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REPORT – VOLUME 4, STUDY 6

CNOOC UGANDA LIMITED

Environmental and Social Impact Assessment for the Kingfisher Development Area in Hoima district, Uganda - Noise Impact Assessment

Submitted to:
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ABBREVIATIONS AND ACRONYMS

dB(A)	Decibels, A-weighting filter applied
ESIA	Environmental and Social Impact Assessment
EHS	Environmental, Health and Safety
IFC	International Finance Corporation
ISO	International Standards Organisation
m/s	Metres per second
N/A	Not applicable
UKAS	United Kingdom Accreditation Service

GLOSSARY

L_{Aeq}	the value of the A-weighted sound pressure level in decibels of continuous steady sound that is within a specified time interval, T, has the same mean-squared sound pressure as a sound that varies with time
L_{A90}	the A-weighted sound pressure level which is that exceeded for 90% of the measurement period, indicating the noise level during quieter periods, and is often referred to as the background noise level
dB	Decibel. Acoustic unit used to quantify sound levels relative to a 0 dB reference (20 micropascals sound pressure), set at the typical threshold of perception of an average human.

1.0 INTRODUCTION

1.1 Assessment Objectives

This assessment considers the potential noise impacts arising from the proposed CNOOC project (the Project) in the Kingfisher exploration field on the shore of Lake Albert, Uganda and supersedes a previous version completed by Golder in June 2014. Noise impacts are considered in the context of appropriate guidelines and with reference to noise levels measured during a baseline survey in the study area.

In order to assess the noise impacts associated with the Project, multiple stages of its development have been considered. Where significant noise impacts have been identified at noise-sensitive receptors, mitigation has been considered and specified in order to reduce the significance of predicted impacts to an acceptable level.

2.0 TERMS OF REFERENCE

2.1 Scope of Noise Assessment

The scope of the noise assessment has been determined by making reference to the Scoping Report (Ref. 1) and the Development Plan (Ref. 2) and the Project Description. The primary aims of the noise assessment are:

- To identify receptors which may be sensitive to changes in the ambient noise environment;
- To determine appropriate criteria by which to assess changes to noise levels arising as a result of the Project;
- To predict the noise levels at identified receptors as a result of the different stages of the Project and assess these against the adopted criteria; and
- To provide suggested mitigation where unacceptable impacts are identified.

2.2 Study Area and Receptors

The Kingfisher Field lies on the south flank of the Albert Basin, part of the western arm of the East African Rift System. The location of the Kingfisher Development Area (KDA) is indicated in Figure 1 and the Local Study Area (LSA) for the noise assessment is provided in Figure 2.

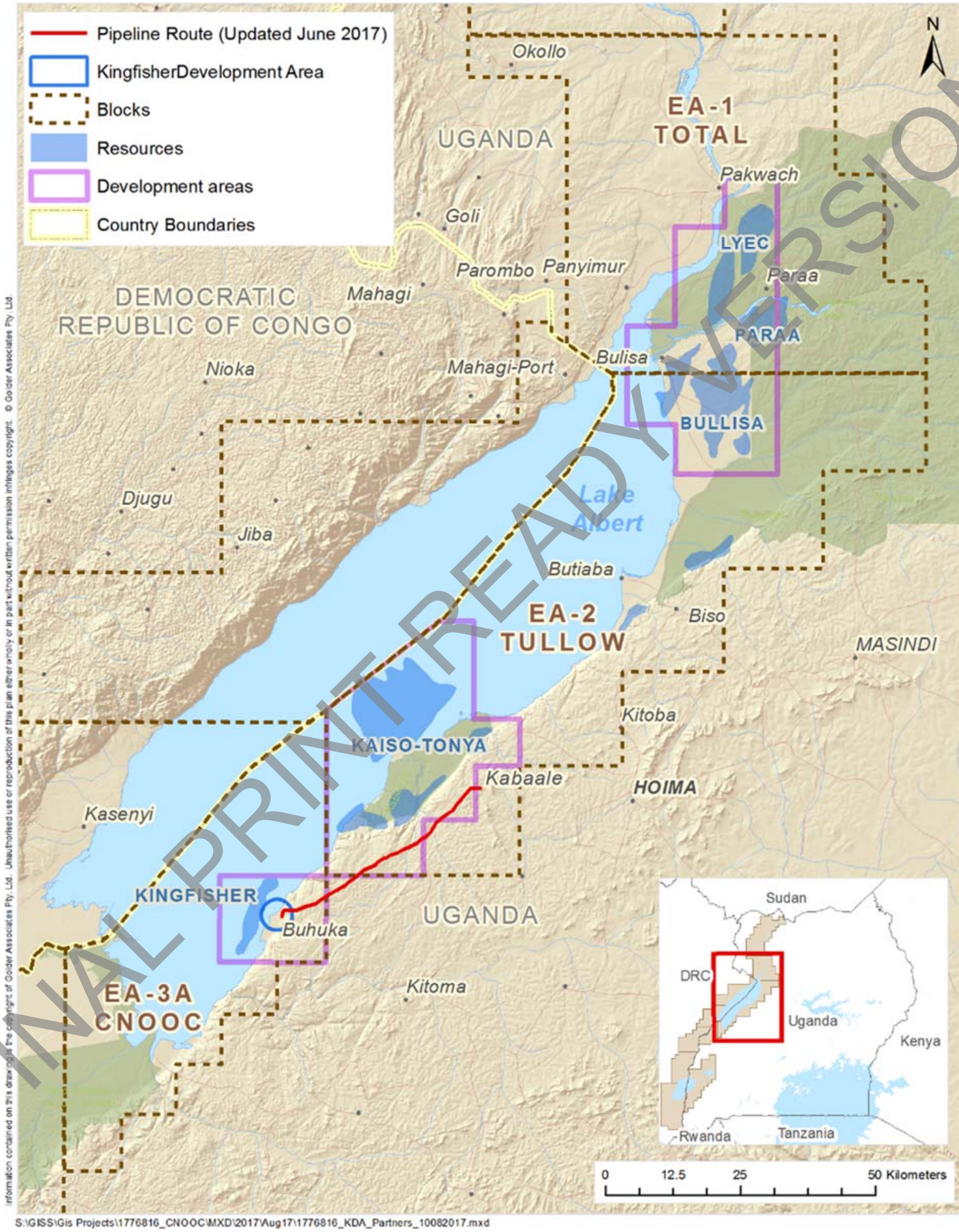

Figure 1: Kingfisher Development Area

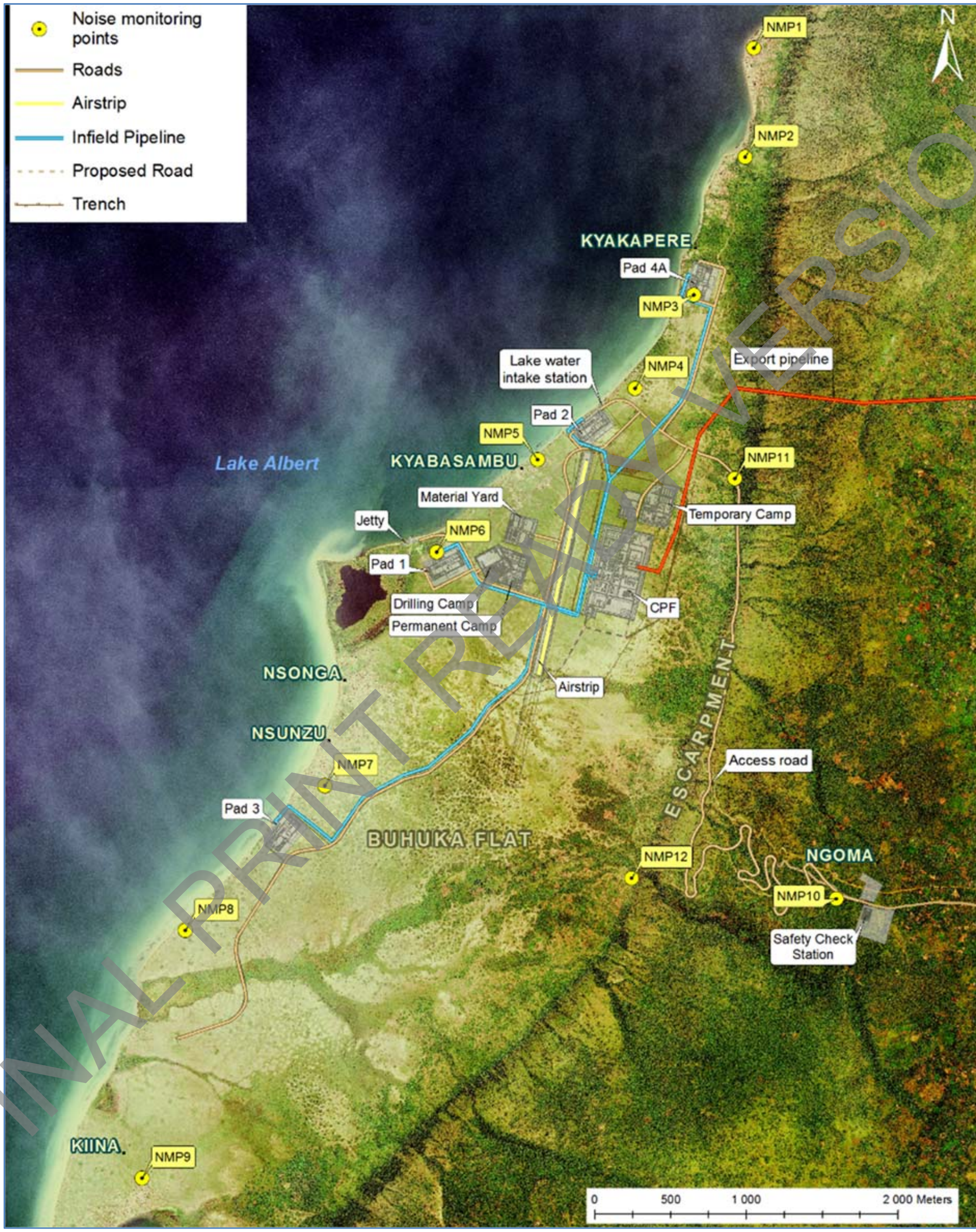

Figure 2: Local Study Area

The Project will comprise a range of oil-producing and supporting facilities including 31 wells comprising 20 production wells and 11 produced water injection wells, located at 4 well-pads, and associated infrastructure including; Central Processing Facility (CPF), production flow line, water injection flow line, oil feeder pipeline, lake water extraction station, workers' camps, a jetty, an airstrip and service roads.

2.3 Relevant Legislation & Guidelines and Selected Noise Evaluation Criteria

2.3.1 Construction Noise

2.3.1.1 *Ugandan Legal Standards*

Ugandan legislation relevant to this assessment is set out in the document 'National Environment (Noise Standards and Control) Regulation, 2003' (the Regulations) (Ref. 3). More recent regulations (dated 2013) are in Draft form (The National Environment (Noise and Vibrations Standards and Control) Regulations, 2013) (Ref. 4).

There are considerable differences in the legal and guideline values for construction noise. The Ugandan construction noise standard is the same in both the 2003 and the Draft 2013 regulations (Table 7-12). Daytime noise at locations other than highly noise-sensitive land uses such as hospitals, schools, institutions of higher learning (i.e: most development on the Buhuka Flats) should not exceed 75 dBA during the day and 65 dBA at night. For sensitive land uses, a noise level of 60 dBA during the day and 50 dBA at night applies. Noise levels are energy averages (quoted as LAeq).

The Ugandan noise regulations also provide limits for noise for the protection of workers within workshops and industrial installations. These are provided in Table 1. The maximum occupational exposure limits have been referenced in identifying source noise terms for proposed plant.

Table 1: Ugandan Noise at Work Limits

Receptor Type	Noise Limit, dB L_{Aeq}
Offices	50
Factory/Workshop Compound	75
Factories/Workshops	85

Any owner of a facility which produces noise that exceeds the standards set out in the Ugandan noise regulations is required to apply to for a License in terms of Part IV.

2.3.1.2 *Comparison with IFC Guidelines*

The Ugandan legal standard is less stringent than the IFC guidelines, which specify target noise levels not exceeding a daytime limit of 55 dBA and a night-time limit of 45 dBA, as well as the requirement that sound levels should not be increased by more than 3 dBA above the background ambient. The IFC guidelines are not specifically designed for construction (temporary) noise and achieving less than a 3 dBA increment under construction conditions is not easily achievable. In the context of construction noise, the IFC 3 dBA criterion is often interpreted to apply only in cases where the baseline ambient already exceeds the IFC maxima specified in **Error! Reference source not found.**.

Table 2: Ugandan Noise Standards compared with IFC Guidelines[1]

Period	IFC	Ugandan Construction Noise Standard (2003)	Draft (Revised) National Ugandan Construction Noise Standard (2013)[2]
Daytime Noise	55 dBA	75 (60)*	75 (60)
Night-time Noise	45 dBA	65 (50)	65 (50)

** numbers in brackets refer to noise-sensitive land uses such as hospitals and schools*

The daytime period in the Ugandan Regulations is defined as 06:00 to 22:00, compared with the IFC's 07:00 to 22:00. This is more conservative than the IFC guidelines, since the lower night-time noise limit applies for a longer period;

2.3.1.3 *Other Construction Noise Guidelines*

Other noise guidelines designed specifically for construction noise impact distinguish between noise levels based on the period of construction. One of the most cogent of these is Rio Tinto's 'Noise *and Vibration Criteria Impact Assessment Criteria and Methodology*'[3] (Table 3). This guideline rates the significance of construction noise on the basis of the period of time over which it occurs (short term <1month, medium term 1-6 months, long term >6 months). For long term construction noise (>6 months), the target values are an $L_{Aeq(1hr)}$ of 55 dBA (daytime) and 45 dBA (night-time). For construction periods lasting between 1-6 months, the daytime target values are an $L_{Aeq\ (1hr)}$ of 65 dBA. Night-time values for the 1-6 month period do not apply to the present project. Noise levels below these values are considered to be insignificant. Impact significance ratings based on these threshold values are shown in Table 3 and Table 4.

Table 3: Rio Tinto Impact Rating Scale for Construction Noise for periods longer than 6 months[4]

Time of Day	Noise Level (dB LAeq, I hr)					
	<45	45-50	50-55	55-60	60-65	>65
Daytime	NS	NS	NS	Minor	Moderate	Major
Night time	NS	Minor	Moderate	Major	Major	Major

NS = Not significant

Table 4: Rio Tinto Impact Rating Scale for Construction Noise for 'medium term' periods of 1- 6 months[5]

Time of Day	Noise Level (dB LAeq, I hr)						
	<45	45-55	55-60	60-65	65-70	70-75	>75
Daytime	NS	NS	NS	NS	Minor	Moderate	Major

NS = Not significant

[1] This assessment assumes that the reference time over which L_{Aeq} levels are averaged is 1 hour, as is common to most international guidance and legislation for environmental noise.

[2] Draft National Environment (Noise and Vibrations Standard and Control) Regulations, 2013: Schedule 4 Part A. the quoted standard is

[3] Rio Tinto (undated)

[4] Ibid

[5] *Ibid*

2.3.2 Operational Noise

2.3.2.1 *Ugandan Legal Standards*

Ugandan legislation relevant to this assessment is set out in the 2003 Regulations. These regulations describe the maximum permissible noise levels from a facility in different environments. Part II (6) 1 sets out the noise levels that should not be exceeded for different types of land use in the 'general environment' The 'Levels for the General Environment', broken down by receptor sensitivity, are provided in Table 5. In Part III Section 8 of the Draft (2013) regulations, it is specified that noise impacts shall not exceed the levels prescribed under these Regulations or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

The environment on the Buhuka Flats presently falls within Category C of Table 5,

Table 5: Ugandan Environmental Noise Limits

Category	Receptor Type	Noise Limit, dB L_{Aeq}	
		Daytime (06:00 – 22:00)	Night-time (22:00 – 06:00)
A	Any building used as hospital, convalescence home, home for the aged, sanatorium, institute of higher learning, conference rooms, public library, environmental or recreational sites.	45	35
B	Residential buildings	50	35
C	Mixed residential (with some commercial and entertainment)	55	45
D	Residential and industry or small-scale production and commerce	60	50
E	Industrial	70	60

This assessment assumes that the reference time over which L_{Aeq} levels are averaged is 1 hour, as is common to most international guidance and legislation for environmental noise.

2.3.2.2 *IFC Guidelines*

The IFC noise guidelines are described in Table 2 above. Target noise levels not exceeding a daytime limit of 55 dBA and a night-time limit of 45 dBA are specified as well as the requirement that sound levels should not be increased by more than 3 dBA above the background ambient.

2.4 Selected Noise Evaluation Criteria

2.4.1 Adopted Construction Noise Evaluation Criteria

The Rio Tinto guidelines are used in this assessment due to the detailed differentiation between construction periods of different lengths. The Rio Tinto targets in Table 3 (period longer than 6 months) can be regarded as a basis for impact assessment for the civil construction at the CPF, the drilling and the feeder pipeline personnel camp, being more stringent than the Ugandan regulations, which are legally defined maxima. The assessment of noise caused by the construction of the feeder pipeline is evaluated in accordance with Table 4, which is based on the Rio Tinto guidelines for construction noise which extends over a period of between 1-6 months.

To adapt the CNOOC ESIA impact rating scale to conform to the above approach, the standard impact rating criteria are not applied. The ratings of 'minor', 'moderate' and 'major' in Table 3 and Table 4 are deemed to be equivalent to 'low', 'medium' and 'high' significance in the CNOOC ESIA rating scale.

2.4.2 Adopted Operational Phase Noise Evaluation Criteria

For the operational phase, the criteria used to evaluate the significance of potential noise impacts follows the general rating system defined for the ESIA. This includes:

Direction of an impact may be positive, neutral or negative with respect to the particular impact. A positive impact is one which is considered to represent an improvement on the baseline or introduces a positive change. A negative impact is an impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.

Magnitude is a measure of the degree of change in a measurement or analysis, and is classified as none/negligible, minor, low, medium or high. The magnitude of impact interpreted on the basis of noise-related criteria is shown in Table 6.

Table 6: Noise Ratings for the Evaluation of Magnitude

Criterion	Rating	Definition
Magnitude	No Significant Impact	Meets Ugandan Regulations during the evaluation period (daytime (55 dBA) / night-time (45 dBA)) AND is below measured baseline
	Minor	Meets Ugandan Regulations during the evaluation period (daytime (55 dBA) / night-time (45 dBA)) AND predicted level due to Project exceeds baseline by < 3 dBA
	Low	Meets Ugandan Regulations during the evaluation period (daytime (55 dBA) / night-time (45 dBA)) AND predicted level due to Project exceeds baseline by 3-5 dBA
	Medium	Meets Ugandan Regulations during the evaluation period (daytime (55 dBA) / night-time (45 dBA)) AND predicted level due to Project exceeds baseline by ≥5 dBA
	High	Exceeds Ugandan Regulations during the evaluation period (daytime (55 dBA) / night-time (45 dBA)) AND increase above baseline by ≥ 5 dBA

Duration refers to the length of time over which an environmental impact may occur: i.e. transient (less than 1 year), short-term (1 to 5 years), medium term (6 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent. Noise generated by plant and equipment at the CPF will be long term.

Scale / Geographic extent refers to the physical area that could be affected by the impact and is classified as indicated below into site, local, regional, national, or international. All noise-related impacts will be local or site based in scale.

Site: impacts that are limited to the direct area of disturbance and immediate surrounds

Local: impacts that affect an area in a radius of up to 10 km around the site

Probability of Occurrence is a measure of the likelihood of the change (or impact) actually occurring. This may be categorised as:

No chance of occurrence 0% chance of change;

Improbable	less than 5% chance;
Low probability	5% to 40% chance;
Medium probability	40 % to 60 % chance;
Highly probable	60% to 90% chance; or
Definite	impact will definitely occur.

A simple scoring system is applied in line with the example provided in Table 7 below.

Table 7: Scoring system

Magnitude	Duration	Scale	Probability
10 Very high/ don't know	5 Permanent	5 International	5 Definite/don't know
8 High	4 Long-term (impact ceases after closure of activity)	4 National	4 Highly probable
6 Medium	3 Medium-term (5 to 15 years)	3 Regional	3 Medium probability
4 Low	2 Short-term (0 to 5 years)	2 Local	2 Low probability
2 Minor	1 Transient	1 Site only	1 Improbable
1 None/Negligible			0 No chance of occurrence

The significance of the change (impact) is then be determined as:

SP (Signifiance Points) = (Magnitude + Duration + Extent) x Probability

where the relative significance of the change (or impact) is typically ranked as set out in Table 8 below.

Table 8: Ranking system

Value	Significance	Implications for the Project
SP ≥75	Indicates **high** environmental and/or social significance	The degree of change (or impact) that the Project may have upon the environment and/or the community(s) is unacceptably high. High residual impacts carry substantial weight for authority decision making about the project. The impact must be mitigated or avoided. If this impact cannot be mitigated or avoided, the Project is unlikely to be permitted for development.
SP 30 - 75	Indicates **medium** environmental and/or social significance	The degree of change (or impact) that the Project may have upon the environment and/or the community(s) is medium. The Project may be compromised if this residual impact cannot be avoided or sufficiently mitigated
SP ≤30	Indicates **low** environmental and/or social significance	The degree of change (or impact) that the Project may have upon the environment and/or the community(s) is relatively low. Opportunities to avoid or mitigate the impact should still be considered, however this should not compromise the viability of the Project.

Value	Significance	Implications for the Project
+	**Positive impact**	The changes will have a positive benefit upon the existing environment and/or the community(s).

2.5 Method of Prediction of Change

2.5.1 ISO 9613

In order to determine the specific noise levels attributable to the Project, a noise propagation model was created within the proprietary noise prediction software, CadnaA, and the predicted noise levels compared with the measured noise levels at each receptor. All noise propagation within the model was calculated in accordance with ISO9613 *Parts 1 & 2 Acoustics - Attenuation of sound during propagation outdoors.*

The propagation model described in the ISO standard provides for the prediction of sound pressure levels based on down-wind (i.e. worst-case) conditions and other conditions favourable for noise propagation. The model calculates the predicted sound pressure level by taking the SWL for each turbine in separate octave bands and subtracting a number of attenuation factors, according to the following:

$$\text{Predicted Octave Band Noise Level} = L_w - A$$

Where Lw is the octave band sound power level and A represents the various attenuation factors, also in dB. A is defined as:

$$A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{mis}$$

A_{div} is the attenuation due to geometric divergence. This is the reduction in noise levels caused by the spherical spreading of the noise over distance from the point source. The attenuation factor therefore increases as the distance from the noise source increases.

A_{atm} is the atmospheric absorption of the noise in the atmosphere as sound energy is converted to heat. The level of absorption varies depending on the distance from source and the atmospheric conditions (temperature and humidity). ISO 9613-1, *Acoustics Attenuation of Sound during Propagation Outdoors: Part 1 - Method of calculation of the attenuation of sound by atmospheric absorption* provides appropriate air attenuation factors for differing atmospheric conditions.

A_{gr} is the ground attenuation factor and represents the reduction in noise levels due to the absorption and reflection of sound energy by ground cover. The ground attenuation will vary significantly depending on the absorptive qualities of the ground cover. ISO9613-1 provides advice on appropriate ground attenuation factors based on ground cover ranging from hard ground (concrete) to soft absorbent ground.

A_{bar} relates to the attenuation due to the screening and reflection effects provided by obstacles between the source and the receiver. The level of attenuation will vary depending on the degree by which the line of sight between source and receptor is affected and the frequency considered.

A_{mis} represents any miscellaneous causes of attenuation.

2.5.2 Noise Prediction Model Settings

Reported atmospheric conditions in the local area based on internet research fall within the temperature range 9^{o}C – 32^{o}C with a relative humidity (RH) of 88%. The attenuation effect on noise propagation is inversely proportional to air temperature; the higher the temperature and humidity the greater the atmospheric attenuation of noise. Noise predictions have therefore assumed a worst-case air temperature of 10^{o}C and 70% RH.

Ground conditions in the study area, determined from an examination of aerial imagery and ground investigations by the wider Golder team, comprise of a mix of cleared agricultural areas, wetlands and woodland. A ground absorption factor of G=0.5 representative of mixed ground (i.e. non-developed, moderately reflective) has been used within the model. Localised areas of ground absorption factor G=0 (such as large water bodies or hard, reflective surfaces) have been assumed within the Project area for the surface of Lake Albert. The Kingfisher Field is predominantly flat-lying in the vicinity of the majority of Project infrastructure, however, topographic contours of the area have been included within the model in order to account for any screening effects of topography.

2.5.3 Scenarios

The Project will comprise 5 distinct scenarios or phases of activity; site clearance and construction of infrastructure, construction of the feeder pipeline, well drilling, production, and decommissioning / abandonment. Some of the ancillary project infrastructure has already been licensed and built. The main road down the escarpment into the project area is in place. Project access roads to the northern end of the CPF boundary and to well pads 1, 2 and 3 are in place. The well pads have been partly cleared and developed for the exploration drilling which has taken place to date. The drilling camp is fully established and fenced and the supply base is cleared and fenced and is partly developed to support exploration activities. The airfield is presently a grass strip, developed to its full length. A jetty has been built for importing equipment and materials for exploration, although this will need to be upgraded.

The activities, plant assemblages and assumptions made in the prediction of noise levels of the 5 identified phases are set out below.

The noise prediction models of each scenario provide snap-shots of the activities which will be undertaken during the lifetime of the Project. In each model the 'worst-case' has been assumed, whereby the stage of works considered to have the greatest potential impact has been modelled. The noise sources modelled and their assumed sound power levels for operations for each phase of the Project are provided in APPENDIX A.

The infrastructure associated with the Project is shown in Figure 3.

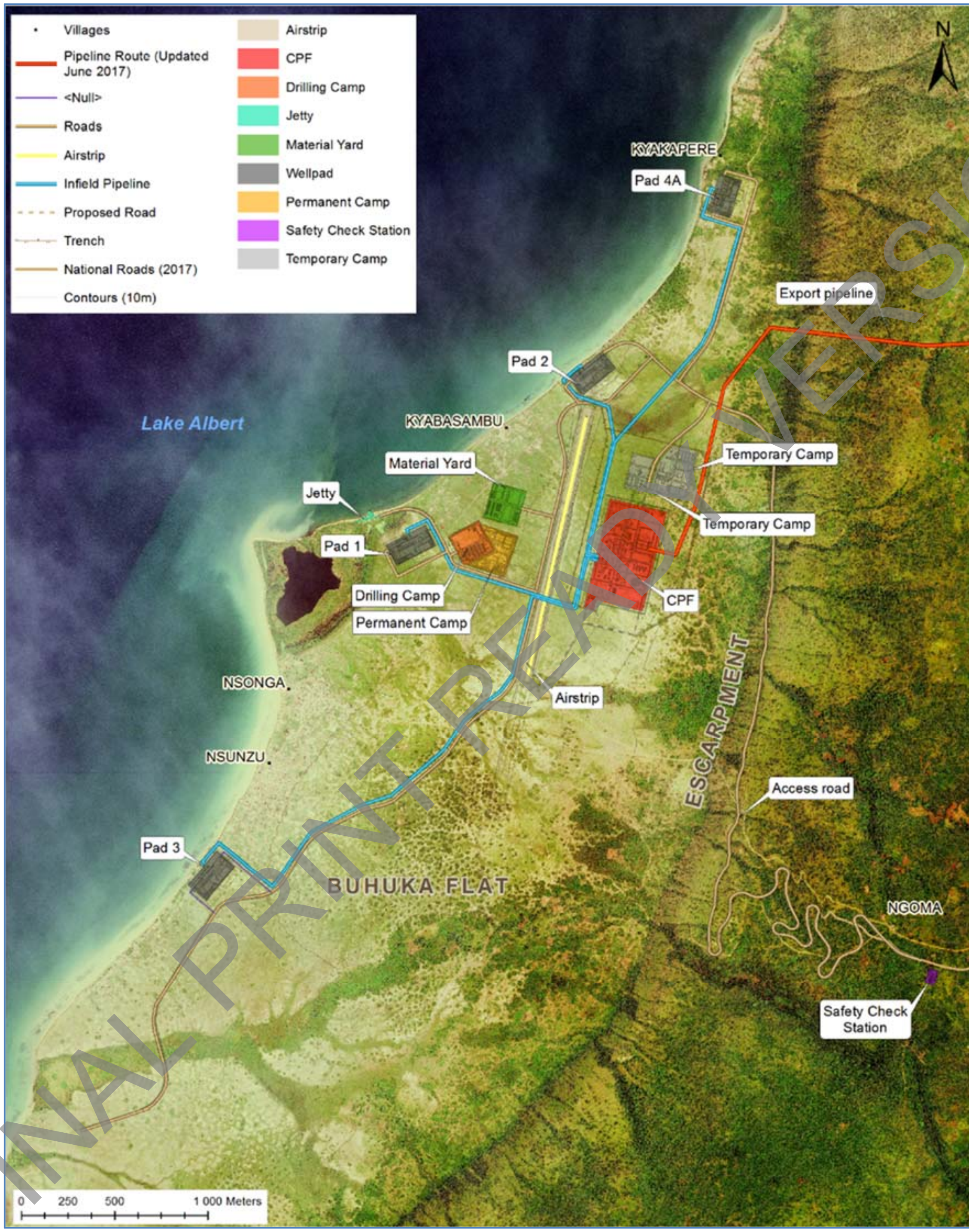

Figure 3: Project infrastructure

2.5.3.1 *Site clearance and construction of infrastructure*

It is anticipated that the construction of Project infrastructure, such as roads, the central processing facility (CPF) and the upgrade of existing facilities and camps will be completed prior to the commencement of drilling.

The pre-drilling construction work will comprise the following:

- Upgrade and improvement of existing facilities and camps;
- Clearance, levelling and construction of CPF;
- Clearance, excavation and laying of injection pipelines and flowlines;
- Final clearance of Well Pads 1,2 and 3, including expansion to their full extent, clearance and levelling of proposed Well Pad 4-A;
- Excavation of drainage;
- Jetty construction and upgrade.

Source noise terms for items of construction plant were obtained from British Standard BS 5228 (Ref. 6). BS 5228 provides recommendations for control of noise from construction and open sites and includes an annex which provides measured noise levels from a wide range of construction plant and activities.

The noisiest stage of the construction works has been assumed to be clearance and construction works at the well pads, CPF and the laying of pipelines. Such works typically generate higher levels of noise than fabrication and finishing works, since greater numbers of heavy mobile plant are required. CNOOC have confirmed that no noisy construction works will be undertaken during the night-time period at the CPF; this assessment therefore assumes that night-time activities will be restricted to use of hand tools and assembly activities, and no heavy plant will be used. During construction of the feeder pipeline, no construction activities at all will be undertaken during the night-time period. The construction phase of the CPF and supporting infrastructure will involve the following general activities:

- Clearing, levelling and terracing
- Foundations and civil construction works
- Installation of Equipment
- Electrical and other tie ins
- Commissioning and testing of plant and equipment

The construction sites will involve a multitude of activities, employing up to 1,173 personnel (including day workers) at peak times. Cranes, excavators, bulldozers, heavy vehicles, vibrating rollers, and a wide range of other mechanical and hand-operated equipment will be used. Most of the activity will be restricted to within defined work areas, the principal of these being the CPF and permanent camp, as well as ancillary work areas which will include road construction sites (not already completed), the water intake station, the jetty (upgraded) and the airfield (upgraded).

An assemblage of mobile plant comprising excavators, dump trucks and bulldozers has been assumed, based on typical requirements of site clearance activities. Mobile plant items have been assumed to have a utilisation of 80 percent.

Road upgrade and construction in the Kingfisher Field, along with associated extraction of rock from the borrow pits and crushing at the crushing plant have been completed prior to the commencement of the Project and were considered in the road ESIA. These activities have therefore been excluded from this assessment.

The construction phase has been modelled assuming works will take place at each worksite (CPF, Well Pad1, Well Pad 2, Well Pad 3 and Well Pad 4A) sequentially, rather than simultaneously. A representative assemblage of plant, comprising two excavators, two road wagons, a dozer, a crane and a vibrating roller has been modelled at each worksite and noise levels predicted at the closest receptors to the worksite.

All source noise terms for construction plant and activities have been obtained from BS5228. Details of the modelled noise sources are provided in Appendix A.

2.5.3.2 *Construction of feeder pipeline to Kabaale*

It has been assumed that the feeder pipeline to Kabaale will be constructed in 1 km long stages, with each stage of work occurring sequentially. Rather than model each 1 km stage, noise levels from the activities associated with pipeline construction; clearing, excavating, laying pipe, welding and backfilling, have been predicted for a single 1 km stretch, and impacts evaluated at a range of stand-off distances from the works. A representative assemblage of plant associated with pipeline construction, comprising two dozers, two large excavators, two cranes, two low-loading trucks and two sets of welding plant has been assumed. Noise levels have been predicted at stand-off distances of 10 m, 50 m, 100 m and 200 m from the pipeline construction works.

2.5.3.3 *Well Drilling*

Drilling of wells at one well pad may be undertaken while construction works and production activities continue at other well pads. An activity schedule for the project programme has been provided, indicating that well drilling is anticipated to start in 2019 at Well Pad 2. The programme further notes that drilling activities will move sequentially between well pads in the following order:

- Well Pad 2 (171 days);
- Well Pad 3 (184 days);
- Well Pad 1 (157 days);
- Well Pad 2 (220 days);
- Well Pad 1 (137 days);
- Well Pad 3 341 days);
- Well Pad 2 (169 days); and finally
- Well Pad 4A (460 days).

CNOOC proposes to use a single drill, with identified drill components and supporting equipment indicated to comprise the following:

- Drilling rig; comprising draw-works and top drive;
- Mud pumps x3;
- Tank system;
- Pressure control; and
- Diesel generators.

Sound power levels for the drill rig, equivalent to the proposed plant listed above, have been obtained from published noise levels available freely online. Source noise terms for items of plant for which no source noise terms were available were obtained from typical levels for construction plant published in BS 5228.

The drill rig comprises two principal noise sources; the engine, including hydraulic pumps and exhaust, which is located close to ground level, and the top drive, which moves from the top of the rig towards the ground as the well advances. The assumed sound power levels of the rig engine and the top drive are 111 dB(A) and 106 dB(A) respectively. The top drive has been modelled as a noise source at the top of the rig mast, 45 m above ground level. The engine and all items of ancillary plant have been assumed to have an effective source height of 2 m above ground level.

Ancillary plant such as mud pumps and generators have been assumed to have an on-time (utilisation) of 100 percent. Drill rig utilisation has been assumed to be 85 percent to allow for downtime and operations such as the addition and removal of drill rods to the drill string which will not require full power. Noise levels have been predicted for each well pad individually.

In later stages of the Project drilling will occur at some well pads while production is occurring at others. Concurrent drilling and production represents “worst case”, therefore throughout the drilling phase the CPF has been assumed to be operational, with all items of fixed plant running with an on-time of 100 percent. As production increases, it is expected that noise levels from the CPF will also increase, however, a worst-case scenario of maximum CPF utilisation has been assumed from the start of the drilling phase.

2.5.3.4 *Production Operations*

The project description notes that first production will mark the start of the operational phase, and that this will overlap with continued construction and drilling of wells for the first 5 years. To consider the worst-case, this assessment considers operations at the CPF in parallel with drilling at well pads. All fixed plant at the CPF is assumed to have a utilisation of 100%, with the exception of the flare, which will operate only during purge and non-routine operations, and has therefore been excluded from this study. The production stage is anticipated to be approximately 25 years.

CNOOC proposes that, on completion of drilling, the operation of well pads will be automated; the presence of operatives at well pads will therefore not be required. Noise from vehicle traffic in the LSA has therefore been assumed to be not significant and has been excluded from this assessment. The majority of the equipment associated with production will be located at the CPF and noise sources at the well pads will be limited.

The CPF will comprise the following items of fixed plant and assemblages of plant:

- Water treatment plant;
- 4 x 16 MW gas turbine generators (3 operational, 1 standby) and substation for power generation;
- Excess gas utilisation package;
- Oil separation plant;
- Fuel gas and flash gas compressors;
- Water injection pumps;
- Pumps and heating for oil transmission system; and
- Emergency flares.

Well pads will comprise the following items of fixed plant:

- Wellhead apparatus;
- Injection and production manifolds;
- Transformer and substation;
- Chemical injection skid; and
- Wellhead control panel.

During the production stage, at both the CPF and the well pads it is considered that items of mobile plant may be required for maintenance purposes. Such activities will be infrequent and of short duration and have therefore been assumed to be not significant.

Source noise terms for items of fixed plant at the well pads and CPF were not available at the time of this assessment; however, CNOOC has undertaken to comply with Ugandan regulations for the protection of employees' hearing. The daily permissible noise level for workers at a factory or workshop is 85 $dBL_{Aeq,8hr}$, which does not take hearing protection into account. It has therefore been assumed that no single item of plant at the CPF will have a sound pressure level exceeding 80 dB(A) at 1 m, in order that several such items operating simultaneously in close proximity will not exceed 85 dB(A) at a given receiver, assuming that hearing protection will not be required at the CPF or well pads during the production phase. A sound pressure of 80 dB(A) at 1 m corresponds to a sound power level of 91 dB(A) for a point source operating under free-field conditions. All noise sources at the CPF have been assumed to have an effective height of 2 m above ground level.

During production, noise from plant at the well pads is anticipated to be minimal. CNOOC has confirmed that noise from the well pads during production will not exceed 3 dB above the measured baseline when measured at the boundary of the well pad. Should noise levels due to production operations exceed the measured baseline by more than 3 dB noise attenuation will be fitted to the noisiest items of plant until this condition is met.

CNOOC proposes to limit noise emissions from the CPF by installation of acoustic enclosures where protection of the workforce is required, however, no details of any such mitigation has yet been specified. This assessment assumes that acoustic enclosures will limit the sound pressure level from any single noise source to 80 dB(A) at 1 m in order to meet the workforce protection requirements. Other measures proposed as part of the current Project design which may mitigate noise propagation include the placement of a 200 m exclusion zone around the CPF.

2.5.3.5 *Decommissioning and Abandonment*

Decommissioning activities are anticipated to comprise dismantling, decontamination and removal of process equipment and facility structures and remediation activities. The following works have been identified for this stage of the Project:

- Removal of production/injection wells and well pads;
- Excavation and removal of field flow lines;
- Decommissioning, demolition and removal of CPF;
- Demolition and removal of accommodation; and
- Removal of other infrastructure.

The decommissioning phase is anticipated to include activities and plant items similar to those used in the construction phase. No additional noise predictions have been undertaken for the decommissioning phase, as noise levels and associated impacts are assumed to be the same as those identified for the construction of infrastructure phase.

2.5.4 Exclusions

This assessment assumes that the airstrip will be decommissioned and that helicopter flights will be infrequent; a worst-case comprising a maximum of 1 flight per day, occurring during daylight hours. Noise from aircraft has therefore been excluded from this assessment.

No information was available regarding the flow of traffic on Project roads. This assessment has included traffic movements during the construction stage only, when material will be transported to and from the stockpile areas. Road traffic during the drilling and production stage of the Project has been assumed to be infrequent and therefore not significant.

This assessment assumes that Project-related boat traffic from the new jetty will mostly be inaudible at human receptors. Project-related boat movements have been assumed to be infrequent and to not contribute significantly to total boat movements on the lake.

2.5.5 Cumulative and Trans-boundary Impacts

Golder is not aware of any nearby projects which have the potential to generate cumulative noise effects. No cumulative effects have therefore been considered within this assessment. The Democratic Republic of Congo (DRC) lies on the opposite shore of Lake Albert, however, given the 40 km distance to the nearest DRC receptors, noise from the Project will not be audible and is therefore not considered further.

3.0 BASELINE NOISE SURVEY

A baseline noise survey was undertaken in March 2014. Ambient noise measurements were conducted at communities within the LSA and at other potentially noise-sensitive locations in the vicinity of the Project. Potentially noise-sensitive receptors were identified using aerial imagery and digital maps of the study area prior to commencement of monitoring. The chosen locations are shown in Figure 4 and listed in Table 9, along with justification for their selection.

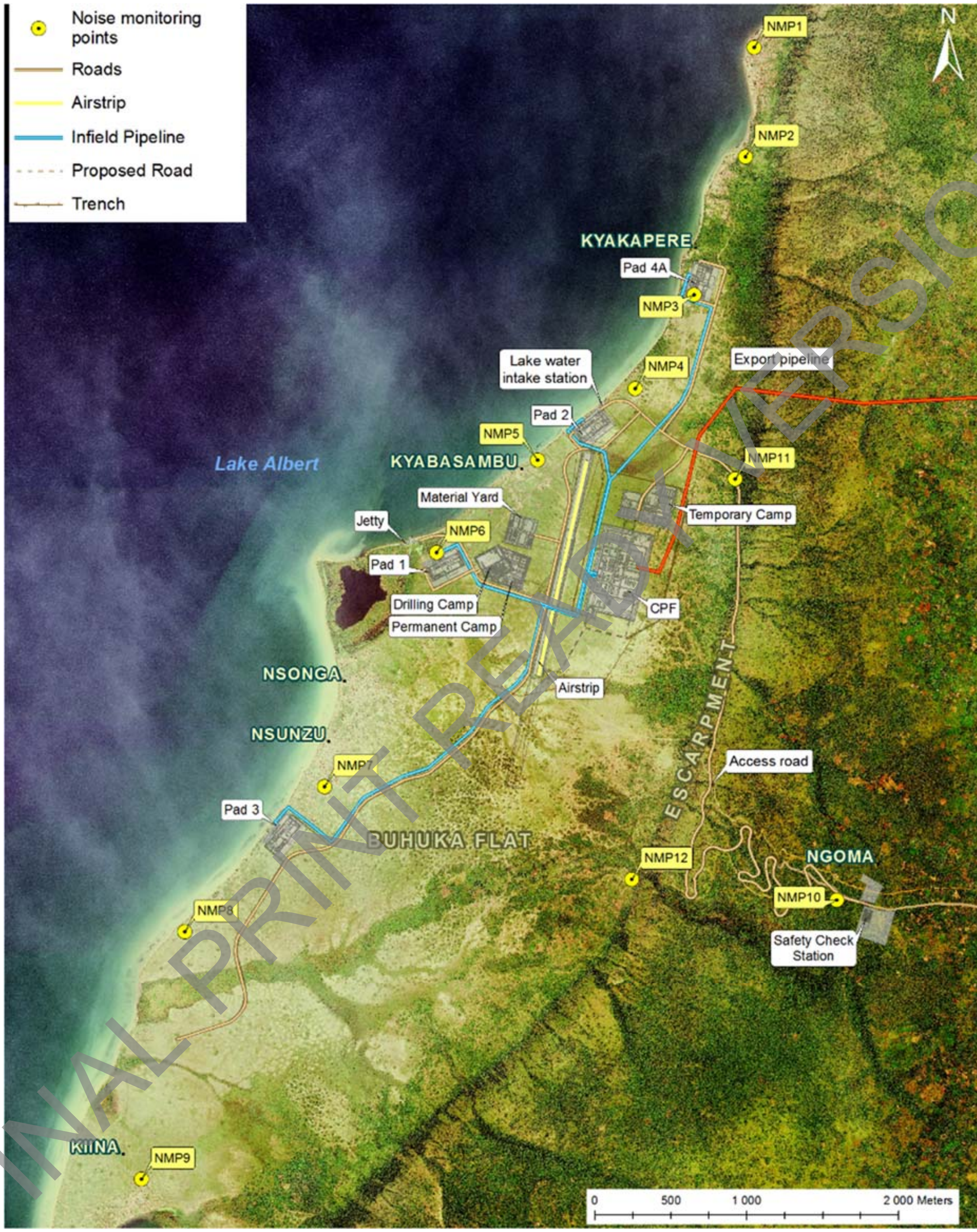

Figure 4: Local study area and baseline noise monitoring locations

Table 9: Baseline Noise Monitoring Locations

Monitoring Location Name	Monitoring Location Number	UTM grid coordinates		Justification
		X	Y	
Kyakapere Village	NMP1	250685	141300	Village; proximity to Well Pad 4-2*
Kyakapere Village	NMP2	250627	140581	Village; proximity to pipeline*
Kyakapere Village	NMP3	250289	139667	Village; proximity to pipeline
Kyakapere Village	NMP4	249900	139051	Village; proximity to Well Pad 2
Kyabasambu Village	NMP5	249256	138576	Village; proximity to Well Pad 2
Kingfisher 1 Pad	NMP6	248591	137965	Currently derelict, close to village
Nsonga	NMP7	247851	136417	Village; proximity to Well Pad 3
Nsunsu	NMP8	246929	135460	Village; proximity to Well Pad 5*
Kiina Village	NMP9	246643	133827	Village; proximity to Well Pad 5*
Ikamiro Village	NMP10	251229	135669	Village; proximity to storage yard
Inland, mid-escarpment	NMP11	250559	138450	Isolated farms; proximity to CPF
Inland, foot of escarpment	NMP12	249877	135806	Proximity to borrow pit

Note – In the latest design of the Project, Well Pad 4-2 has been replaced by Well Pad 4A and Well Pad 5 is no longer proposed, therefore some baseline monitoring locations are no longer close to proposed project infrastructure. All measured data is reported here in the interests of completeness.

At Kyakapere Village monitoring was undertaken at four locations; at NMP2 and NMP4, 24-hour surveys were completed. In order to confirm that these long-term measurements were representative of the character of this elongated settlement, spot measurements were undertaken for 1 hour during the daytime and 1 hour during the night-time period at NMP1 and NMP3.

Monitoring was undertaken in accordance with international guidelines ISO 1996-1:2003 Part 1 (Ref. 6) using two Norsonic Nor-131 Class 1 sound level meter (SLMs). The SLMs were commissioned in environmental monitoring kits, comprising a power supply, a microphone protection assembly and a hard case to protect the instrument. SLMs were field calibrated before and after each measurement.

In compliance with IFC EHS guidelines, monitoring equipment was located at least 3 m away from any vertical sound-reflecting surfaces (e.g. walls) and at a height of approximately 1.5 m above ground level. All noise measurements were undertaken in external free-field locations, therefore negating interference of vertical reflective surfaces.

Ikamiro Village was included within the baseline survey due to its proximity to the access road. We understand that the road has now been completed, however, Ikamiro has been used as a proxy baseline location for evaluation of noise due to construction of the feeder pipeline.

3.1 Findings of Baseline Noise Survey

The L_{A90} noise parameter is typically considered to be representative of the steady 'background' noise level because it is less affected by short-term noisy events, which may not be representative of prevailing conditions, than the L_{Aeq} 'ambient' parameter.

The baseline measurements were conducted using a 10-minute averaging period, in order to provide sufficient resolution to characterise the variability of the ambient and background noise levels throughout the 24-hour monitoring period. For the purposes of the baseline characterisation the 10-minute values have been referred to. In the assessment, however, hourly averages have been adopted in accordance with international best practice.

Analysis of the baseline monitoring data from the 12 survey locations indicated the following:

- Measured noise levels were broadly consistent at all locations, with maximum, minimum and average L_{Aeq} and L_{A90} values of the daytime and night-time periods typically falling within a 10 dB range;
- Noise sources at the survey locations were typically wildlife, livestock, people and motorbikes; and
- Diurnal variation was evident at all monitoring locations, to a varying degree. The ambient (L_{Aeq}) and background (L_{A90}) noise levels typically varied widely throughout the daytime period, becoming more consistent during the night-time period. Typically a peak was noted at sunset, followed by a gradual decrease in noise level throughout the night-time period, followed by a second peak at sunrise.

3.1.1 Kyakapere Village

Noise surveys were completed at four monitoring locations in this elongated settlement; NMP1, NMP2, NMP3 and NMP4. Of these, NMP2 and NMP4 were 24-hour measurements and NMP1 and NMP3 were spot measurements of 1 hour during the daytime and 1 hour during the night-time period.

The village comprises several clusters of traditional dwellings, built with mud walls and with thatched roofs. The settlement is bounded to the west by a steep escarpment and to the east by Lake Albert. The noise monitoring locations were sited approximately 100 m from the shore of Lake Albert. It is understood that fishing and livestock farming are the primary economic activities. Observations recorded during the survey indicate that audible noise at this community included noise from anthropogenic sources such as boats and motorcycles, as well as noise from children playing and from natural sources including livestock and wildlife.

The measured 10-minute averaged L_{Aeq} and L_{A90} levels recorded over the 24-hour monitoring periods at NMP2 are provided in Figure 5.

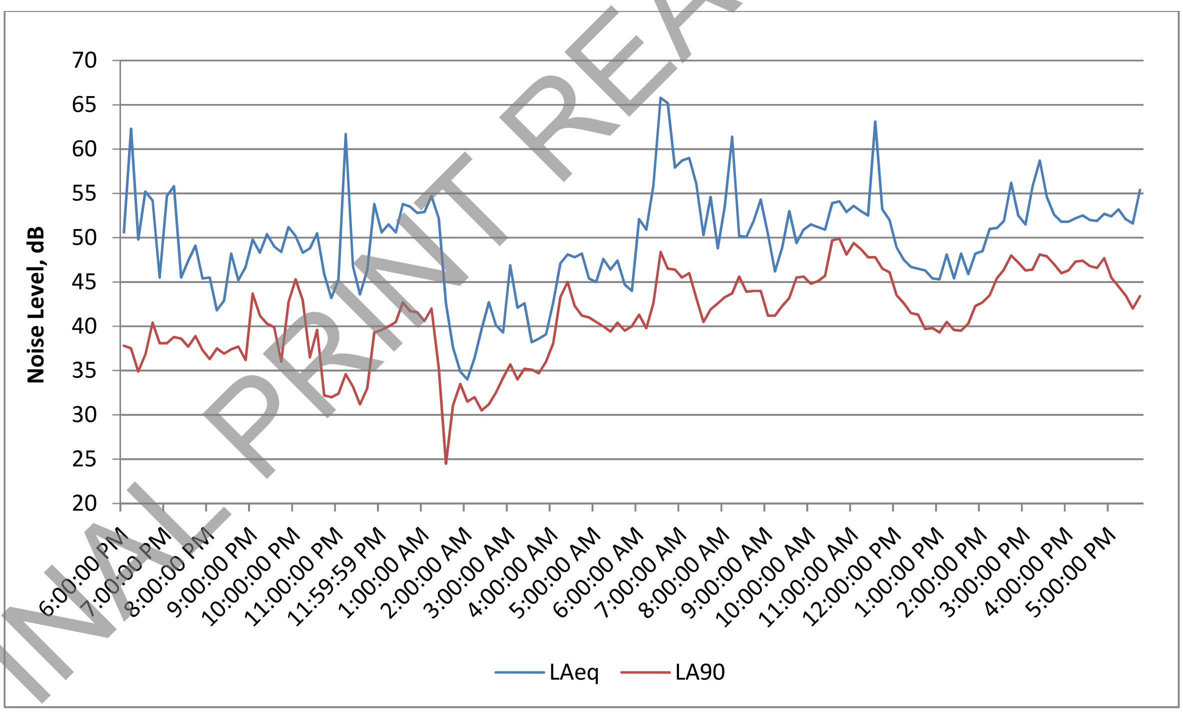

Figure 5: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP2

A summary of the measured noise levels is provided in Table 10.

Table 10: Measured noise levels at NMP2

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	61.5	65.8	47.9	49.9
Min	45.6	41.8	37.0	34.9
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	54.9	61.7	42.3	45.3
Min	39.5	34.0	32.2	24.5
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			No	-

A peak in the ambient noise level occurred at NMP2 at 06:30 and may relate to either an increase in human activity, such as of fishermen departing from, or returning to, land, or an increase in wildlife noise coinciding with sunrise.

NMP2 is shown in Figure 6.

Figure 6: Kyakapere village, monitoring location NMP2 near foot of escarpment

The measured 10-minute averaged L_{Aeq} and L_{A90} levels recorded over the 24-hour monitoring periods at NMP4 are provided in Figure 7.

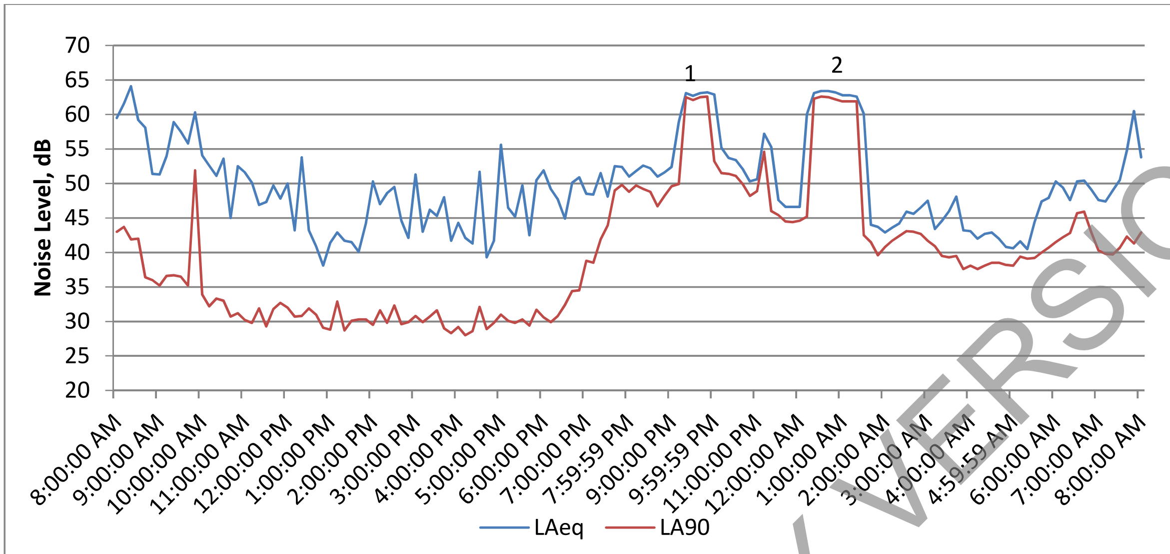

Figure 7: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP4

A summary of the measured noise levels is provided in Table 11.

Table 11: Measured noise levels at NMP4

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	61.8	64.1	60.8	62.6
Min	42.2	38.1	29.7	28.0
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	62.0	63.4	60.7	62.6
Min	42.3	40.5	38.2	37.6
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			Yes	-

At NMP4 two discrete peaks in the ambient and background levels of approximately 30 minutes and 1 hour duration (annotations 1 and 2 in Figure 3) were recorded during the night-time period. These episodes suggest a constant noise source, such as an engine or generator, operating at a fixed intensity and distance from the monitoring location. Field observations indicate that boats anchor near to this monitoring location, the engines or on-board generators of which have been attributed as the likely cause of these peaks.

NMP4 is shown in Figure 8.

Figure 8: Photograph of monitoring location NMP4 at Kyakapere Village with escarpment in distance

3.1.2 Kyabasambu Village

Kybabasambu village is smaller and more sparsely developed than Kyakapere, however, the construction of the dwellings and the primary activities are similar. Field notes indicate the dominant noise sources at the village to be wildlife, including frogs and ducks. Children and livestock (chickens) were also noted to be audible.

The measured 10-minute averaged ambient and background levels at NMP5 are provided in Figure 9.

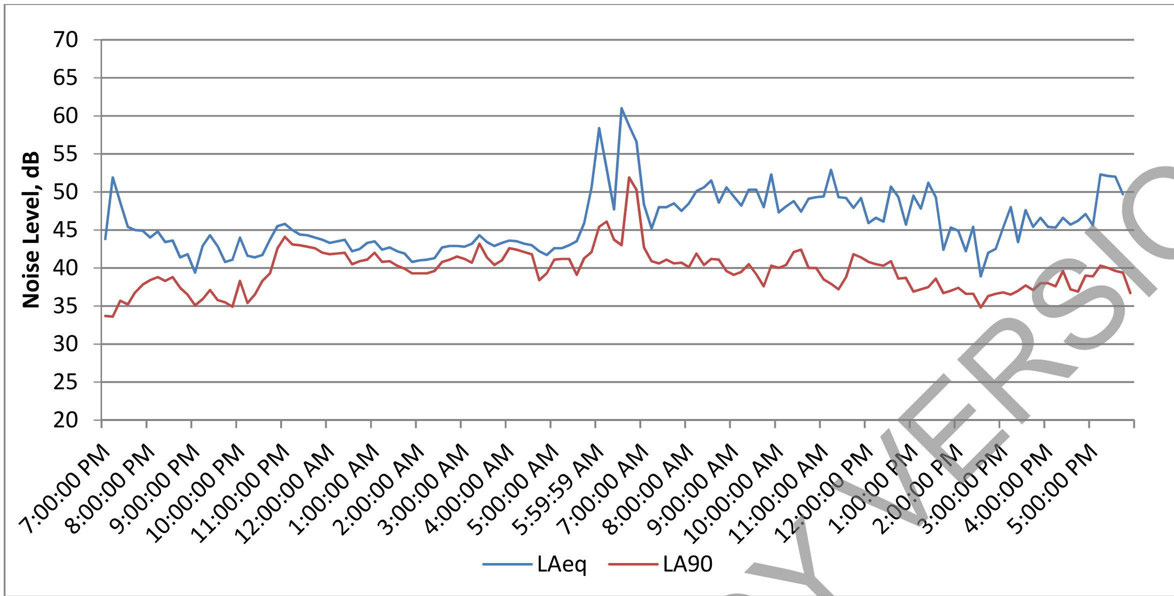

Figure 9: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP5

A summary of the measured noise levels is provided in Table 12.

Table 12: Measured noise levels at NMP5

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	57.5	61.0	48.0	51.9
Min	42.2	38.9	35.7	33.6
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	45.9	50.6	43.0	44.1
Min	42.1	40.8	39.0	35.4
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			Yes	-

Measured ambient and background noise levels varied little throughout the monitoring period, becoming particularly steady during the night-time period, with a range of 3.9 dB L_{A90}. This suggests a very constant noise source and is attributed to constant wildlife noise. Two peaks in the ambient and, to a lesser extent, background, noise levels occurred at 06:00 and 06:30. As with NMP2, this may represent an increase in human activity or animal noise at sunrise.

NMP5 is shown in Figure 10.

Figure 10: Kyabasambu Village

3.1.3 Kingfisher: Pad 1

Noise levels in the vicinity of the existing well pad were measured at NMP6. The pad is currently derelict and clear of structures and lies approximately 200 m from the nearest dwelling. The monitoring location is approximately 180 m from the edge of a lagoon and noted ecologically important area.

Anthropogenic noise sources in the area noted and included vehicles including trucks, cars and motorcycles. Noise from wildlife including birds, insects and amphibians was also audible. The measured 10-minute averaged ambient and background levels at NMP6 are provided in Figure 11.

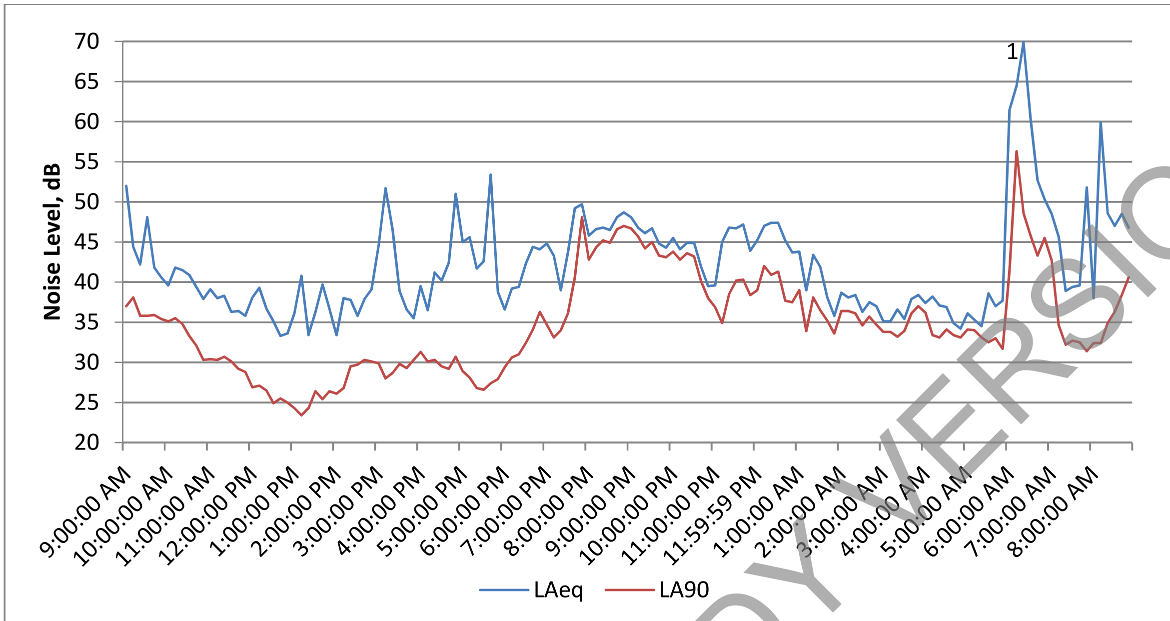

Figure 11: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP6

A summary of the measured noise levels is provided in Table 13.

Table 13: Measured noise levels at NMP6

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	64.1	69.9	50.1	56.3
Min	36.6	33.3	25.2	23.4
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	46.2	47.4	42.4	43.8
Min	36.6	34.2	33.1	31.7
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			No	-

A peak in measured noise levels occurred between 06:00 and 06:40 (annotation 1) which, as with other receptors, is attributed to an increase in human activity in the vicinity, or natural noise from either wildlife or meteorological conditions; a storm was noted in the area during the night-time monitoring.

NMP6 is shown in Figure 12.

Figure 12: Photograph of monitoring location NMP6 at Kingfisher 1 Pad

3.1.4 Nsonga (shore)

Nsonga lies on the plain between Lake Albert and the escarpment and is larger and more densely developed than Kyabasambu. Dwellings present in the village are constructed using traditional methods and materials. The currently-abandoned well pad 3 lies at the southern extent of the village.

The measured 10-minute averaged ambient and background levels at NMP7 are provided in Figure 13.

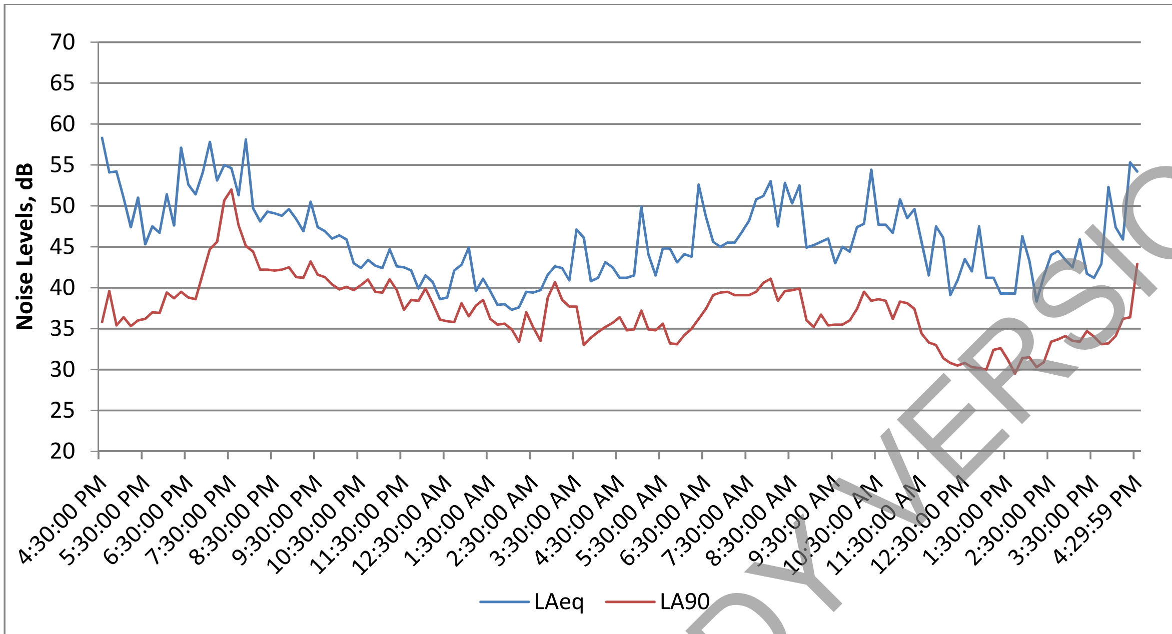

Figure 13: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP7

A summary of the measured noise levels is provided in Table 14.

Table 14: Measured noise levels at NMP7

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	55.6	58.3	48.6	52.0
Min	42.0	38.3	30.7	29.5
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	45.6	49.9	40.1	41.0
Min	39.4	37.3	35.0	33.0
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			No	-

Noise arising from human activities and also from livestock (cattle and goats) was noted to be dominant at this location. A peak in the background noise level occurred at 19:30, possibly due to an increase in wildlife noise at sunset.

The monitoring location is shown in Figure 14.

Figure 14: Photograph of monitoring location NMP7 at Nsonga

3.1.5 Nsunsu

Nsunsu is one of the smaller, lower density settlements in the area, predominantly located within 150 m of the lake shore. The ambient noise environment was noted to be dominated by livestock and human activity, including the use of motorcycles. The measured 10-minute averaged ambient and background levels at NMP8 are provided in Figure 15.

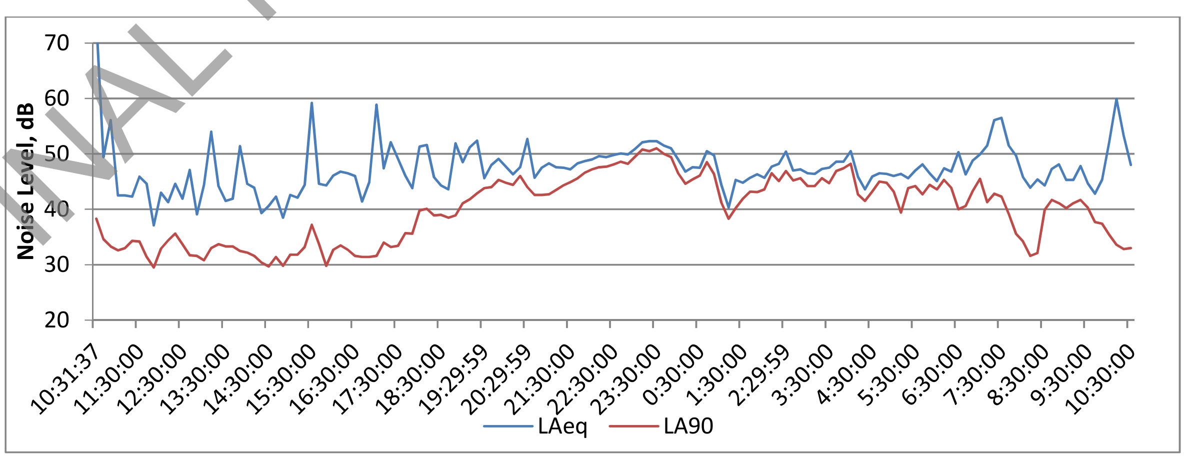

Figure 15: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP8

A summary of the measured noise levels is provided in Table 15.

Table 15: Measured noise levels at NMP8

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	53.4	74.5	44.8	46.6
Min	42.1	37.1	31.0	29.5
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	51.7	52.3	50.2	51.0
Min	44.8	40.3	41.6	38.3
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			Yes	-

The background noise level increases steadily from approximately 17:00 through until 23:30, after which it reaches a plateau and gradually decreases. The ambient and background values remain consistently close throughout the night-time period, diverging during the daytime. Such a pattern suggests a highly constant noise source being dominant during the night-time period. The constant noise level is attributed to noise from wildlife, such as insects and amphibians. Human activities or livestock are anticipated to be the cause of daytime variability.

The monitoring location is shown in Figure 16.

Figure 16: Photograph of monitoring location NMP8 at Nsunsu

3.1.6 Kiina Village

Kiina lies to the south of the Kingfisher Field area and there is little existing infrastructure nearby. The measured 10-minute averaged ambient and background levels at NMP9 are provided in Figure 17.

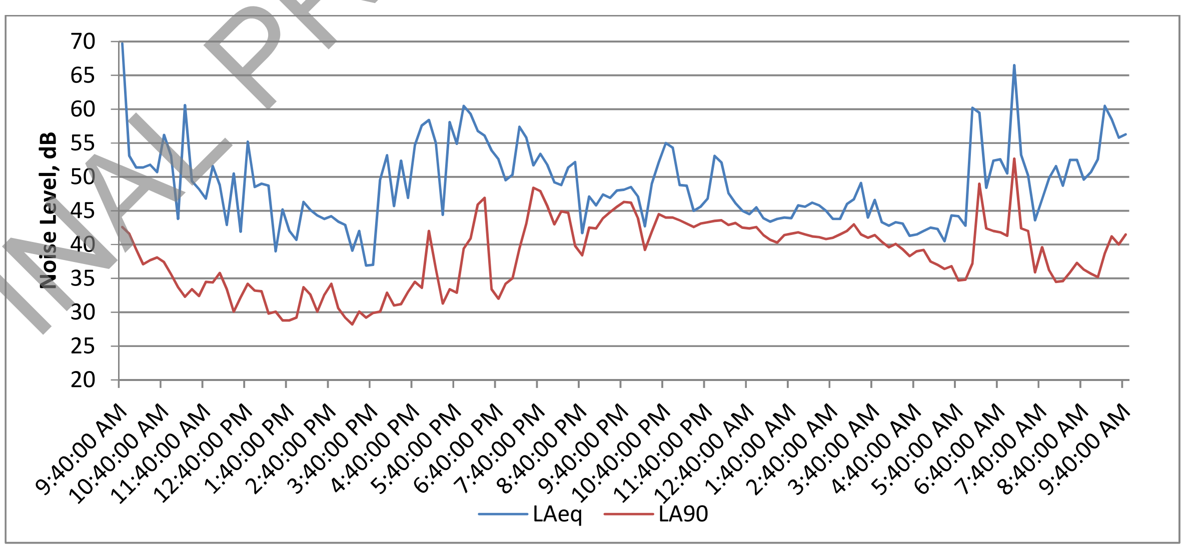

Figure 17: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP9

A summary of the measured noise levels is provided in Table 16.

Table 16: Measured noise levels at NMP9

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	59.2	69.7	46.0	52.7
Min	43.8	36.9	29.5	28.2
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	51.8	55.0	43.2	44.5
Min	42.4	40.5	36.3	34.7
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			Yes	-

Noise levels at Kiina Village varied in a broadly similar manner to those at other monitoring locations, with the background and ambient levels becoming consistent during the night-time and diverging during the day. Two peaks in the ambient noise level occurred at 06:00 and 07:00, possibly a result of human activity. Observations on the ambient noise environment at Kiina indicate livestock and human activity, including motorcycles, are dominant.

The monitoring location is shown in Figure 18.

Figure 18: Photograph of monitoring location NMP9 at Kiina Village

3.1.7 Ikamiro Village

Ikamiro Village lies approximately 3.5 km inland from the shore of Lake Albert and is surrounded by mature trees and forest, compared with the grassland and scrub found at the other receptors. The dominant noise sources at this location were, however, similar to those at other communities. People and livestock were noted to be the dominant contributors to ambient noise levels. The measured 10-minute averaged ambient and background levels at NMP9 are provided in Figure 19.

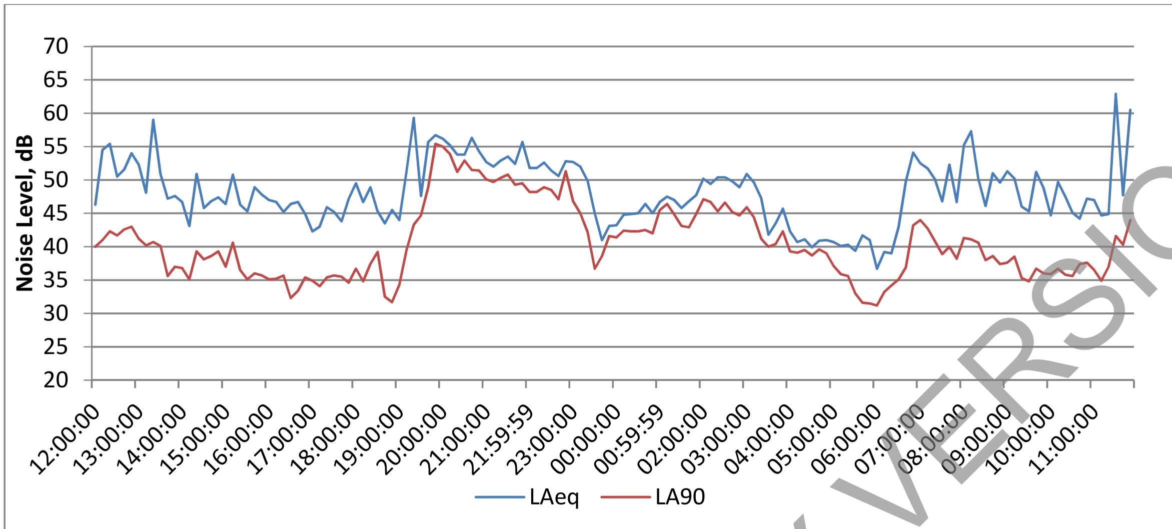

Figure 19: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP10

A summary of the measured noise levels is provided in Table 17.

Table 17: Measured noise levels at NMP10

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	57.3	62.9	52.9	55.4
Min	44.9	36.7	34.7	31.2
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	51.9	52.8	48.9	51.3
Min	40.6	39.4	34.6	31.5
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			No	-

Background and ambient noise levels at NMP10 are more consistent than at other monitoring locations in the study, with a smaller difference between the $L_{Aeq,10min}$ and $L_{A90,10min}$ during the daytime period. The pattern of variation was, however, similar; the background noise level at NMP10 reached a peak in the evening, followed by a gradual decrease throughout the night-time period. A second peak occurred which coincided with sunrise. Given the distance to the lake shore and consequent absence of fishing activity this increase is attributed to noise from wildlife and livestock. Wind-induced noise from the surrounding forest may also be a factor.

The monitoring location is shown in Figure 20.

Figure 20: Photograph of monitoring location NMP10 at Ikamiro Village

3.1.8 Mid-escarpment

Monitoring at location NMP11 was undertaken on the escarpment which bounds the plain of the shoreline of Lake Albert. Siting of the monitoring equipment was affected by the need to avoid wildfire hazards; hence the chosen location was approximately 160 m from the nearest dwelling. The measured 10-minute averaged ambient and background levels at NMP11 are provided in Figure 21.

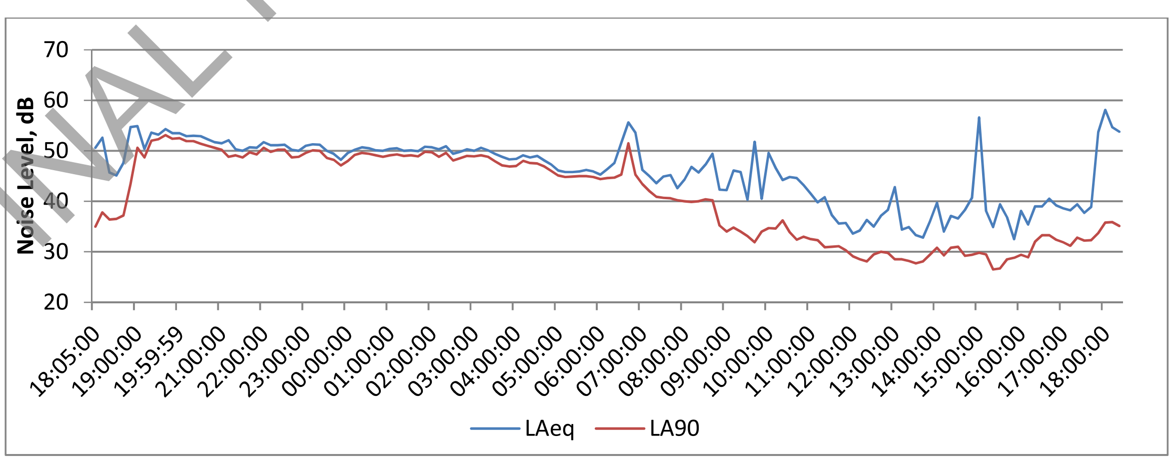

Figure 21: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP11

A summary of the measured noise levels is provided in Table 18.

Table 18: Measured noise levels at NMP11

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	53.5	58.1	51.7	53.1
Min	36.1	32.5	28.4	26.5
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	50.9	51.7	49.8	50.6
Min	46.0	45.8	44.9	44.8
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			Yes	-

Monitoring notes indicated that the dominant noise sources at this location included cattle and wildlife, principally birds. The night-time ambient and background noise levels show a high degree of consistency, likely to be a result of wildlife noise.

Daytime ambient and background noise levels are typically lower than night-time noise levels at this monitoring location, this may be a result of the remoteness of this monitoring location from human habitation. Peaks in the daytime ambient noise level are likely to be a result of human activities.

The monitoring location is shown in Figure 22.

Figure 22: Photograph of monitoring location NMP11 on the escarpment

3.1.9 Foot of Escarpment

NMP12 was sited close to a watercourse at the foot of the escarpment, to the east of the Kingfisher Field. Close to this monitoring location people from the nearby villages quarry rocks on a small scale from the channel of the watercourse (River Nyakate). The measured 10-minute averaged ambient and background levels at NMP12 are provided in Figure 23.

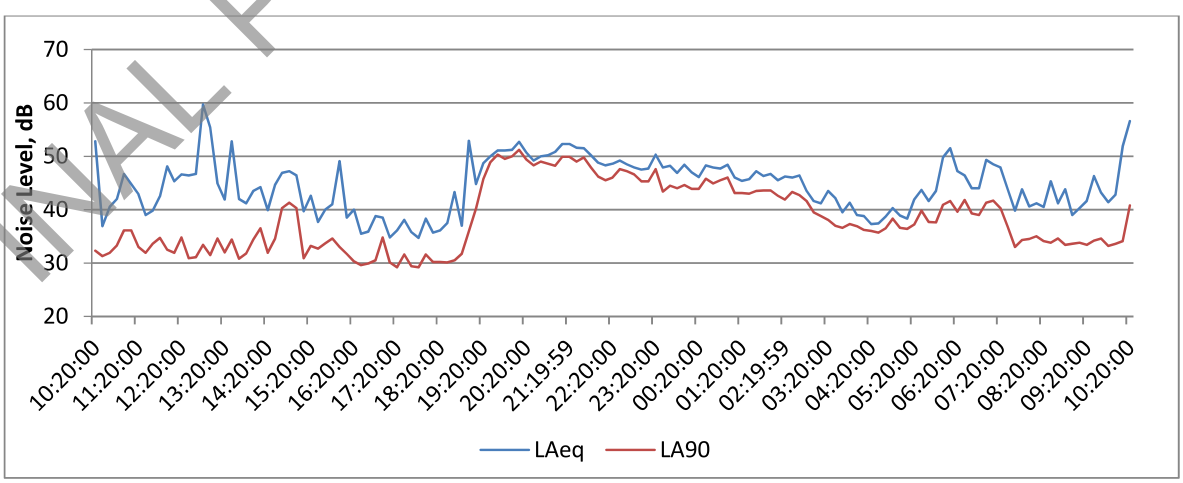

Figure 23: Measured $L_{Aeq,10min}$ and $L_{A90,10min}$ noise indices at NMP12

A summary of the measured noise levels is provided in Table 19.

Table 19: Measured noise levels at NMP12

	$L_{Aeq,1hr}$	$L_{Aeq,10min}$	$L_{A90,1hr}$	$L_{A90,10min}$
Daytime period (06:00 – 22:00)				
Max	52.9	59.7	49.5	51.2
Min	36.6	34.7	30.8	29.2
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (50 dB)?			No	-
Night-time period (22:00 – 0600)				
Max	48.6	50.3	46.6	47.6
Min	38.7	37.3	36.7	35.7
$LA_{90,1hr}$ minimum exceeds Ugandan permissible level (35 dB)?			Yes	-

Noise from the river and from quarrying activities was noted to be dominant during the daytime period, which is consistent with the steady background level recorded. The monitoring location is surrounded by bush, and the increase in background noise level around sunset is attributed to noise from wildlife such as insects and amphibians.

Peaks in the ambient noise level during the daytime are considered to represent human activity, including quarrying. The monitoring location is shown in Figure 24.

Figure 24: Photograph of monitoring location NMP12 at Nsonga

3.2 Summary of Baseline Noise Levels

A summary of the findings of the baseline noise survey is provided in Table 20.

Full results of the baseline survey are included in APPENDIX B.

Table 20: Average Measured Background Noise Levels by Receptor, dB L_{A90}

Monitoring Location	Lowest Daytime Background dB $L_{A90,1hr}$ (06:00 – 22:00)	Lowest Night-time Background dB $L_{A90,1hr}$ (22:00 – 06:00)
NMP2 Kyakapere	37.0	32.2
NMP4 Kyakapere	29.7	38.2
NMP5 Kyabasambu	35.7	39.0
NMP6 Kingfisher 1 Pad	25.2	33.1
NMP7 Nsonga	30.7	35.0
NMP8 Nsunsu	31.0	41.6
NMP9 Kiina	29.5	36.3
NMP10 Ikamiro	34.7	34.6
NMP11 Mid-escarpment	28.4	44.9

Monitoring Location	Lowest Daytime Background dB $L_{A90,1hr}$ (06:00 – 22:00)	Lowest Night-time Background dB $L_{A90,1hr}$ (22:00 – 06:00)
NMP12 Foot of escarpment	30.8	36.7
Ugandan Regulations Permissible Noise Level, dB L_{Aeq}	**50.0**	**35.0**

Measured background noise levels at all receptors are highly spatially consistent across the study area, with daytime and night-time period-averaged levels typically falling within a 10 dB range, despite the differences in the micro-environments at which measurements were undertaken. Daytime and night-time period averaged noise levels vary little between the centres of villages to less developed, and more rural areas. Natural (non-anthropogenic) processes, and wildlife in particular, were found to be the dominant noise sources across the study area, with anthropogenic industrial noise from vehicles and machinery typically either absent or a minor contributor to the noise environment, except for defined short durations.

The 10-minute averaged background noise level varied greatly throughout the daytime period. The degree of diurnal variation in noise levels across the study area is attributed to the dominance of natural noise sources, with night-time noise levels higher than daytime levels at some monitoring locations. Natural environmental triggers, such as sunrise and sunset, result in observable increases in noise levels at most of the monitoring locations. Such noise sources may vary seasonally according to the life cycles of the organisms responsible, however, this assessment assumes that the levels measured are representative of "worst case" conditions. This assessment assumes that residents of the villages in the study area will be accustomed to the natural noise sources currently present, and that these natural noise sources will not typically result in sleep disturbance. As a result of revisions to the Project description since completion of the baseline noise survey, the results of the spot measurements taken at NMP1 and NMP3 are remote from project infrastructure, they are therefore not considered relevant to the assessment and results of the monitoring is not included in this report. The data is, however, provided in Appendix B.

The lowest average background noise levels for each village have been adopted as representative of the baseline noise environment and are provided in Table 21. The levels presented have been rounded to the nearest integer value. Where multiple monitoring locations were used for the same receptor (village) the lowest measured levels have been adopted.

Table 21: Adopted Background Noise Levels by Village, dB L_{A90}

Location	Daytime, dB $L_{A90,16hr}$ (06:00 – 22:00)	Night-time, dB $L_{A90,8hr}$ (22:00 – 06:00)
Kyakapere Village – north	37	32
Kyakapere Village – south	30	38
Kyabasambu – north	36	39
Kyabasambu – south (KF1 pad)	25	33
Nsonga	31	35
Nsunsu	31	42
Kiina	30	36
Ikamiro	35	35

4.0 IMPACT ASSESSMENT

4.1 Construction Noise Impact

4.1.1 Construction Activities Assessed

The assessment of construction noise impact separately considers the impacts of the construction activities to build the processing complex (the CPF, well pads, flowlines access roads where not already built and other ancillary infrastructure on the Buhuka Flats, including the water intake station); and the impacts of drilling. Noise in the construction phase will last for 3 years, being limited to the period prior to first production at the CPF. Drilling continues beyond this date, but is then considered to be a joint operational impact, continuing for a further 5 years before all of the production and reinjection wells are completed. Decommissioning noise is considered to be similar to construction noise for the CPF complex.

The Rio Tinto evaluation criteria described in Section 2.3.1.3 above have been used as the basis for the evaluation of construction noise impact, with the Ugandan noise regulations providing the upper permissible limit.

4.1.2 Noise Predictions

Noise levels associated with decommissioning and abandonment stage have been assumed to be the same as those associated with construction, given the similarity between the work locations and the items of mobile plant which will be used.

The Kingfisher field comprises linear settlements, bounded by the shore of Lake Albert. The segmented and dispersed nature of the proposed Project infrastructure results in scenarios where settlements may be affected by noise sources on more than one side. Noise has been modelled for unmitigated and mitigated scenarios. Based on the modelling, the number of buildings within each 5 dBA impact zone has been defined and overlaid onto mapping showing village infrastructure. This provides an accurate representation of the number of buildings within each impact zone.

Where drilling and production occur simultaneously, noise levels at the closest receptors to the well pad where drilling is active are assumed to be 10 dB or more above those due to production alone at the same well pad. At these receptors, predicted levels from "drilling and production" will therefore be the same as those due to drilling only.

4.1.3 General Construction on the Buhuka Flats

4.1.3.1 *Impacts*

The noisiest stage of the construction works has been assumed to be clearance and construction works at the well pads, CPF and the laying of pipelines. Such works typically generate higher levels of noise than fabrication and finishing works, since greater numbers of heavy mobile plant are required. CNOOC have confirmed that no noisy construction works will be undertaken during the night-time period; this assessment therefore assumes that night-time activities will be restricted to use of hand tools and assembly activities, and no heavy plant will be used.

The construction sites will involve a multitude of activities, employing up to 1,173 personnel (including day workers) at peak times. Cranes, excavators, bulldozers, heavy vehicles, vibrating rollers, and a wide range of other mechanical and hand-operated equipment will be used. Most of the activity will be restricted within defined work areas, the principle of these being the CPF and permanent camp, as well as ancillary work areas which will include road construction sites (not already completed), the water intake station, the jetty (upgraded) and the airfield (upgraded), and the completion of 3 well pads (well pads 1, 2, and 3)[6].

Noise during the construction phase has been modelled on the basis that works will take place at the CPF over the full construction period of three years, and at each well pad over a short period during the

[6] *Well pad 4A will be constructed during the operational phase, prior to the start of drilling in 2024*

construction phase. A representative assemblage of plant, comprising two excavators, two road wagons, a dozer, a crane and a vibrating roller has been modelled at each worksite and noise levels predicted at the closest receptors to the worksite. Mobile plant items have been assumed to have an utilisation of 80 percent.

Figure 25[7] presents an example of the effect of construction noise at well pad 3. Table 22 shows how many structures will be exposed to noise levels that exceed the upper permissible limits of the project standard. The increase in noise levels above the pre-existing background can be seen by comparing the data in the table with the measured sound levels shown for each village presented in Column 1 of the table.

[7] Figure 25 shows a snapshot of construction while civil activities are taking place at well pad 3. The plots showing construction noise on the other well pads, combined with construction on the CPF, are presented in Appendix xx.

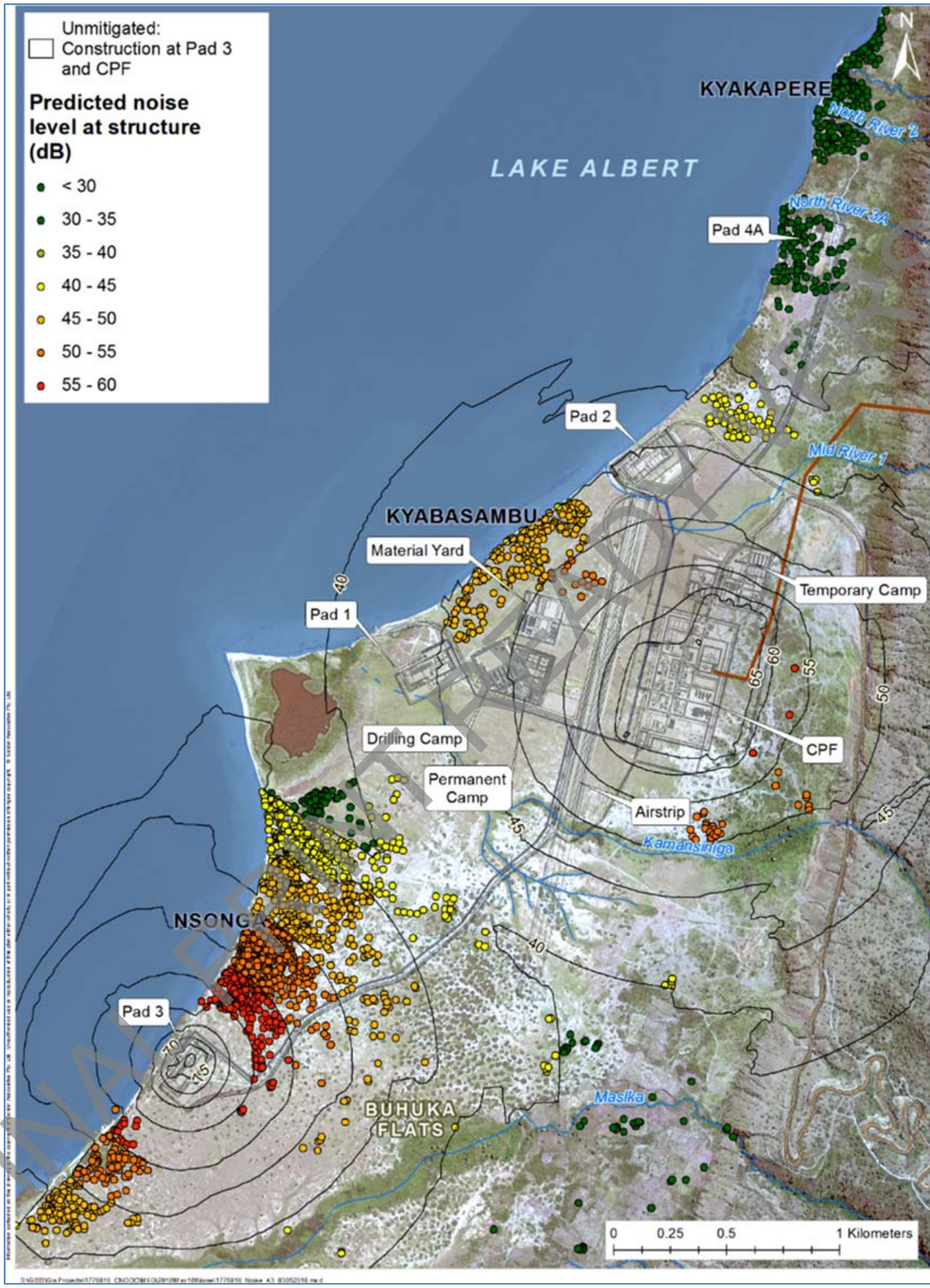

Figure 25: Example of unmitigated civil construction noise showing CPF construction and civil works ongoing simultaneously on Well Pad 3

Buildings are mainly residences, but since a family may occupy more than 1 building, or the buildings may only be seasonally occupied, reference in Table 22 is to buildings rather than households. A rough estimate is that, on average, each structure represents 4.5 people[8].

Table 22: Household exposure to construction noise during the 3-year construction period and exceedance of daytime and night-time project standard - unmitigated case

Village (and adopted background noise levels)	Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the daytime project standard are highlighted in blue)						Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the night-time project standard are highlighted in brown)					
	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA
CPF households			29	3	5				29	3	5	
Kyabasambu South *Daytime: 25 dBA* *Night-time: 33 dBA*			23	22	8				23	22	8	
Nsonga North *Daytime: 37 dBA* *Night-time: 32 dBA*	1	359	53	3			1	359	53	3		
Kyakapere South *Daytime: 30 dBA* *Night-time: 38 dBA*		9	27	30				9	27	30		
Kyabasambu North *Daytime: 37 dBA* *Night-time: 32 dBA*			58	50	10				58	50	10	
Nsonga South *Daytime: 31 dBA* *Night-time: 35 dBA*		153	330	153	55	9		153	330	153	55	9
Nsunzu North *Daytime: 31 dBA* *Night-time: 42 dBA*	7	96	67	12			7	96	67	12		
Kyakapere Village *Daytime: 37 dBA* *Night-time: 32 dBA*	86	16					86	16				
Nsonga East *Daytime: 31 dBA* *Night-time: 35 dBA*	20	25	1				20	25	1			

[8] This is based on data for Kyakapere, which is assumed to be representative for other villages. LC 1 estimates indicate that the population of Kyakapere is 3,700 people. Satellite imagery indicates 824 structures. Therefore a rough relationship between structures (measurable from satellite imagery and population is that 1 structure represents 4.5 people.

Village (and adopted background noise levels)	Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the daytime project standard are highlighted in blue)						Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the night-time project standard are highlighted in brown)					
	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA
Nsonga *Daytime: 31 dBA* *Night-time: 35 dBA*	2	94	10				2	94	10			
Kyabasambu East *Daytime: 37 dBA* *Night-time: 32 dBA*		19	5					19	5			

Note: (i) The boundaries of the villages may be seen from the Baseline section of the ESIA report. This table presents a consolidated assessment of construction at the CPF and well pads 1, 2 and 3. Well pad 4 is constructed during the operational phase of the project and is not included here. (ii) Baseline noise levels at Kyabasambu East were not measured and are assumed to be the same as Kyabasambu North (iii) Table 25 combines the impact of noise on people affected by construction on different well pads. This construction will not take place simultaneously.

The worst affected villages will be Nsonga and Kyabasambu. At night, the number of households affected by noise levels above the standard will be much higher, due to the more stringent threshold limit of 45 dBA. The unmitigated base case does not assume that construction activity will stop at night.

The impacts of greatest magnitude occur near the well pads when the platforms are under construction. This is simply due to their proximity to residents – the CPF construction generates similar or higher noise levels but is a greater distance from most settlement. Daytime noise levels will not exceed 60 dBA at any household (refer to Table 24). Forty one people (9 building structures at an average of 4.5 people per structure) are expected to reside within the 55-60 dBA **low** significance zone Table 23). For night-time noise, with its more stringent compliance requirement to avoid nuisance and sleep disturbance, 360 buildings (1621 people) would be affected by noise levels that exceed the target limit of 45 dBA. Impact significance will vary with distance from the well pad - Table 22 shows the numbers of people affected by varying degrees of daytime and night-time noise impact.

4.1.3.2 *Mitigation*

Careful vehicle and equipment selection in favour of low noise signatures, daytime construction noise impact can be reduced to **low** levels of significance. Regarding night time noise nuisance, the measures that are proposed, and which have been agreed to by CNOOC, will eliminate most night-time construction noise, and the significance of this impact will be **low.**

Table 23: Noise impacts during construction phase

Management Objectives: Noise levels due to the Project at noise sensitive receptors to be below the Ugandan maximum legal limit during daytime (75 $dBL_{Aeq,1hr}$) and night-time (65 $dBL_{Aeq,1hr}$) periods at all times and as far as possible below the target impact threshold levels of 55 dBA daytime and 45 dBA night-time.

Overall Significance before mitigation: Low (daytime), High (night-time)

Overall Significance after mitigation: Low (daytime), NSI (night-time)

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Construction plant silenced with enhanced exhaust mufflers and engine compartment sound insulation.	Daytime noise target of 55 $dBL_{Aeq,1hr}$ not exceeded at neighbouring receptors. Maximum legally permissible noise is 75 dBA	Monthly	CNOOC and Contractors	Use of sound level meters and monitoring techniques and procedures
Construction works involving heavy plant restricted to daytime period only. Only hand tools will be used during any night-time working.	No construction works before 06:00 or after 22:00	N/A	CNOOC and Contractors	N/A

4.1.4 Drilling of Wells

4.1.4.1 *Impacts*

The drilling rig is the single most significant construction phase noise source associated with the project. Drilling noise is generated on the platform and by the motor on top of the mast, at an elevation of around 40 m above the ground. Drilling is a 24/7 activity, and while there will be only one drilling rig on site, which moves from well pad to well pad, the drilling of multiple oil and reinjection wells on the same well pad will mean that the noise in one location will continue over an extended period. In sequence, the drilling during the construction phase is expected to be as follows:

- Well Pad 2 (240 days);
- Well Pad 3 (255 days); and
- Well Pad 1 (210 days).

These periods of noise exposure are far beyond what would be regarded as transient in the Rio Tinto rating scale, being considered to be long term (>6 months).

Table 24 shows the significance of the noise impact in the villages affected by combined CPF construction and unmitigated drilling noise in relation to the number of building structures affected[9]. Figure 26 is a plot of noise levels caused by CPF construction and drilling on well pad 3 at the same time. Other plots showing the combination of CPF construction noise and drilling noise on well pads 1 and 2 are included in Specialist Study 6.

Many households are above the project's target threshold for daytime (blue shading) and night-time (brown shading) construction noise. Most people will also experience a very large increase in noise levels, in some cases exceeding 30 dBA above the natural background noise levels. Assuming a relationship of roughly 4.5 people per building, approximately 972 and 6,485 villagers will be exposed to daytime and night time noise levels respectively that exceed the project's target thresholds. Table 24 shows that in the daytime, most people are impacted by sound levels within 5 dBA of the 55 dBA target threshold. During the night-time, with the more stringent requirements for quiet, larger numbers of people will experience higher levels of noise, with around 15% of the affected people being more than 10 dBA above the 45 dBA target. Broken down, the night-time impact significance in the unmitigated case will be as follows (refer to Table 24):

- **High** significance (>55 dBA): 972 people (216 building structures);
- **Medium** significance (50-55 dBA): 2,556 people (568 building structures); and
- **Low** significance (45-50 dBA): 2,957 people (657 building structures).

One building in Nsonga south exceeds the legal night-time standard (Table xx).

[9] *Plots of drilling noise impacts on other well pads are included in the Specialist Report on Noise*

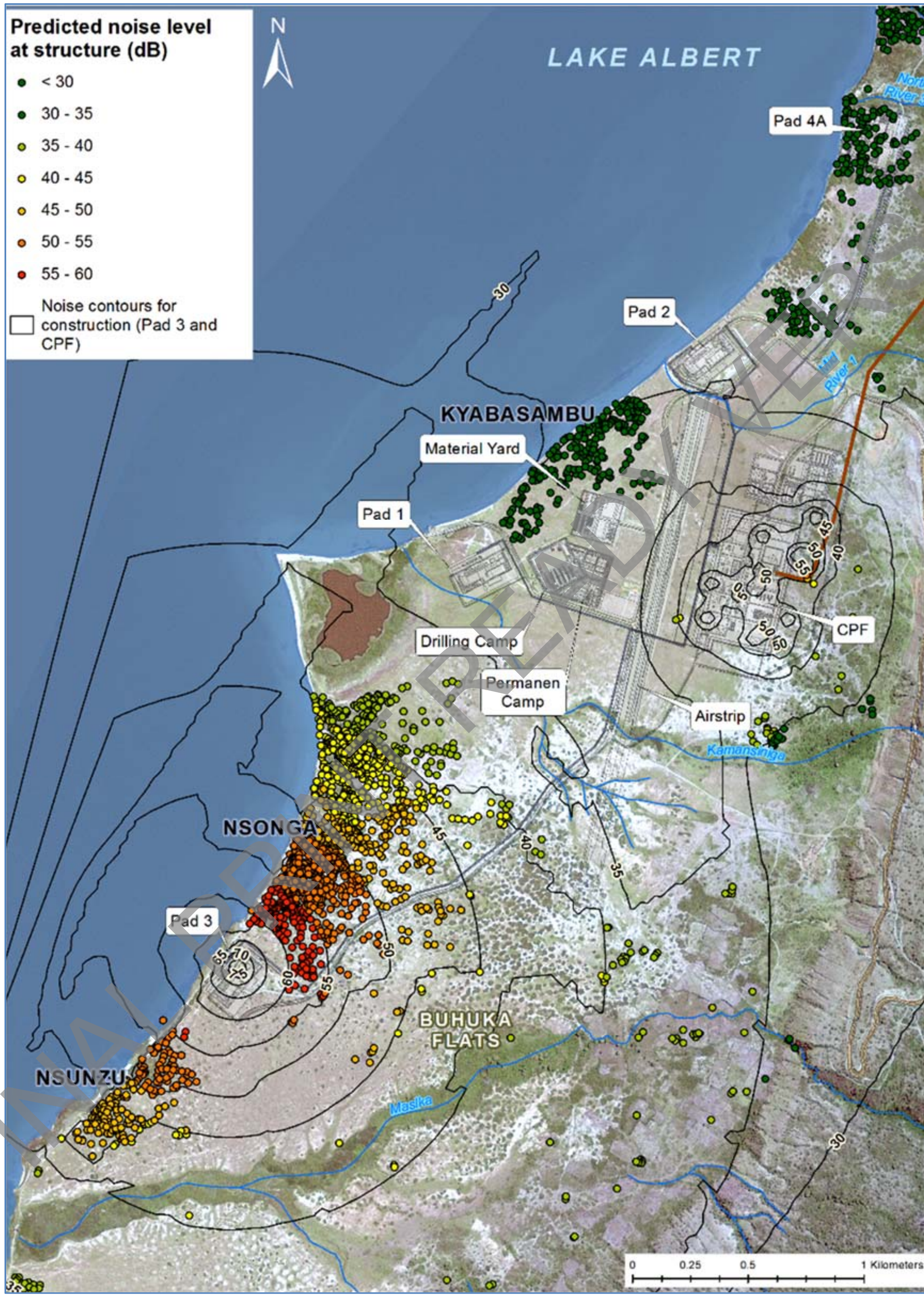

Figure 26: Example of unmitigated drilling noise including CPF construction and drilling on Well Pad 3

Table 24: Household exposure to CPF drilling noise during the 3-year construction period and exceedance of the daytime and night-time project standard – unmitigated case

Village (and adopted background noise levels)	Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the daytime project standard are highlighted in blue)								Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the night time project standard are highlighted in brown)							
	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA	60-65 dBA	65-70 dBA	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA	60-65 dBA	65-70 dBA
CPF Households																
Kyabasambu South *Daytime: 25 dBA* *Night-time: 33 dBA*					19	22	12						19	22	12	
Nsonga North *Daytime: 37 dBA* *Night-time: 32 dBA*			153	257	6						153	257	6			
Kyakapere South *Daytime: 30 dBA* *Night-time: 38 dBA*			3	17	46						3	17	46			
Kyabasambu North *Daytime: 37 dBA* *Night-time: 32 dBA*				23	75	20						23	75	20		
Nsonga South *Daytime: 31 dBA* *Night-time: 35 dBA*			32	164	344	129	30	1			32	164	344	129	30	1
Nsunzu North *Daytime: 31 dBA* *Night-time: 42 dBA*		2	15	99	64	2				2	15	99	64	2		
Kyakapere Village *Daytime: 37 dBA* *Night-time: 32 dBA*	127	90	101						127	90	101					
Nsonga East *Daytime: 31 dBA* *Night-time: 35 dBA*	4	53	10	19					4	53	10	19				
Nsonga *Daytime: 31 dBA* *Night-time: 35 dBA*		1	37	68						1	37	68				
Kyabasambu East *Daytime: 37 dBA* *Night-time: 32 dBA*				10	14							10	14			

Note: The boundaries of the villages may be seen from the Baseline section of the report. This table presents a consolidated assessment of construction at the CPF and well pads 1, 2 and 3. Well pad 4 is constructed during the operational phase and is not included here

4.1.4.2 *Mitigation*

The following mitigation of drilling noise is proposed:

- Erect acoustic barriers (noise 'curtains') around the drilling rig, screening to above the drilling platform, and 5m high screens above ground level around the perimeter of the site and/or acoustic enclosures around the engine, mud pumps and blower fan; and
- Separate the top drive and the blower fans and install the fans at ground level.

Estimates based on data provided by vendor estimates show that up to 10 dBA of source attenuation could be achieved. Screens could be made from a variety of materials of which the most practical may be stacked shipping containers. Table 25 shows the change in affected building structures that will result from the decrease in noise. During the daytime, impact significance will be **low**, with only 1 building structure (roughly 5 people) affected by noise exceeding the 55 dBA target. At night, 973 people (216 buildings) will be affected by noise above the 45 dBA target. Of these, most (60%) will reside in Nsonga South, which is affected primarily by the drilling of wells on well pad 3. The significance of residual impact for night-time noise will be as follows (refer to Table 25:

- **High** significance (>55 dBA): 5 people (1 building structure);
- **Medium** significance (50-55 dBA): 189 people (42 building structures); and
- **Low** significance (45-50 dBA): 779 people (173 building structures).

Table 25: Household exposure to drilling noise at well pads 1, 2 , 3 over a 3-year period and exceedance of the daytime and night-time project standard (the plots show combined noise with construction of the CPF) - mitigated case

Village (and adopted background noise levels)	Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the daytime project standard are highlighted in blue)								Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the night time project standard are highlighted in brown)							
	20-25 dBA	25-30 dBA	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA	20-25 dBA	25-30 dBA	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA
CPF households			30	4	1						30	4	1			
Kyabasambu South *Daytime: 25 dBA* *Night-time: 33 dBA*					19	22	12						19	22	12	
Nsonga North *Daytime: 37 dBA* *Night-time: 32 dBA*			153	257	6						153	257	6			
Kyakapere South *Daytime: 30 dBA* *Night-time: 38 dBA*			3	17	46						3	17	46			
Kyabasambu North *Daytime: 37 dBA* *Night-time: 32 dBA*				23	75	20						23	75	20		

Village (and adopted background noise levels)	Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the daytime project standard are highlighted in blue)								Number of structures exposed to sound levels (dBA) (structures exposed to sound levels exceeding the night time project standard are highlighted in brown)							
	20-25 dBA	25-30 dBA	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA	20-25 dBA	25-30 dBA	30-35 dBA	35-40 dBA	40-45 dBA	45-50 dBA	50-55 dBA	55-60 dBA
Nsonga South *Daytime: 31 dBA* *Night-time: 35 dBA*			32	164	344	129	30	1			32	164	344	129	30	1
Nsunzu North *Daytime: 31 dBA* *Night-time: 42 dBA*		2	15	99	64	2				2	15	99	64	2		
Kyakapere Village *Daytime: 37 dBA* *Night-time: 32 dBA*	127	90	101						127	90	101					
Nsonga East *Daytime: 31 dBA* *Night-time: 35 dBA*	4	53	10	19					4	53	10	19				
Nsonga *Daytime: 31 dBA* *Night-time: 35 dBA*		1	37	68						1	37	68				
Kyabasambu East *Daytime: 37 dBA* *Night-time: 32 dBA*				10	14							10	14			

Note: The boundaries of the villages may be seen from the Baseline section of the report. This table presents a consolidated assessment of construction at the CPF and well pads 1, 2 and 3. Well pad 4 is constructed during the operational phase and is not included here

While the temporary nature of the noise permits higher acceptable noise levels, people around the drilling rigs will be exposed to residual noise (particularly at night) which is far above the existing ambient. Additional mitigation should be considered for the approximately 972 people who will be exposed to noise exceeding the night-time target threshold. This may include temporary housing for the period in which the drilling rig is located in the area.

Table 26: Noise impacts during drilling phase

Management Objectives: Noise levels due to the Project at noise sensitive receptors to be below the Ugandan maximum legal limit during daytime (75 $dBL_{Aeq,1hr}$) and night-time (65 $dBL_{Aeq,1hr}$) periods at all times and as far as possible below the target impact threshold levels of 55 dBA daytime and 45 dBA night-time.

Overall Significance before mitigation: Mainly Medium (daytime), Major (night-time)

Overall Significance after (source and barrier) mitigation: Mainly Low (daytime), Medium (night-time)

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Erection of acoustic barriers (noise 'curtains') around the drilling rig screening to above the drilling platform. Separation of the top drive and the blower fans and installation of the fans at ground level. Erection of acoustic barriers (shipping containers or similar) around the well pad to create 5m high screens and/or acoustic enclosures around the engine, mud pumps and blower fan. The enclosures should be constructed of resilient material, lined with an acoustically absorptive material and appropriately vented and fire-proofed. Screens must completely exclude line of sight to the noise source from the nearest receptor, with no gaps or holes, and be constructed from material of a high surface area density (>15 kg/m^2). The acoustic attenuation surrounding the drill site has been assumed to provide a 10 dB overall reduction in noise. To manage residual impacts, consider temporary relocation of residents affected by noise levels exceeding 50 dBA.	Reduction of noise from elevated noise sources by 10 dB(A) or more. Containment of ground level sources using containers or similar solid barriers between sources and residents. Daytime drilling phase noise target of 55 $dBL_{Aeq,1hr}$ and night-time noise target of 45 $dBL_{Aeq,1hr}$ not exceeded at neighbouring receptors. Maximum legally permissible noise is 75 dBA daytime and 65 dBA daytime	Monthly	CNOOC and Contractors	Use of sound level meters and monitoring techniques and procedures

4.1.5 Construction of Feeder pipeline

4.1.5.1 *Impacts*

No construction will take place at night along the feeder pipeline and noise impacts along the pipeline right of way will therefore not be subject to the more stringent night-time standards described in the relevant guidelines. Assessment of impact is in accordance with the standard in Table 4, described in Section 2.4.1.

Table 26 shows the significance of daytime construction noise impact along the feeder pipeline, based on distance from the construction right of way. A total of 11 buildings (roughly 50 people) will be affected by noise levels that are greater than an L_{Aeq} (1 hr) of 65 dBA. These impacts will be well below the Ugandan legal limit for construction activities of 75 dBA and will be of **low** significance. While the noise generated by vehicles bringing materials along the pipeline right of way may extend for periods of up to six months, the noise generated by construction teams working on the welding and laying of the pipeline would, in most cases, be considerably shorter than this, and would progress quickly past any household, extending the distance of the main noise sources from any receiver daily.

Table 26: Significance of construction phase noise impact with distance from the pipeline for the daytime period (showing number of affected buildings)

Receptor distance from noise source*	Number of Affected Buildings**		
	Predicted sound levels >65 dBA (dB $L_{Aeq,1hr}$) Significance Low	Predicted sound levels 60-65 dBA (dB $L_{Aeq,1hr}$) Significance Negligible (NSI)	Predicted sound levels 55 -60 dBA (dB $L_{Aeq,1hr}$) Significance Negligible (NSI)
0 - 10m from pipeline RoW	11	0	0
10 m - 50m from pipeline RoW	0	5	0
50 m – 100 m from pipeline RoW	0	-	4
100m - 200m from pipeline RoW	0	0	0

RoW = Right of Way

* *Distances are from the edge of the construction right of way*

*** The relationship between building structures and number of people affected is uncertain but is probably in the order of 1 building = 4.5 people.*

4.1.5.2 *Mitigation*

By tolerating a higher level of noise in surrounding communities due to the short term nature of the construction activities, the target thresholds permit a large increase above the background ambient sound levels that are typical of rural areas. Noise levels will be potentially disturbing for short periods of time for people living close to the construction right of way and along the main access roads. All reasonable, practical, means of limiting pipeline construction noise effects should be implemented. This is particularly important if any areas where sensitive land uses such as schools, churches or clinics are affected.

The following mitigation and monitoring is recommended:

- Comply with the daytime construction restrictions. Daytime should be defined as daylight hours from 06:00 - 18:00;
- Train all drivers and equipment operators to minimise unnecessary generation of noise;
- Train all personnel to be aware of noise nuisance and to minimise their noise footprint in the surrounding community;

- Flag any schools, clinics or places of worship within 100m - 200 m of the construction RoW and monitor noise at these locations. If necessary, take measures to minimise the effect of the noisiest activities by timing them to avoid critical periods in the school/worship calendar;
- Ensure that silencers on all vehicles and equipment are properly maintained;
- Communicate with the families in proximity to the right of way to ensure that there is an understanding of the temporary nature of the noise and the expected schedules for construction;
- Use the pipeline construction as an educational opportunity for school children in the communities along the pipeline;
- In areas where blasting is necessary, advise surrounding communities well in advance of the blast schedules. If any blasting is required within 200 m of households, undertake photograph surveys of the buildings before and after blasting and measure blast shock; and
- Shield the camp generator with acoustic screening. This should provide the necessary acoustic insulation to minimise night-time noise to levels of low significance.

These measures will assist in minimising the more annoying and unnecessary aspects of construction noise along the feeder line RoW.

4.1.6 Production (Operational) Phase

4.1.6.1 *Impacts*

Noise generated at the CPF during the operational phase will include the operation of gas engines and other plant. Details of noise emission sources are provided in Section 2.5.3.4. No households will exceed the maximum recommended daytime or night-time limit of 55 dBA and 45 dBA respectively, due to noise caused by the production facility (Figure 27). Noise levels in Figure 27 include the embedded mitigation indicated by CNOOC, described in Section 2.5.3.4. Three buildings (households) will be relocated/ compensated for since they are within the footprint of the CPF. Two buildings that are close to the eastern and south-eastern boundaries of the CPF will experience noise levels that are potentially up to 3 dBA above the existing baseline. For these households, impacts will be local, definite, of low magnitude and long duration, resulting in a rating of **low medium** impact significance. For all other households, impact magnitude will be negligible and impact significance will be **low**.

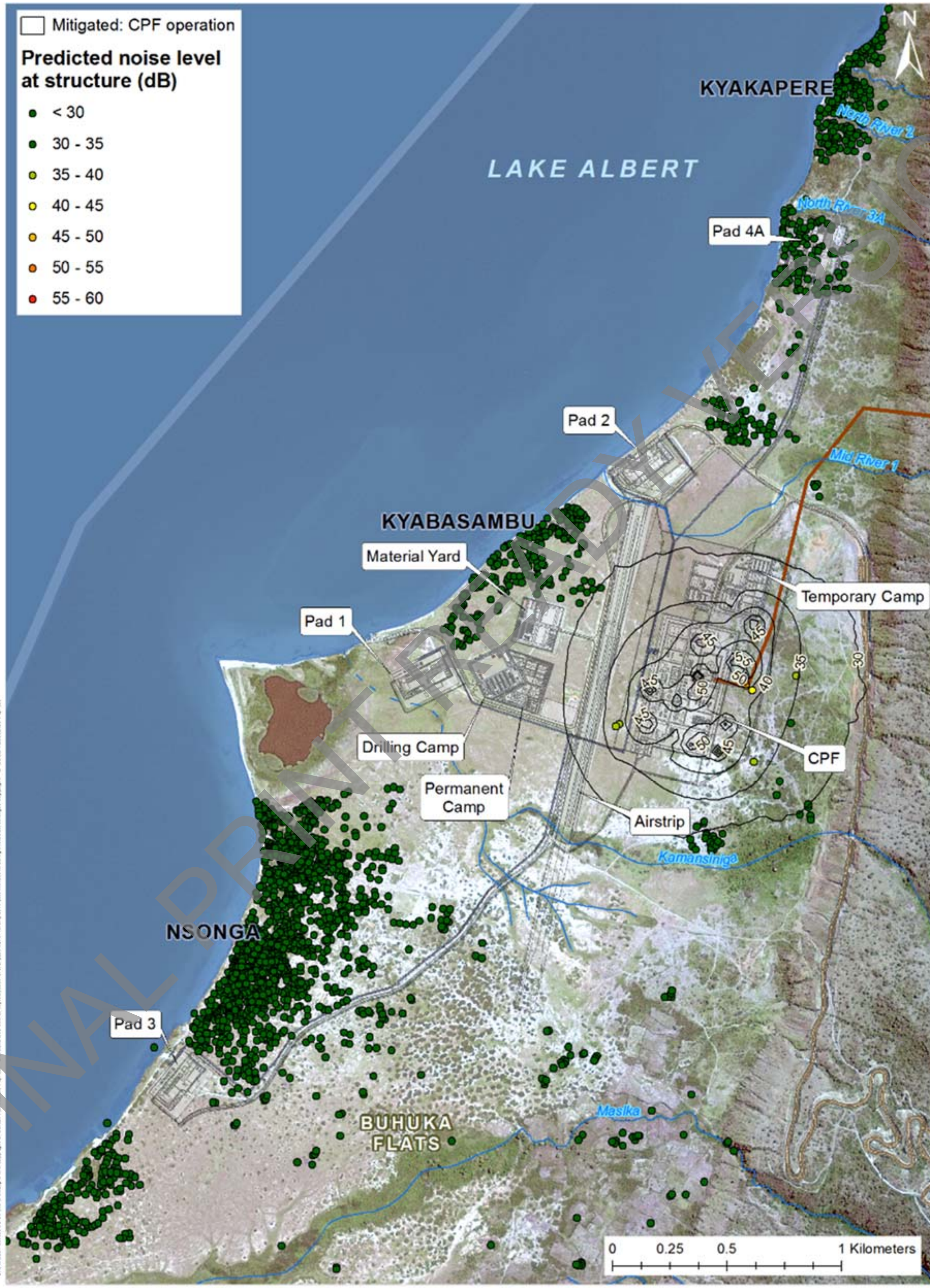

Figure 27: Noise Levels caused by Production at the CPF (including embedded mitigation indicated in Section 2.5.3.4)

4.1.6.2 *Mitigation*

Noise during production, when all of the well pads are assumed to be running semi-autonomously, with no mobile noise sources, may be effectively controlled by installation of screens and acoustic enclosures. At the well pads, noise from items of fixed plant will be limited to a maximum of 3 dB above the background level measured at the closest baseline monitoring point when measured at the well pad boundary.

At the CPF, the embedded noise controls proposed by CNOOC, which may include sourcing of quieter equipment, acoustic enclosures and other attenuation measures to reduce sound power levels of each source to a maximum of 75 dB(A), will reduce noise levels to low levels of significance in all but 2 cases, where predicted noise levels will exceed 35 dBA. These households are situated within a proposed buffer zone, proposed by Golder for the management of environmental and social impact as a whole, and where settlement should not be permitted. Subject to resettlement of the affected families outside of this zone, all operational noise impact will be of **low** significance.

Table 27: Noise impacts during production phase

Management Objectives: Noise levels due to the Project at noise sensitive receptors below the Ugandan permissible noise levels during daytime (55 $dBL_{Aeq,1hr}$) and night-time (45 $dBL_{Aeq,1hr}$) periods

Overall Significance before mitigation: Low (daytime), Low (night-time) except 2 households east of CPF (Low Medium)

Overall Significance after mitigation: Low (daytime), Low (night-time)

Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Responsible Entity	Training Necessary
Specification of acoustic enclosures and noise attenuation measures at CPF to fixed plant to reduce sound power level of each item to a maximum of 75 dB(A) or as required in order to meet daytime and night-time permissible noise levels at neighbouring receptors. Households within the 35 dBA noise contour (east of the CPF) to be relocated. At well pads the noise level at the boundary of the pad will not exceed the measured baseline level at that location by more than 3 dB. Attenuation to be fitted to plant if this boundary limit is exceeded.	Daytime operations phase noise limit of 55 $dBL_{Aeq,1hr}$ and night-time operations phase noise limit of 45 $dBL_{Aeq,1hr}$ not exceeded at neighbouring receptors. Increase should not exceed existing baseline by >3 dBA	Subsequent to installation and switch-on and annually thereafter	CNOOC and Contractors	Use of sound level meters and monitoring techniques and procedures

4.1.7 Impact Rating

4.1.7.1 *Construction Phase (civil construction excluding drilling impacts)*

Impacts are rated in Table 28 in accordance with the methodology described in Section 2.4.1.

Table 28: Construction phase impacts of noise (civil works of CPF complex and associated infrastructure)

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Daytime Impact of Civil Construction Noise (9 buildings – 55-60 dBA)	-	-	-	-	Low	-	-	-	-	Low
Night time Impact of Civil Construction Noise (9 buildings - 55-60 dBA)	-	-	-	-	High	No work at night				NSI
Night time Impact of Civil Construction Noise (78 buildings - 50-55 dBA)	-	-	-	-	Medium	No work at night				NSI
Night time Impact of Civil Construction Noise (273 buildings- 45-50 dBA)	-	-	-	-	Low	No work at night				NSI

KEY (Note: The standard ESIA rating scale does not apply to construction noise – refer to the methodology above)

Magnitude	Duration	Scale	Probability
10 Very high/ don't know	4 Permanent	5 International	5 Definite/don't know
8 High	3 Long-term (>6 months)	4 National	4 Highly probable
6 Medium	2 Medium-term (1-6 months)	3 Regional	3 Medium probability
4 Low	1 Short-term (<1 month)	2 Local	2 Low probability
1 Minor		1 Site only	1 Improbable
			0 No chance of occurrence

Significance: Low ≤30; Low Medium 31– 52; High Medium 53 – 74; High ≥75. Positive: +. NSI No Significant Impact

4.1.7.2 *Construction Phase (civil construction including drilling impacts)*

Impacts are rated in Table 28 in accordance with the methodology described in Section 2.4.1.

Table 29: Construction phase impacts of noise (civil works of CPF complex and drilling)

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Daytime Impact of Drilling Noise	1 structure (5 people)				High	-				NSI
	42 structures (189 people)				Medium	-				NSI

Indicator of potential impact	Pre-mitigation: Magnitude	Duration	Geographic Extent	Probability	Significance	Post-mitigation: Magnitude	Duration	Geographic Extent	Probability	Significance
	173 buildings (779 people)				Low	1 structure (5 people)				Low
Nighttime Impact of Drilling Noise	216 buildings (223 people)				High	1 structure (5 people)				High
Nighttime Impact of Drilling Noise	568 buildings (2556 people)				Medium	42 structures (189 people)				Medium
Nighttime Impact of Drilling Noise	657 buildings (2956 people)				Low	173 structures (779 people)				Low

KEY (Note: The standard rating scale does not apply to drilling noise – refer to the methodology in Section 7.1.3.1)

Magnitude	Duration	Scale	Probability
10 Very high/ don't know	4 Permanent	5 International	5 Definite/don't know
8 High	3 Long-term (>6 months)	4 National	4 Highly probable
6 Medium	2 Medium-term (1-6 months)	3 Regional	3 Medium probability
4 Low	1 Short-term (<1 month)	2 Local	2 Low probability
1 Minor		1 Site only	1 Improbable
			0 No chance of occurrence

Significance: Low ≤30; Low Medium 31– 52; High Medium 53 – 74; High ≥75. Positive: +. NSI No Significant Impact

4.1.7.3 *Construction Phase (Feeder Pipeline)*

The impacts of the feeder pipeline are divided into those associated with the work site and those associated with the personnel camp.

Table 30: Construction phase impacts of noise (feeder pipeline)

Indicator of potential impact	Pre-mitigation: Magnitude	Duration	Geographic Extent	Probability	Significance	Post-mitigation: Magnitude	Duration	Geographic Extent	Probability	Significance
Daytime Impact of Civil Construction Noise	11 buildings (50 people) 65 -70 dBA				Low	11 buildings (50 people) <65 dBA				NSI
Daytime Impact of Civil Construction Noise (9 buildings)	9 buildings (40 people) 55-60 dBA				Low	11 buildings (50 people) <65 dBA				NSI
Daytime Impact of Personnel Camp Noise	No household within 200 m				NSI	-				NSI
Night-time Impact of Personnel Camp Noise	No household within 200 m				NSI	-				NSI

KEY (Note: Standard rating scale does not apply to construction noise – refer to the methodology above)

Magnitude	Duration	Scale	Probability

10 Very high/ don't know	Merged into the magnitude ratings for construction-related noise	5 International	5 Definite/don't know
8 High		4 National	4 Highly probable
6 Medium		3 Regional	3 Medium probability
4 Low		2 Local	2 Low probability
1 Minor		1 Site only	1 Improbable
			0 No chance of occurrence
Significance: Low ≤30; Low Medium 31– 52; High Medium 53 – 74; High ≥75. Positive: +. NSI No Significant Impact			

4.1.7.4 *Operational Phase*

The impacts described in Table 31 are for the long term operation of the production facility, after drilling is completed. Impacts are evaluated in accordance with the methodology described in Section 2.4.2.

Drilling during the first 5 years of the operational phase will result in the same impacts described in Section 4.1.7.2.

Table 31: Operational phase impacts of noise (excluding drilling)

Indicator of potential impact	**Pre-mitigation**					**Post-mitigation**				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Impact of the CPF Operation (all villages)	1	4	1	5	Low 30	1	4	1	5	Low 30
Two households east of the CPF	4	4	2	5	Low Medium 50	-	-	-	-	NSI

KEY			
Magnitude	Duration	Scale	Probability
10 Very high/ don't know	5 Permanent	5 International	5 Definite/don't know
8 High	4 Long-term (impact ceases after closure of activity)	4 National	4 Highly probable
6 Medium	3 Medium-term (5 to 15 years)	3 Regional	3 Medium probability
4 Low	2 Short-term (0 to 5 years)	2 Local	2 Low probability
2 Minor	1 Transient	1 Site only	1 Improbable
1 None/Negligible			0 No chance of occurrence
Significance: Low ≤30; Low Medium 31– 52; High Medium 53 – 74; High ≥75. Positive: +			

5.0 RECOMMENDED CONTINUOUS MONITORING AND ADOPTION OF GOOD PRACTICE

5.1 Monitoring programme

The requirements of the monitoring program are anticipated to change throughout the lifespan of the Project. Each phase of the Project will affect receptors to a varying degree, depending on the active work areas, plant in use and hours of work.

During construction and drilling of wells, when the intensity of works is anticipated to be variable, monthly noise surveys will be undertaken at the receptors closest to the active work areas. Each receptor will be monitored for a period not less than 24 hours and the results compared with the evaluation criteria.

During the production stage, when noise levels are anticipated to be less variable, the frequency of monitoring will be reduced to annual surveys, with additional spot-checks of 1 hour's duration during the daytime and night-time at receptors conducted monthly. Supplementary 24-hour surveys will be conducted should noise complaints be received.

5.2 Noise control measures

In order to minimise noise generation at the site it is recommended that best practice is followed during the construction and operations phases of the Project. Noise mitigation should be incorporated into the design and operation of the Project, with noisy activities conducted during the daytime period and at locations far from receptors where possible. Items of equipment, both fixed and mobile, should be selected for lower noise models, where possible.

A programme of noise monitoring should be established at noise sensitive receptors, and measured levels compared with noise limits. Where exceedances are identified appropriate actions should be taken to reduce noise at the affected receptors.

6.0 CONCLUSION

This assessment has considered potential noise impacts associated with the proposed development of an oil facility in the Kingfisher Field on the shore of Lake Albert, Uganda.

International guidance and Ugandan legislation were reviewed in order to determine appropriate standards for construction and operational noise. In all cases, the Ugandan legal standard was used as the threshold for 'high' impact significance. Other guidelines for construction and operational impacts were also applied.

A baseline study of noise levels in the Kingfisher Field was completed in early 2014. Background noise levels in the study area were found to be lower than the Ugandan daytime guide of 55 dBA for mixed residential areas at all receptors. During the night-time period the background noise levels are typically between 32 dBA and 42 dBA.

Noise predictions were made in accordance with three distinct phases of the project; construction of infrastructure, drilling of wells and production. The decommissioning phase was not modelled, as decommissioning noise impacts have been assumed to be similar to or less than those arising from the construction of infrastructure.

Noise impacts associated with the different phases of the Project were assessed against the adopted evaluation criteria for construction and operational noise. Where initial noise impacts at the closest receptors to the proposed Project infrastructure were identified as significant, further modelling was undertaken and mitigation options considered.

Significant impacts are predicted at the nearby villages due to the construction of civil infrastructure on the Buhuka Flats, caused by the use of heavy mobile plant items for site clearance and levelling and other potentially noisy activities. Impact significance during the daytime will generally be low, taking into consideration that construction impacts are tolerated to a greater degree than long term impacts due to their transient nature. If noisy night work occurs, this will result in impacts of high, medium and low significance for surrounding inhabitants due to the more stringent criteria for the evaluation of such noise. No impacts exceeding the Ugandan standard for construction noise are expected. Mitigation specified includes limiting noisy construction works to the daytime period only and the use of 'silenced plant' with enhanced exhaust mufflers and application of additional silencing of the engine bays, and the training of personnel to minimise unnecessary noise generation. Residual impacts are predicted to be of low significance.

Significant impacts are predicted at the nearby villages due to drilling. This activity will negatively affect large numbers of people in varying degrees, from high to low significance. Specified mitigation measures to lower the impacts include the use of an acoustic curtain to enclose parts of the drill rig, the relocation of the xxxx and acoustic screening of ancillary plant at the level of the well pad. While this mitigation is expected to lower noise levels by around 10 dBA, residual noise levels will still exceed the project standard and the legal limits for construction at many households, mainly during the night time period when sleep disturbance is an issue. As a result, it is recommended that the worst affected households are temporarily relocated during drilling.

Potential impacts are predicted for a small number of residents along the feeder pipeline as a result of their proximity to ongoing construction at the work sites. Impact will generally be over a short period, often only a few weeks. Mitigation includes measures to limit source noise and to train vehicle and equipment operators to be considerate of nearby local households. Additional measures may be required where sensitive land uses are affected. Subject to the range of specified mitigation, it is predicted that impacts can be reduced to low levels of significance.

The static nature of the noise sources during the production phase has enabled the specification of enhanced noise attenuating housings for fixed plant items. These measures are predicted to reduce noise at the closest receptors to low or negligible levels of significance during the production phase, with the exception of two building structures to the east and south east of the CPF. It is recommended that these households are resettled further from the boundary of the CPF.

7.0 REFERENCES

1) Scoping Report for the Environmental and Social Impact Assessment for Kingfisher Discovery Area in Hoima District, Uganda, by CNOOC Uganda Ltd. - Golder Associates and Eco & Partner, December 2013

2) Kingfisher Field Development Plan – CNOOC, September 2012.

3) National Environment (Noise Standards and Control) Regulation, 2003. Ugandan Government, 2003.

4) Environmental Health and Safety Guidelines, Noise. International Finance Corporation, 2007.

5) BS 5228:1 – 2009: Code of practice for noise and vibration control on construction and open sites. British Standards Institute, 2009.

6) Attenuation of sound during propagation outdoors. International Standards Institute, 1993.

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Noise Consultant

Stuart McGowan
Senior EIA, Air Quality & Noise Consultant

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APPENDIX A

Noise Sources Modelled

Construction phase - export pipeline - area source 1 km long & 20m wide

Plant	Resultant sound power level, dB			Number of moving point sources within area		
	Day	Evening	Night	Number		
	(dBA)	(dBA)	(dBA)	Day	Evening	Night
30T Excavator	107.5	107.5	-	4	4	-
100T crane	102.1	102.1	-	2	2	-
Dozer	111.7	111.7	-	2	2	-
LowLoader	111.1	111.1	-	2	2	-
Welder	103.9	103.9	-	2	2	-

Construction phase - CPF & well pad construction

Plant	Resultant sound power level, dB			Number of moving point sources within area		
	Day	Evening	Night	Number		
	(dBA)	(dBA)	(dBA)	Day	Evening	Night
Excavators 30T	104.5	104.5	-	2	2	-
Crane 100T	99.1	99.1	-	1	1	-
Bulldozers 20T	111.7	111.7	-	2	2	-
Wagons	111.1	111.1	-	2	2	-
Vibrating roller	101.5	101.5	-	1	1	-
OtherPlant (10T telehandler)	101.5	101.5	-	2	2	-

Drilling Phase					
Name	**Resultant sound power level, dB**			**Lw / Li**	
	Day	**Evening**	**Night**	**Type**	**Value**
	(dBA)	**(dBA)**	**(dBA)**		
Well pad plant:					
Water Pump 1	90	80	80	Lw	90
Water Pump 2	90	80	80	Lw	90
Water Pump 3	90	80	80	Lw	90
Drill Rig 1 top drive	111	81	81	Lw	111
Drill Rig 1 engine	114	84	84	Lw	114
Mud Pump 1	109	79	79	Lw	109
Telehandler 1	99	89	89	Lw	99
Lighting rig 1	93	83	83	Lw	93
100 kVA generator 1	105	95	95	Lw	105
CPF plant					
Genset 1	88	88	88	Lw	88
Genset 2	88	88	88	Lw	88
Genset 1	88	88	88	Lw	88
Genset 2	88	88	88	Lw	88
Genset 3	88	88	88	Lw	88
Water treatment system	88	88	88	Lw	88
Substation	88	88	88	Lw	88
Oil Separation System	88	88	88	Lw	88
Flash Gas Compressor	88	88	88	Lw	88
Fuel Gas Compressor	88	88	88	Lw	88
Excess Gas Utilisation Package	88	88	88	Lw	88
Water Injection Pumping System	88	88	88	Lw	88
Kingfisher Main Inlet & Water Injecti	88	88	88	Lw	88
Kingfisher North Inlet & Water Injecti	88	88	88	Lw	88
Oil Transmission Pumps & Metering	88	88	88	Lw	88
Oil Heating Medium	88	88	88	Lw	88
Oil Export System	88	88	88	Lw	88

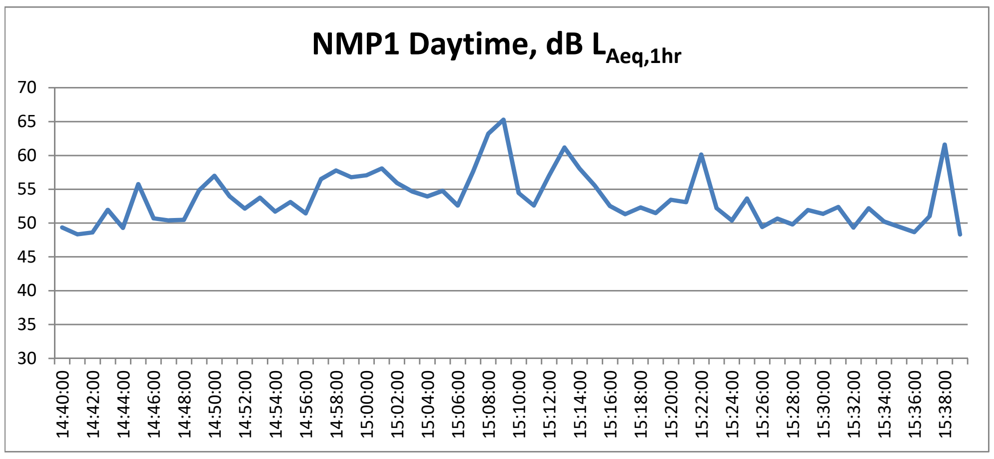
Raw Water System	88	88	88	Lw	88

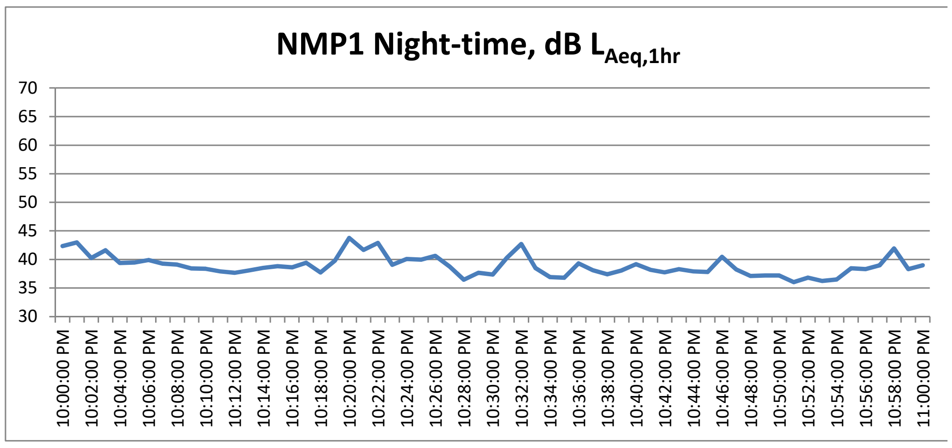
Production phase

Name	Result. PWL			Lw / Li		Height	Coordinates	
	Day	Evening	Night	Type	Value		X	Y
	(dBA)	(dBA)	(dBA)			(m)	(m)	(m)
Genset 1	88	88	88	Lw	88	2	250051	137953.3
Genset 2	88	88	88	Lw	88	2	250017	137957.5
Genset 1	88	88	88	Lw	88	3	250064.3	137920.6
Genset 2	88	88	88	Lw	88	3	250032.9	137926.8
Genset 3	88	88	88	Lw	88	3	249999	137935.6
Water treatment system	88	88	88	Lw	88	3	250090	138106.5
Substation	88	88	88	Lw	88	3	250046.9	137879
Oil Separation System	88	88	88	Lw	88	3	249968.7	137664.3
Flash Gas Compressor	88	88	88	Lw	88	3	249829	137801.4
Fuel Gas Compressor	88	88	88	Lw	88	3	249832.8	137831
Excess Gas Utilisation Package	88	88	88	Lw	88	3	249840.3	137879.9
Water Injection Pumping System	88	88	88	Lw	88	3	249856.2	137613.1
Kingfisher Main Inlet & Water Injectio	88	88	88	Lw	88	3	249820.1	137580.2
Kingfisher North Inlet & Water Injecti	88	88	88	Lw	88	3	249618.1	137672.6
Oil Transmission Pumps & Metering	88	88	88	Lw	88	3	249637.2	137821.5
Oil Heating Medium	88	88	88	Lw	88	3	249751	137772.6
Oil Export System	88	88	88	Lw	88	3	249928.5	137555.7
Raw Water System	88	88	88	Lw	88	3	249857.8	138023.2
WP4A (area source)	65	65	65	Lw	75	1	250314.9	139780.7
WP2 (areas source)	72	72	72	Lw	75	1	249566.2	138806.4
WP1 (area source)	70	70	70	Lw	75	1	248638.7	137922.4
WP3 (area source)	74	74	74	Lw	75	1	247575.3	136155.4

APPENDIX B

Baseline – Measured Levels & Graphs


NMP1 Daytime, dB $L_{Aeq,1hr}$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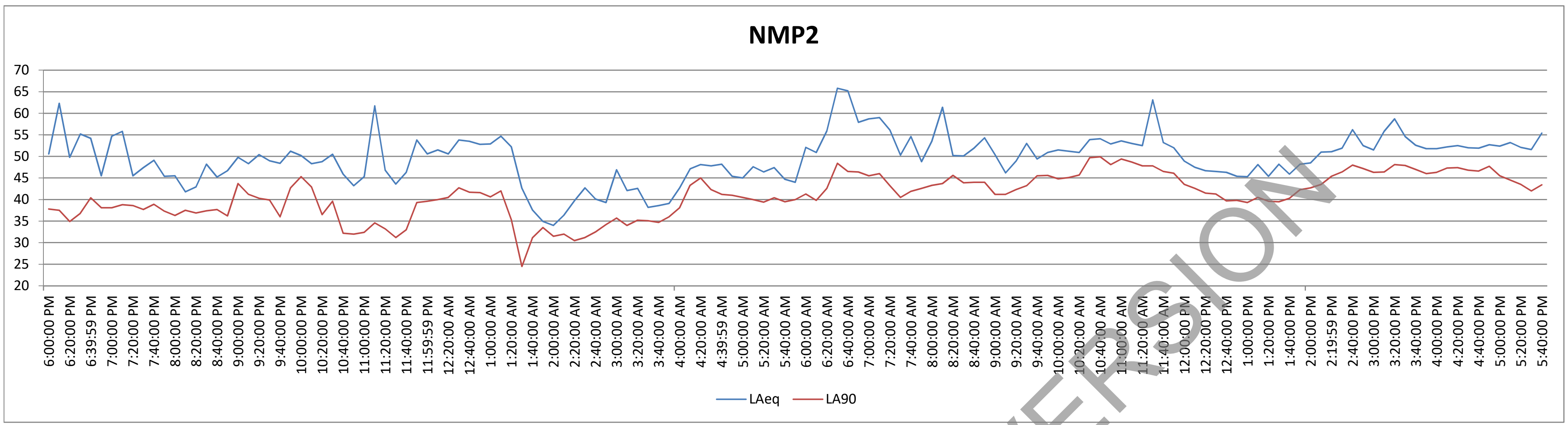
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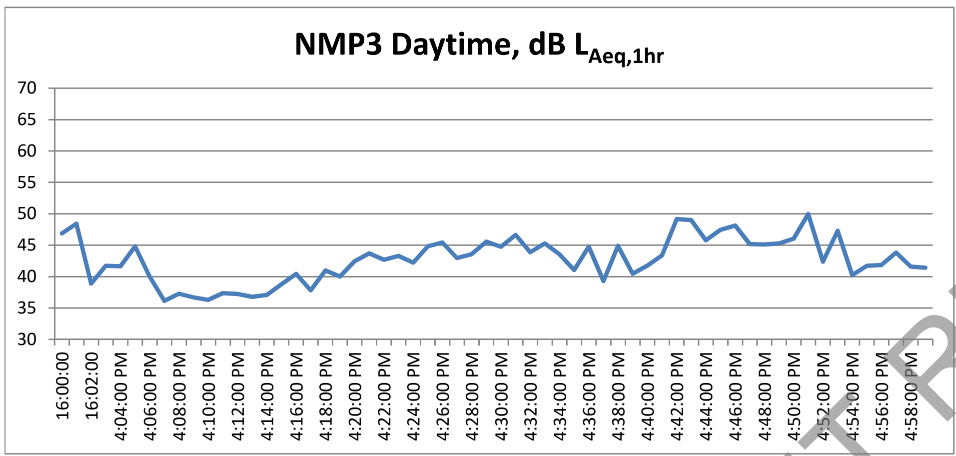
LAeq
LA90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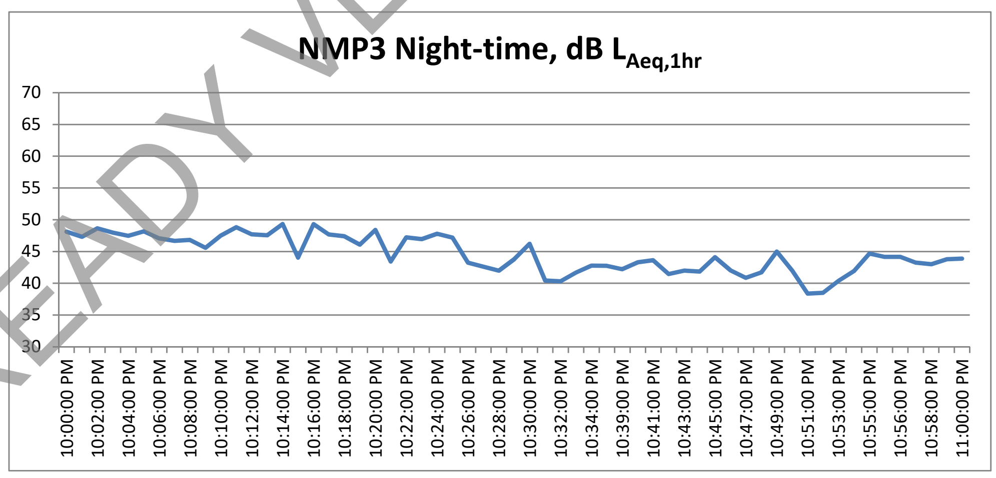
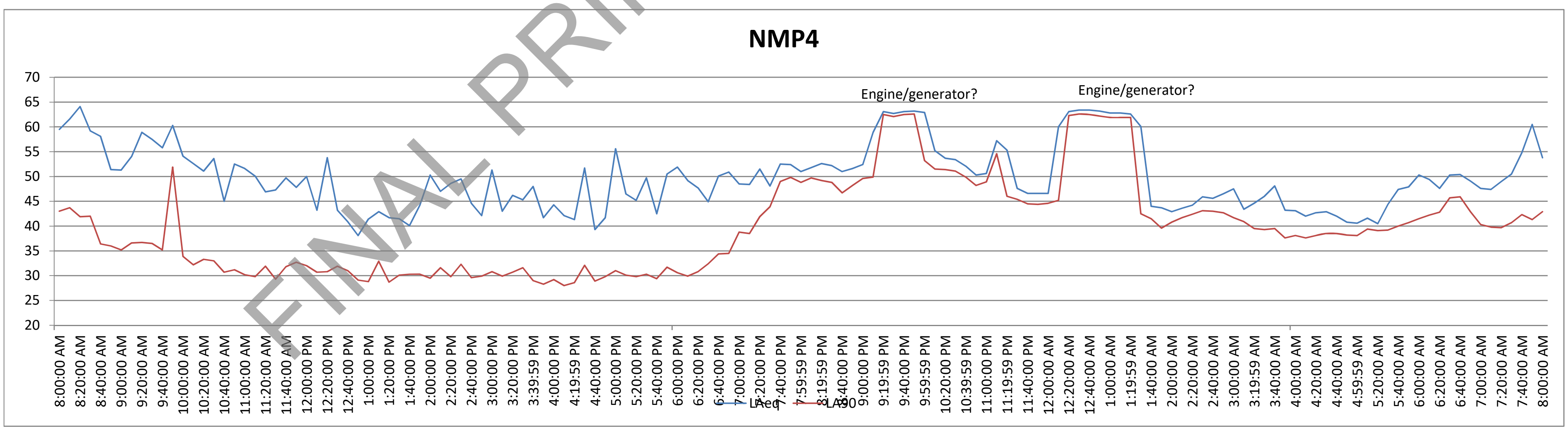

NMP3 Night-time, dB $L_{Aeq,1hr}$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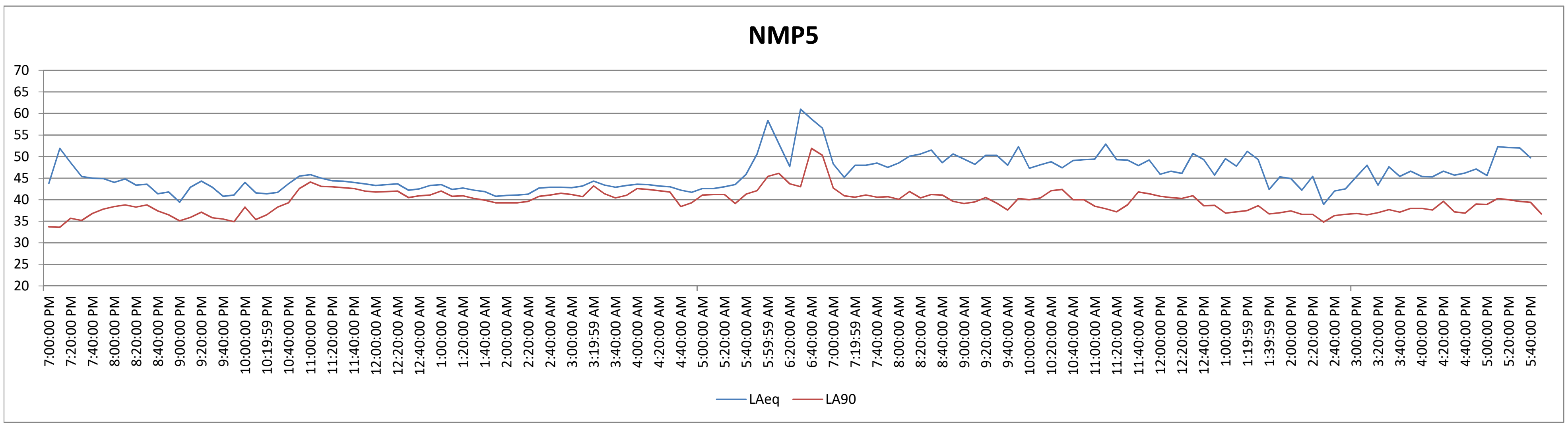
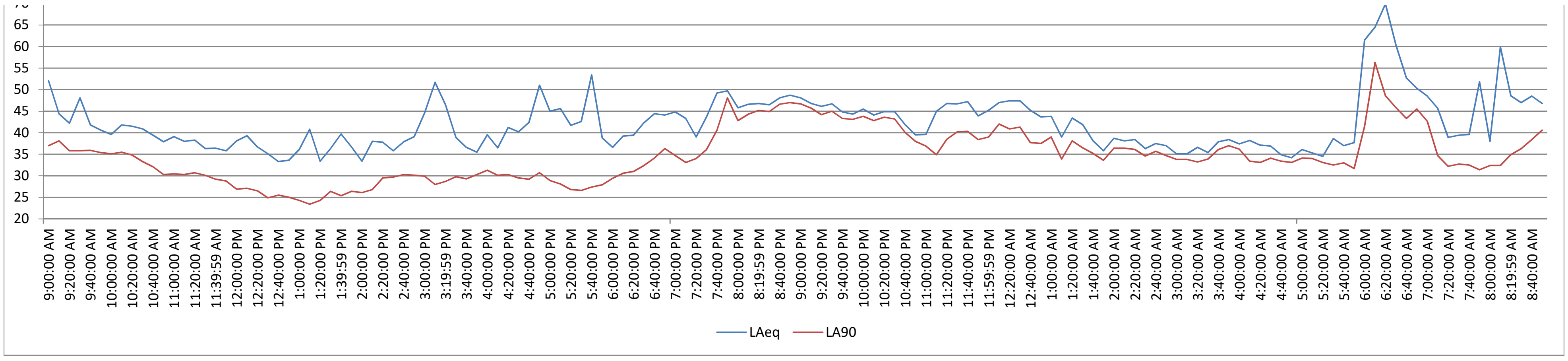
Engine/generator?
Engine/generator?
LAeq
LA90


NMP5
LAeq
LA90


NMP6
06:30 - Dawn chorus?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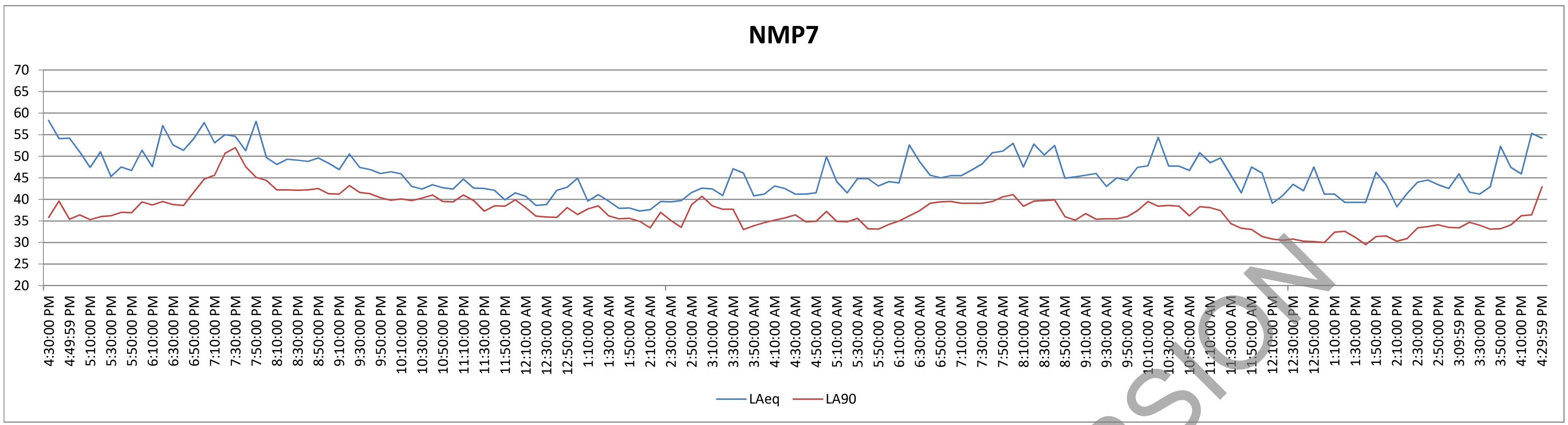
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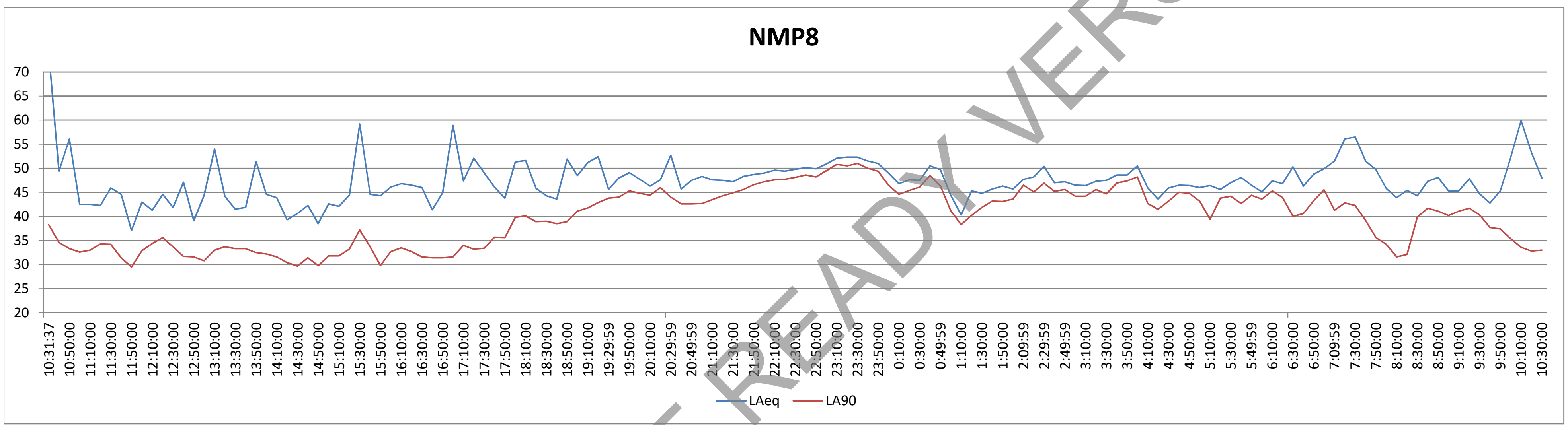
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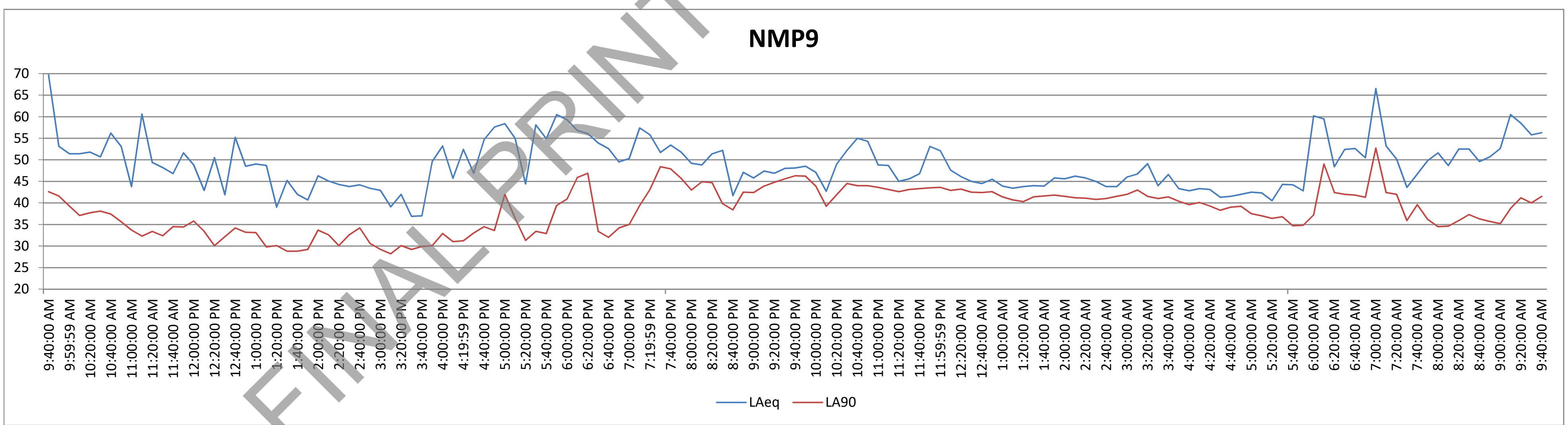
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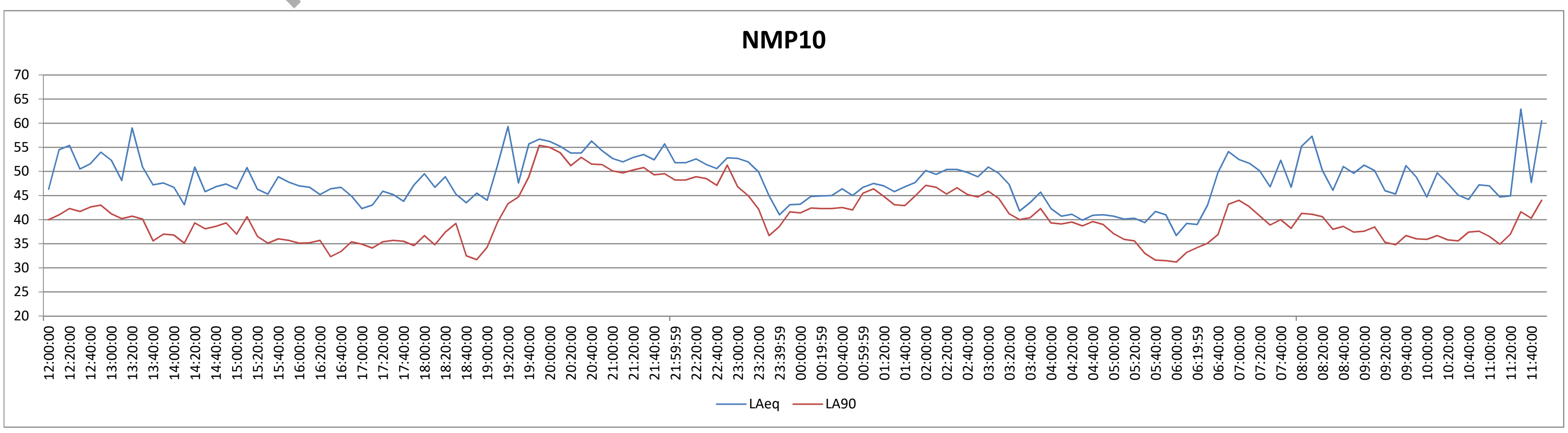
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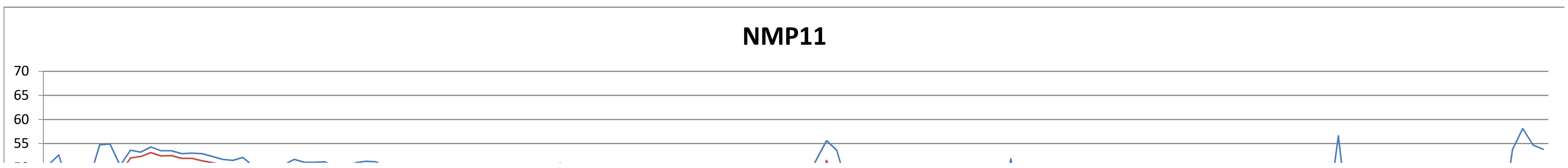
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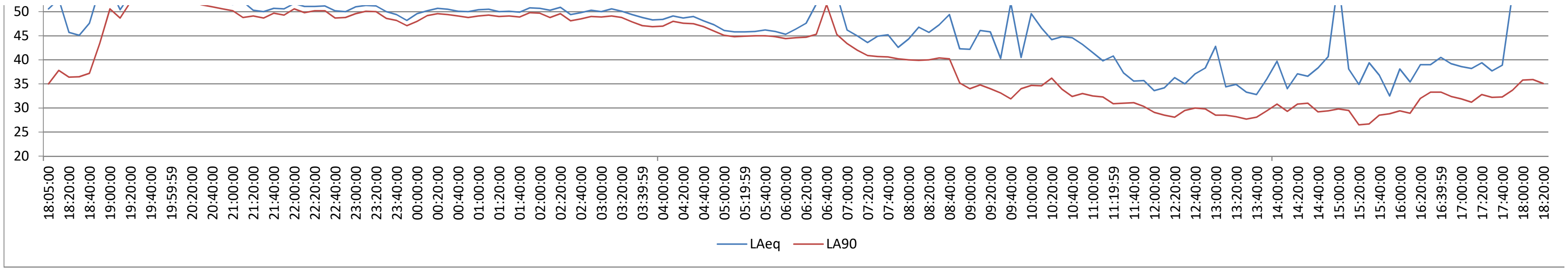
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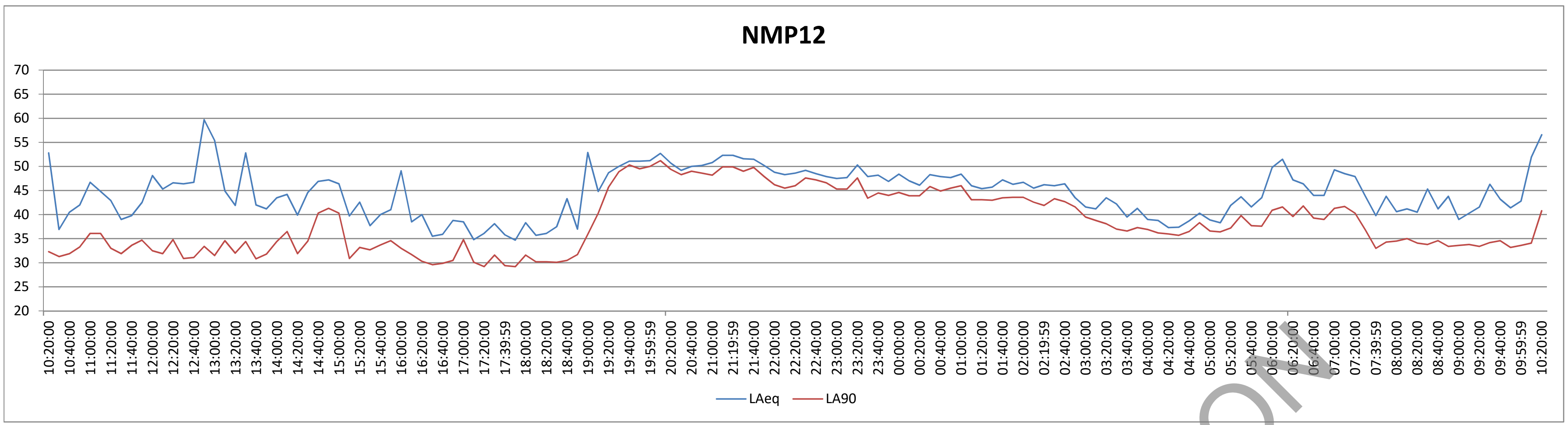
NMP12
LAeq
LA90

APPENDIX C

Predicted Noise Levels by Receptor

CONSTRUCTION PREDICTIONS

Post-mitigation		
Name	Level Lr	
	Day (dBA)	Night (dBA)
Pad 4_2 - nearest receptor	72.6	0.0
Pad2 - nearest receptor	54.4	0.0
Kyabasambu nearest receptor	48.9	0.0
Wellpad1 - nearest receptor	54.0	0.0
Nsonga North	43.4	0.0
Nsonga South	54.0	0.0
Pad 3 nearest receptor - Nsunzu north	48.6	0.0
Pad 5 - nearest receptor	66.4	0.0
Kiina closest receptor	36.3	0.0
Ikamiro Village	54.0	0.0

PRODUCTION PREDICTIONS

Post-mitigation			
Name	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**
Pad 4_2 - nearest receptor	R1	23.5	23.5
Pad2 - nearest receptor	R2	17.6	17.6
Kyabasambu nearest receptor	R3	22.2	22.2
Wellpad1 - nearest receptor	R4	25.3	25.3
Nsonga North	R5	17.2	17.2
Nsonga South	R6	8.8	8.8
Pad 3 nearest receptor - Nsunzu north	R7	15.0	15.0
Pad 5 - nearest receptor	R9	14.1	14.1
Kiina closest receptor	R10	18.2	18.2
Ikamiro Village	R11	27.4	27.4

APPENDIX D

Predicted noise contours of construction and drilling phases

SUMMARY OF WORST-CASE DRILLING NOISE

Pre-mitigation						Post-mitigation			
Name	ID	Level Lr Day (dBA)	Night (dBA)	Identified Receptor village	Source	Name	ID	Level Lr Day (dBA)	Night (dBA)
Pad 4_2 - nearest receptor	R1	80.8	80.8	Kyakapere	Pad 4_2	**Pad 4_2 - nearest receptor**	R1	70.0	70.0
Pad2 - nearest receptor	R2	58.4	58.4	Kyakapere	Pad 2	**Pad2 - nearest receptor**	R2	46.2	46.2
Kyabasambu - nearest receptor	R3	58.0	58.0	Kyabasambu	Pad 2	**Kyabasambu - nearest receptor**	R3	44.4	44.4
Wellpad1 - nearest receptor	R4	64.1	64.1	Kyabasambu	Pad 1	**Wellpad1 - nearest receptor**	R4	52.7	52.7
Nsonga North	R5	51.2	51.2	Nsonga	Pad 1	**Nsonga North**	R5	41.2	41.2
Nsonga South	R5	67.9	67.9	Nsonga	Pad 3	**Nsonga South**	R6	55.1	55.1
Pad 3 nearest receptor - Nsunzu north	R7	57.5	57.5	Nsunzu	Pad 3	**Pad 3 nearest receptor - Nsunzu north**	R7	46.7	46.7
Pad 5 - nearest receptor	R9	79.5	79.5	Kiina	Pad 5	**Pad 5 - nearest receptor**	R9	62.9	62.9
Kiina closest receptor	R10	47.5	47.5	Kiina	Pad 5	**Kiina closest receptor**	R10	39.0	39.0
Ikamiro Village	NMP11	24.3	23.4	Ikamiro	Pad 1	**Ikamiro Village**	R8	15.2	14.5

DRILLING NOISE BY WELLPAD

Name	ID	Level Lr Day (dBA)	Night (dBA)	Identified Receptor village	area	Name	ID	Level Lr Day (dBA)	Night (dBA)
Wellpad 1						**Wellpad 1**			
Pad 4_2 - nearest receptor	R1	25.6	25.6	Kyakapere	north	Pad 4_2 - nearest receptor	R1	19.4	19.4
Pad2 - nearest receptor	R2	38.6	38.6	Kyakapere	south	Pad2 - nearest receptor	R2	33.9	33.9
Kyabasambu - nearest receptor	R3	47.3	47.3	Kyabasambu	north	Kyabasambu - nearest receptor	R3	39.4	39.4
Wellpad1 - nearest receptor	R4	64.1	64.1	Kyabasambu	south	Wellpad1 - nearest receptor	R4	52.7	52.7
Nsonga North	R5	51.2	51.2	Nsonga	north	Nsonga North	R5	41.2	41.2
Nsonga South	R6	36.0	36.0	Nsgonga	south	Nsonga South	R6	30.4	30.4
Pad 3 nearest receptor - Nsunzu north	R7	32.7	32.7	Nsunzu	north	Pad 3 nearest receptor - Nsunzu north	R7	27.5	27.5
Pad 5 - nearest receptor	R9	22.6	22.6	Kiina	north	Pad 5 - nearest receptor	R9	18.6	18.6
Kiina closest receptor	R10	20.9	20.9	Kiina	south	Kiina closest receptor	R10	16.6	16.6
Ikamiro Village	R8/NMP11	24.3	23.4	Ikamiro	Pad 1	R8/NMP11	NMP11	15.2	14.5
Wellpad 2						**Wellpad 2**			
Name	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**	**Identified Receptor village**	**area**	**Name**	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**
Pad 4_2 - nearest receptor	R1	32.1	32.1	Kyakapere	north	Pad 4_2 - nearest receptor	R1	25.8	25.8
Pad2 - nearest receptor	R2	58.4	58.4	Kyakapere	south	Pad2 - nearest receptor	R2	46.2	46.2
Kyabasambu - nearest receptor	R3	58.0	58.0	Kyabasambu	north	Kyabasambu - nearest receptor	R3	44.4	44.4
Wellpad1 - nearest receptor	R4	43.4	43.4	Kyabasambu	south	Wellpad1 - nearest receptor	R4	34.6	34.6
Nsonga North	R5	35.7	35.7	Nsonga	north	Nsonga North	R5	28.5	28.5
Nsonga South	R6	27.4	27.4	Nsgonga	south	Nsonga South	R6	23.0	23.0
Pad 3 nearest receptor - Nsunzu north	R7	25.7	25.7	Nsunzu	north	Pad 3 nearest receptor - Nsunzu north	R7	20.8	20.8
Pad 5 - nearest receptor	R9	16.7	16.7	Kiina	north	Pad 5 - nearest receptor	R9	11.1	11.1
Kiina closest receptor	R10	15.5	15.5	Kiina	south	Kiina closest receptor	R10	11.0	11.0
Ikamiro Village	R8/NMP10	23.7	22.8	Ikamiro		Ikamiro Village	R8/NMP10	11.8	11.5
Wellpad 3						**Wellpad 3**			
Name	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**	**Identified Receptor village**	**area**	**Name**	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**
Pad 4_2 - nearest receptor	R1	16.3	16.3	Kyakapere	north	Pad 4_2 - nearest receptor	R1	10.9	10.9
Pad2 - nearest receptor	R2	27.3	27.3	Kyakapere	south	Pad2 - nearest receptor	R2	24.4	24.4
Kyabasambu - nearest receptor	R3	30.5	30.5	Kyabasambu	north	Kyabasambu - nearest receptor	R3	28.3	28.3
Wellpad1 - nearest receptor	R4	34.4	34.4	Kyabasambu	south	Wellpad1 - nearest receptor	R4	29.7	29.7
Nsonga North	R5	40.7	40.7	Nsonga	north	Nsonga North	R5	33.5	33.5
Nsonga South	R6	67.9	67.9	Nsgonga	south	Nsonga South	R6	55.1	55.1
Pad 3 nearest receptor - Nsunzu north	R7	57.5	57.5	Nsunzu	north	Pad 3 nearest receptor - Nsunzu north	R7	46.7	46.7
Pad 5 - nearest receptor	R9	37.1	37.1	Kiina	north	Pad 5 - nearest receptor	R9	32.8	32.8
Kiina closest receptor	R10	34.7	34.7	Kiina	south	Kiina closest receptor	R10	28.3	28.3
Ikamiro Village	R8/NMP10	22.9	22.0	Ikamiro	-	Ikamiro Village	R8/NMP10	13	12.5
Wellpad 4-2									
Name	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**	**Identified Receptor village**	**area**	**Name**	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**
Pad 4_2 - nearest receptor	R1	80.8	80.8	Kyakapere	north	Pad 4_2 - nearest receptor	R1	70.0	70.0
Pad2 - nearest receptor	R2	36.5	36.5	Kyakapere	south	Pad2 - nearest receptor	R2	27.0	27.0
Kyabasambu - nearest receptor	R3	33.9	33.9	Kyabasambu	north	Kyabasambu - nearest receptor	R3	27.6	27.6
Wellpad1 - nearest receptor	R4	30.5	30.5	Kyabasambu	south	Wellpad1 - nearest receptor	R4	25.6	25.6
Nsonga North	R5	25.4	25.4	Nsonga	north	Nsonga North	R5	19.0	19.0
Nsonga South	R6	17.1	17.1	Nsgonga	south	Nsonga South	R6	12.1	12.1
Pad 3 nearest receptor - Nsunzu north	R7	17.5	17.5	Nsunzu	north	Pad 3 nearest receptor - Nsunzu north	R7	10.5	10.5
Pad 5 - nearest receptor	R9	5.7	5.7	Kiina	north	Pad 5 - nearest receptor	R9	4.5	4.5
Kiina closest receptor	R10	7.3	7.3	Kiina	south	Kiina closest receptor	R10	2.6	2.6
Ikamiro Village	R8/NMP10	14.7	14.7	Ikamiro	-	Ikamiro Village	R8/NMP10	9.6	9.5
Wellpad 5									
Name	ID	Level Lr Day (dBA)	Night (dBA)	Identified Receptor village		**Name**	**ID**	**Level Lr Day (dBA)**	**Night (dBA)**
Pad 4_2 - nearest receptor	R1	8.2	8.2	Kyakapere	north	Pad 4_2 - nearest receptor	R1	6.3	6.3
Pad2 - nearest receptor	R2	23.0	23.0	Kyakapere	south	Pad2 - nearest receptor	R2	22.4	22.4
Nsunzu nearest receptor	R3	27.0	27.0	Kyabasambu	north	Kyabasambu - nearest receptor	R3	26.6	26.6
Wellpad1 - nearest receptor	R4	27.5	27.5	Kyabasambu	south	Wellpad1 - nearest receptor	R4	25.8	25.8
Nsonga North	R5	26.8	26.8	Nsonga	north	Nsonga North	R5	23.6	23.6
Nsonga South	R6	36.9	36.9	Nsgonga	south	Nsonga South	R6	32.2	32.2
Pad 3 nearest receptor - Nsunzu north	R7	40.9	40.9	Nsunzu	north	Pad 3 nearest receptor - Nsunzu north	R7	35.6	35.6
Pad 5 - nearest receptor	R9	79.5	79.5	Kiina	north	Pad 5 - nearest receptor	R9	62.9	62.9
Kiina closest receptor	R10	47.5	47.5	Kiina	south	Kiina closest receptor	R10	39	39
Ikamiro Village	R8/NMP10	18.6	18.6	Ikamiro	-	Ikamiro Village	R8/NMP10	11.6	11.2

APPENDIX E

Predicted noise contours

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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