing equipment.
- Stick to designated speed limits.
- Keep roads in good condition..
- If possible enclose fixed noise sources such as generators.
- Switch off equipment when not in use.

Additional mitigation measures may include:

- If fixed noise producing sources such as generators, pump stations and crushers are not housed in enclosures, then put up barriers around the noise source. The barriers to be installed between the noise source and sensitive noise receptor, as close to the noise source as possible. Barriers may be in the form of soil berms.

Table 9-3: Construction Significance Statement

RATING		Temporal Scale	Spatial Scale	Severity of Impact	Risk or Likelihood
	Without Mitigation	Short term	Study area	Severe	Definite
	With Mitigation	Short term	Localised	Moderate	May occur
Overall Significance without mitigation					**MOD**
Overall Significance with mitigation					**LOW-**

9.2 Operational phase

Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the operational phase.

Cause and Comment

All mining related machinery, tools and vehicles as well as associated ore beneficiation activities may impact on the surrounding ambient noise levels at the noise sensitive receptors near the project area.

Mitigation and Management

- Implement applicable mitigation measures from the construction phase.

- Construct earth berms around the opencast areas, especially the west pit operations.
- processing plants have been located away from any communities.

Additional mitigation measures include:

- Earth berms to be constructed around the east operations to attenuate the noise towards the villages.
- The noise barrier should be as tall as the line-of-sight between the noise source and the receptor, plus 30%. So for example if the line-of-sight is 10m high, then the barrier should be at least 13m tall for best performance (Sound Fighter Systems, 2007). It is therefore recommended that the berm around the pit operations be constructed to a height of at least six meters.

Table 9-4: Operational Significance Statement

RATING		Temporal Scale	Spatial Scale	Severity of Impact	Risk or Likelihood
	Without Mitigation	Long term	Regional	Severe	Definite
	With Mitigation	Long term	Study area	Moderate	May occur
Overall Significance without mitigation					**HIGH**
Overall Significance with mitigation					**MOD**

9.3 Decommissioning phase

Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the decommissioning phase.

Cause and Comment

The equipment and machinery involved such as excavators, pneumatic tools, bulldozers and haul trucks may impact on the surrounding ambient noise levels at the noise sensitive receptors near the project area.

Mitigation and Management

There are standard mitigation measures to ensure that vehicle noise is kept within acceptable limits. Vehicles should be kept in good repair; they should use standard exhaust and silencing equipment. Drivers should stick to designated speed limits. Roads should be kept in good condition. As far possible keep decommissioning activities to daylight hours. Fixed noise sources such as generators should be enclosed.

Table 9-5: Decommissioning Significance Statement

RATING		Temporal Scale	Spatial Scale	Severity of Impact	Risk or Likelihood
	Without Mitigation	Short term	Localised	Slight	Unlikely
	With Mitigation	Short term	Localised	Slight	Unlikely
Overall Significance without mitigation					**LOW-**
Overall Significance with mitigation					**LOW-**

10 CUMULATIVE IMPACTS

Cumulative impacts should be considered for the overall improvement of ambient noise levels. The proposed project is considered a causative source of noise pollution of a low moderate to high significance. The existing noise sources in the immediate area of the proposed project are limited to agricultural activities, as well as infrequent vehicular movement on the surrounding roads infrastructure.

The proposed Balama Graphite Mine will significantly contribute to the existing ambient noise levels at the surrounding villages due to the expected cumulative noise contribution from the haul roads, east and west pit as well as the processing plant.

After the post closure phase of the proposed Balama Graphite Mine project, it is assumed that overall ambient levels will decrease to the pre-mining baseline and the cumulative impacts in the area will improve.

11 MITIGATION MEASURES AND MANAGEMENT PLAN

The objectives described for the recommended mitigation and/or management measures for each identified impact associated with each activity are presented below in Table 11-1 Table 11-1 lists the relevant activities for each phase of the mining operation and provides information pertaining to the legal requirements, recommended actions plans, timing, responsible person and significance after mitigation.

Table 11-1: Information pertaining to the recommended mitigation measures.

Activity	Objectives	Mitigation/Management measure	Frequency of mitigation	Legal Requirements	Recommended Action Plans	Timing of implementation	Responsible Person
Construction phase							
Site clearing and construction of infrastructure.	To prevent the noise emanating from the construction machinery from impacting on the sensitive receivers	• Mining-related machines and vehicles must be serviced on a regular basis to ensure noise suppression mechanisms are effective e.g. installed exhaust mufflers; • Switching off equipment when not in use; and • Fixed noise producing sources such as generators, pump stations and crushers to be to be either housed in enclosures or barriers put up around the noise source. The barriers should be installed between the noise source and sensitive noise receptor, as close to the noise source as possible. Barriers should be in the form of soil berms.	Vehicles to be serviced according to service plan. Machinery to be switched off when not in use.	IFC EHS guidelines	Noise monitoring programme to be followed. Regular vehicle inspections.	Construction	Environmental Manager
Operational phase							
Operation of surface infrastructure and mining of graphite.	To prevent the noise emanating from the mining activities from impacting on the sensitive receivers	• Mining-related machines and vehicles must be serviced on a regular basis to ensure noise suppression mechanisms are effective e.g. installed exhaust mufflers; • Switching off equipment when not in use; and • Fixed noise producing sources such as generators, pump stations and crushers to be to be either housed in enclosures or barriers put up around the noise source i.e. acoustic louvers installed on generators and crusher as well as resistance mufflers in the exhausts. • Earth berms to be constructed around the east and west pit operations to attenuate the noise towards the villages. • The noise barrier should be as tall as the line-of-sight between the noise source and the receptor, plus 30%. So if the line-of-sight is 10m high, then the barrier should be at least 13m tall for best performance (Sound Fighter Systems, 2007). It is therefore recommended that the berm around the pit operations be constructed to a height of at least six meters. • With regards to the earth berms: ○ Berms at both pits should be constructed at each pit's final void limit boundary ○ The west pit's berm should be constructed along the western limit boundary to minimize the impact on Piriri; and ○ The east pit's berm should be constructed along the north eastern limit boundary to minimize the impact on Nquide.	Vehicles to be serviced according to service plan. Machinery to be switched off when not in use.	IFC EHS guidelines	Noise monitoring programme to be followed. Regular vehicle inspections.	Operational phase	Environmental Manager
Decommissioning phase							

Demolition of infrastructure and rehabilitation activities.	To prevent the noise emanating from the machinery from impacting on the sensitive receivers	• Mining-related machines and vehicles must be serviced on a regular basis to ensure noise suppression mechanisms are effective e.g. installed exhaust mufflers; • Switching off equipment when not in use; • Limiting transport activities to daylight hours which are between 07:00 and 19:00; and • Limiting decommissioning activities to daylight hours where possible.	Vehicles to be serviced according to service plan. Machinery to be switched off when not in use.	IFC EHS guidelines	Noise monitoring programme to be followed. Regular vehicle inspections.	Decommissioning phase	Environmental Manager

12 MONITORING PROGRAMME

It is recommended that a monitoring plan be implemented to determine potential sources of noise, any increases and decreases in noise levels, and determine the level of mitigation required. Components to be included in the proposed monitoring plan are discussed in Table 12-1 below:

Table 12-1: Monitoring plan

Method	Monitoring locations	Frequency	Target	Reporting
Monitoring in accordance with the IFC EHS guidelines; Noise measurements should be taken for a 24 hour period at each location	The noise measurements should be taken at the measurement locations N1 – N4) as per the baseline study	To be conducted on a quarterly basis throughout the life of mine; Once it is established that the mitigation measures have decreased the specific noise levels from the mining activities, the noise monitoring should be carried out on a bi-annual basis thereafter.	Noise levels from the proposed mining activities should not result in a maximum increase in the existing background/ambient levels of 3dBA at the surrounding villages.	A report must be compiled quarterly/ bi-annual, depending on the intervals of the monitoring programme then submitted to management to ascertain compliance with the required standards

13 STUDY SUMMARY

In terms of the baseline conditions, it is gathered that the existing ambient day and night time noise levels in the surrounding villages are mostly below the IFC EHS noise rating limit for residential districts.

The findings have indicated by means of dispersion modelling that the noise levels from the proposed construction phase, especially the haul road development, will measure above the existing ambient noise levels at the village of Piriri. During the operational phase the proposed mining activities are expected to measure between 10dBA and 20dBA above the current ambient levels at Nquide and Maputo during the day and night time, but only during the night time at Piriri.

14 CONCLUSION

The overall pre-mitigation significance of the noise impact from the proposed Balama Graphite Mine is moderate to high during the construction and operational phase and drops to a low significance during the decommissioning phase.

The noise contributions can be reduced through the implementation of the recommended mitigation measures, especially the construction of the earth berms around the pits, which will help with the noise attenuating towards the villages. Depending on the general construct of the earth berms, an effective noise contribution decrease of between 5dBA and 10dBA can be achieved. The post-mitigation significance of the noise impact is considered to be moderate to low.

15 REFERENCES

Brüel & Kjær, Sound & Vibration Measurement A/S. *Environmental Noise,* 2001;

International Finance Corporation. *Environmental, Health and Safety guidelines: Noise management*, 2007.

Sound Fighter Systems 2007, Sound Fighter Systems USA, Shreveport, Los Angeles, viewed 22 October 2009, < http://www.soundfighter.com/content.asp?page=20 >

Appendix A: Curriculum Vitae and Declaration of Independence

CURRICULUM VITAE (CV)

Position Title and No.	**Environmental Noise Specialist**
Name of Expert:	Lukas Sadler
Date of Birth:	02 March 1983
Country of Citizenship/Residence	South African

Education:

Institution	Dates	Degree(s) or Diploma(s) obtained:
Mackenzie Hoy Consulting Acoustic Engineers	2013	Environmental Noise Control
University of Johannesburg	2010	Air Quality Management
Open Access Industrial Training College (OAITC)	2009	Occupational and Environmental Noise
North West University	2002	B.Com Environmental Management
Randburg High School	2001	Matric

Employment record relevant to the assignment:

Period	Employing organization and your title/position. Contact info for references	Country	Summary of activities performed relevant to the Assignment
2008 to date	**Organisation:** Digby Wells Environmental **Position / Title:** Environmental Consultant: Noise Unit **Reference:** Graham Trusler (CEO), graham.trusler@digbywells.com	South Africa	Environmental Noise Impact Assessments; Environmental Noise Modelling; Environmental Noise Monitoring

Membership in Professional Associations and Publications:

- Member: National Associates for Clean Air

Language skills (indicate only languages in which you can work):

- Afrikaans - excellent (speak, read, write)
- English - excellent (speak, read, write)

Adequacy for the Assignment:

Detailed tasks assigned on Consultant's team of experts:	Reference to prior work/assignments that best illustrates capability to handle the assigned tasks:	
As above	**Project name:**	Putu Iron Ore Project
	Year:	2013 - ongoing
	Location:	Grand Gedeh County, Liberia
	Client:	Atkins Global
	Main project features:	Proposed opencast iron ore mine. Project proponent: Severstal
	Position held:	Environmental Noise Impact Assessment
	Activities performed:	Review and inclusion of baseline noise measurements as well as noise dispersion modelling in support of the noise impact assessment.
	References:	Irene Bopp, Senior Consultant, Water & Environment, Atkins Global Tel: +44 (0)14546 62346 Cell: +44 (0)7812237938

Detailed tasks assigned on Consultant's team of experts:	Reference to prior work/assignments that best illustrates capability to handle the assigned tasks:	
As above	**Project name:**	New Liberty Gold Mine
	Year:	2012 - ongoing
	Location:	Grand Cape Mount County, Liberia
	Client:	Aureus Mining Inc.
	Main project features:	Proposed opencast gold mine.
	Position held:	Environmental Noise Impact Assessment
	Activities performed:	Baseline noise monitoring survey and noise dispersion modelling
	References:	Patrys Laubscher, EHS Manager, Aureus Mining Inc. Skype: patrys132 Email: patrys.laubscher@aureus-mining.com
As above	**Project name:**	Thabametsi opencast, underground mine
	Year:	2012 – 2013
	Location:	Limpopo Province, South Africa
	Client:	Exxaro Resources
	Main project features:	Opencast & underground coal mine and infrastructure development in the Lephalale region.
	Position held:	Undertaking environmental noise impact assessment
	Activities performed:	Baseline noise monitoring survey, noise dispersion modelling and management plan
	References:	Koos Smit Environmental Management Specialist Unit, Exxaro Corporative Centre, Pretoria Tel: +27 (12) 307 3234 Fax: +27 (12) 307-5188 koos.smit@exxaro.com
As above	**Project name:**	Cooke Uranium Project
	Year:	04/2012 – 09/2012
	Location:	Gauteng Province, South Africa
	Client:	Gold One International Ltd.
	Main project features:	Re-mining of historic tailings facilities and establishment of a single large new Tailings Storage Facility for residual tailings
	Position held:	Undertaking environmental noise impact assessment
	Activities performed:	Baseline noise monitoring survey, noise dispersion modelling and management plan
	References:	Dick Plaistowe Golder One International dick.plaistowe@Gold1.co.za
As above	**Project name:**	Temo Coal Project
	Year:	03/2012 – 10/2012
	Location:	Limpopo Province, South Africa
	Client:	Temo Coal Mining (Pty) Ltd
	Main project features:	Mining right application Management of research & report compilation for addressing authority
	Position held:	Undertaking environmental noise impact assessment
	Activities performed:	Baseline noise monitoring survey, noise dispersion modelling and management plan
	References:	John Schoeman john@ciholdings.co.za

Detailed tasks assigned on Consultant's team of experts:	Reference to prior work/assignments that best illustrates capability to handle the assigned tasks:	
As above	**Project name:**	Kibali Hydropower stations Project
	Year:	2012 –2013
	Location:	Orientale Province, Democratic Republic of Congo
	Client:	Randgold Resources Ltd
	Main project features:	Environmental and social studies for development of hydropower stations along the Nzoro and Kibali river
	Position held:	Undertaking environmental noise impact assessment
	Activities performed:	Baseline noise monitoring survey, noise dispersion modelling and management plan
	References:	Charles Wells Charles.Wells@randgoldresources.com

Expert's contact information:

E-mail address: lukas.sadler@digbywells.com

Telephone: +27 11 789 9495

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience, and I am available to undertake the assignment in case of an award. I understand that any misstatement or misrepresentation described herein may lead to my disqualification or dismissal by the Client, and/or sanctions by the Bank.

Name of expert	Signature	Date
Lukas Sadler		16 January 2014

I, Lukas Sadler, declare that I –

- Act as the independent specialist for the undertaking of a specialist section for the proposed Balama Graphite Mine ;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed;
- Do not have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

Lukas Sadler

Name of the Specialist

Signature of the Specialist

Digby Wells and Associates

Name of company

05/06/13

Date