



AKHM
ALEXCO KENO HILL
MINING CORP.

NOISE MONITORING AND MANAGEMENT PLAN

KENO HILL SILVER DISTRICT MINING OPERATIONS

September 2017

ALEXCO KENO HILL MINING CORP.



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1 INTRODUCTION

Alexco Keno Hill Mining Corp (AKHM) is permitted to operate the Keno District Mill as well as the Bellekeno, Lucky Queen, Onek 990 and the Flame and Moth Mines in the vicinity of Keno City, Yukon. In addition, the Bermingham Mine development and production program is currently being proposed. A Noise Management Plan has been developed to address any potential noise effects that may occur with the operations of the Mines and Keno District Mill.

The Noise Management Plan was based in part on a Noise Impact Assessment (NIA) completed by Patching Associates Acoustical Engineering Ltd (PAAE) and conducted during the *Yukon Environmental and Socio-Economic Assessment Act* (YESAA) process (Project 2011-0315 – Lucky Queen and Onek Deposit Production). The present update to the Noise Monitoring and Management Plan also considers a more recent NIA by PAAE conducted during the YESAA process (Project 2013-0161 – Flame and Moth Development and Production Program), as well as on a PAAE review of a noise monitoring memorandum by Access Consulting Group.

The NIA identified the noise sources from the Bellekeno, Lucky Queen and Onek and Flame and Moth mining-related activities, noise receptors, and predicted the anticipated noise level from all existing sources and those associated with Flame and Moth mining operations. Additional noise sources associated with Bermingham mine, although not included in the NIA, are considered here in the Noise Management Plan.

Section 2 of this Plan outlines noise sources from the Bellekeno, Lucky Queen, Onek and Flame and Moth Mines, Keno District Mill operations and the Bermingham mine development and operations, and Section 3 identifies noise receptors within Keno City. Section 4 summarizes the anticipated project noise predicted by the NIA and measures to mitigate potential noise-related impacts are presented in Section 5. AKHM's approach to noise management, through monitoring, creating a Noise Disturbance Registry, and reporting protocols, is described in Section 6.

2 POTENTIAL NOISE SOURCES

The NIA identifies potential noise generators for the operation of the Bellekeno, Onek and Lucky Queen mines, and the development and operation of the Flame and Moth mine in the Keno Hill Silver District.

The following are the potential noise sources identified in the NIA, shown on Figure 1.

- Bellekeno mine operations;
- Lucky Queen mine operations;
- Onek mine operations;
- Flame and Moth mine operation;
- Keno District Mill;
- Onek 400 Level Adit Water Treatment Plant;
- Trucking activity and traffic noise (up to 2 km away from Keno City centre);

- Wernecke Road;
- Christal Lake Road;
- Silver Trail Highway;
- Keno City Bypass Road;
- Bellekeno Haul Road; and
- Flame and Moth Haul Road.

Additional noise sources associated with the development and operation of the Bermingham mine include the Bermingham mine operations and traffic between the Bermingham portal and the crusher.

2.1 TRAFFIC ROUTING AND VOLUMES

Mine traffic associated with the Bermingham mine will use the Bermingham Access road, the Calumet Road and a short section of the Duncan Creek road between the Mill and the Bermingham Mine, as shown in Figure 1-2. As the mine operations at Bermingham begin, traffic from other deposits is expected to decrease, and the net level of traffic for the district should remain the same. A decrease in traffic along the Bellekeno Bypass Road is expected during Bermingham operations as Bellekeno mine operations are expected to cease during the active operations period at Bermingham. There will be no additional traffic through Keno City for the Bermingham Mine. Estimated traffic volumes associated with mining activities at Bermingham are shown in Table 1 below.

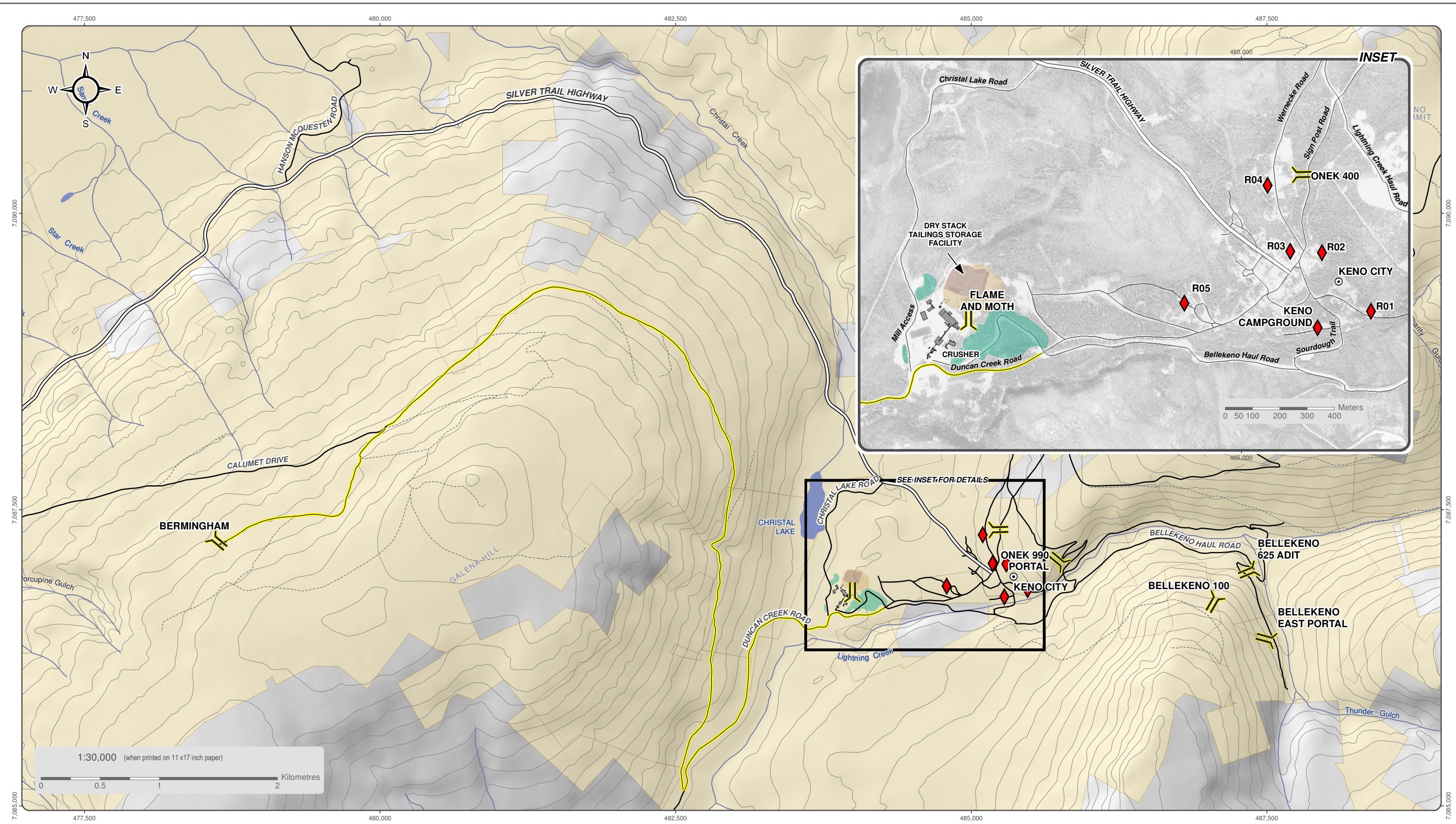
Table 1 Estimated Daily Traffic Count – Bermingham

Vehicle Type – One way traffic count	Travel Direction	Shift Change	Day Shift	Shift Change	Night Shift
		6 am – 8 am	7 am – 7 pm	4 pm- 6 pm	7 am – 7 pm
Light Trucks (< 1 ton) and Autos	Elsa to Mine/Mill	4	12	4	6
Buses	Elsa to Mine/Mill	2		2	
Heavy Trucks (>5 tonne) bulk materials	Elsa to Mine/Mill		3		
Ore Trucks (>20 tonne) hauling ore	Mine to Crusher		8		
Ore Trucks (>20 tonne) hauling tailings or empty	Crusher to Mine		8		
Total round trips per day		6	31	6	6

Notes:

- 1) Warehouse receiving and shopping normally confined to hours between 8 am and 4 pm. This will minimize heavy traffic during shift changes. Normally no heavy truck deliveries on night shift.
- 2) Bulk materials include fuel, reagents, materials, supplies and concentrate haulage.
- 3) Above values are considered typical of daily traffic anticipated during operations. Variations up to 50% are possible on any given day.
- 4) Based on 408 t/d production rate which results in highest ore haulage traffic count.

The Flame & Moth mine will be in operation concurrently with the Bermingham Mine and estimated traffic volumes associated with mining activities at Flame & Moth are shown in Table 2 below. Mine traffic associated with the Flame & Moth mine will use the Christal Lake Road and a short haul road (~175m) to be constructed between the portal and the crusher pad, as shown in Figure 1.



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Satellite imagery obtained from Yukon Geomatics map service <http://mapservices.gov.yk.ca/ArcGIS/services> on September 2017

Datum: NAD 83; Map Projection: UTM Zone 8N

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- ◆ Noise Monitoring Station
- Road from Birmingham to Crusher
- Alexco/ERDC Quartz Claims
- DSTF 322k Tonnes Design
- Current DSTF
- Proposed Features
- Existing Building
- Waterbody
- Watercourse
- Silver Trail Highway
- Other Road
- Limited-Use Road



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FIGURE 1
NOISE SOURCES AND RECEPTORS

SEPTEMBER 2017

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(Last edited by: amafshereva, 22/09/2017 08:26 AM)

Table 2 Estimated Daily Traffic Count – Flame & Moth

Vehicle Type – One way traffic count	Travel Direction	Shift Change	Day Shift	Shift Change	Night Shift
		6 am – 8 am	7 am – 7 pm	4 pm- 6 pm	7 am – 7 pm
Light Trucks (< 1 ton) and Autos	Elsa to Mine/Mill	4	8	4	6
Buses	Elsa to Mine/Mill	2		2	
Heavy Trucks (>5 tonne) bulk materials	Elsa to Mine/Mill		3		
Ore Trucks (>20 tonne) hauling ore	Mine to Crusher		14		
Ore Trucks (>20 tonne) hauling tailings or empty	Crusher to Mine		14		
Total round trips per day		6	44	6	6

Notes:

- 1) Warehouse receiving and shopping normally confined to hours between 8 am and 4 pm. This will minimize heavy traffic during shift changes. Normally no heavy truck deliveries on night shift.
- 2) Bulk materials include fuel, reagents, materials, supplies and concentrate haulage.
- 3) Above values are considered typical of daily traffic anticipated during operations. Variations up to 50% are possible on any given day.
- 4) Based on 408 t/d production rate which results in highest ore haulage traffic count.

3 NOISE RECEPTORS

Five locations were selected in the NIA as being potential noise receptors within the 2 km radius study area around Keno City, listed in Table 3.

Table 3 Representative Locations Assessed in Keno City from the Noise Impact Assessment

Residence	GPS Location	Description
R01	N63.90827 W135.29599	East end Residence, north side of Lightning Creek Road
R02	N63.91019 W135.29968	Residence, east side of Sign Post Road
R03	N63.91023 W135.30205	Town Center, north from the Snack Bar
R04	N63.91239 W135.30376	Residence, west side of Wernecke Road
R05	N63.90851 W135.30993	Residence, about 850m east from the Mill

The background noise levels experienced by these locations vary considerably, depending on location and local activities, currently and proposed mining operations will be in addition to normal fluctuations in background levels. Climate parameters, such as relative humidity, temperature, and temperature inversions impact the sound level and propagation experienced by each of these receptors.

4 ANTICIPATED PROJECT NOISE

The intent of the NIA was to predict the combined noise level of the current and proposed Flame & Moth mining operations at the receptor locations and to determine whether there is likely to be an increase compared to the current noise level.

Research into the human perception of changes in sound level indicates the following (PAAE, 2014a):

- A 3-dB change is just perceptible,

- A 5-dB change is clearly perceptible, and
- A 10-dB change is perceived as being twice or half as loud.

Tables 4 and 5 summarize the results presented within the NIA for daytime and nighttime periods. Results were based on predictive modelling using the noise modelling software package CadnaA developed by Datakustik. The complete set of assumptions, data, and results can be found in the NIA in Appendix A.

Table 4 Summary of Predicted Sound Levels Generated by AKHM Current and Planned Mining Operations including proposed Flame and Moth Mine under Downwind Conditions - Daytime

Residence	Predicted Facility Sound Levels Daytime (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Sound Levels Daytime plus Ambient Sound Levels (dBA)	Predicted Sound Level Increase above the Current Sound Level (dB)
R01	30	30	39	0
R02	30	35	36	0
R03	31	27	32	0
R04	32	34	36	0
R05	31	32	35	1

Table 5 Summary of Predicted Sound Levels Generated by AKHM Current and Planned Mining Operations including proposed Flame and Moth Mine under Downwind Conditions - Nighttime

Residence	Predicted Facility Sound Levels Nighttime (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Sound Levels Nighttime plus Ambient Sound Levels (dBA)	Predicted Sound Level Increase above the Current Sound Level (dB)
R01	22	38	38	0
R02	19	28	29	1
R03	24	26	28	0
R04	27	30	32	1
R05	19	-	-	-

PAAE (2014a) concluded that: “The results of this assessment indicate that the predicted cumulative sound level from the operations of the proposed Flame and Moth mine together with the existing AKHM current operations (i.e., existing Bellekeno Mine and Keno District Mill) and Onek and Lucky Queen operations (planned projects) is expected to have negligible changes in sound level increase at the assessed residences under downwind conditions when compared to the current situation. This assumed all the surface equipment running simultaneously and at full power level at all times.

[...] The most impacted residence is R04, which is also the closest residence to Onek portal site, will have 3-4 dBA increase of sound level based on measured ambient sound pressure level and only a 2 dBA increase based on current sound level.”

Because the Bermingham mine is located at a greater distance from Keno City receptors (6 km) than the Flame and Moth Mine (1.3 km), it is expected that noise effects of mining operations at the Bermingham mine will be of smaller magnitude than those from the activities at the Flame & Moth mine. The NIA concluded that “the

predicted cumulative effects from the different mining operations including the proposed Flame and Moth mine will have negligible effect on the Keno City residences”, therefore a similar conclusion can be reached for the Birmingham mine.

5 NOISE MITIGATION MEASURES

5.1 MITIGATIONS COMMITTED TO BY AKHM

AKHM commits to the following measures that mitigate potential impacts associated with noise:

- Mine traffic will be routed around Keno City via the Keno City Bypass Road, rather than through the community.
- Under normal operating conditions, there will be no ore haulage to/from Onek between the hours of 1900 and 0700.
- The compressor at Onek and Flame and Moth will be housed in a sound dampening enclosure. The vent fan will have inlet and exhaust sound dampeners.
- The cone crushing plant will be covered with a sprung cover structure similar to the fine ore stockpile cover, or similar enclosure.
- To reduce impacts from low frequency noise, the crusher or DSTF packer will not be operated between the hours of 1900 and 0700.
- Limiting use of air-brakes in and around Keno where possible.
- Taking regular sound level measurements at the facility and mining areas to determine if there are any significant changes to sound emanating from the facility.
- Equipping facility related vehicles including heavy and light trucks with appropriate mufflers.
- Advising nearby residents of significant loud activities and schedule these loud events during daytime hours of 7 AM to 5 PM.
- Ensuring all internal combustion engines are fitted with appropriate muffler systems.
- Maintaining a noise control standard when procuring equipment.
- Keeping record of all noise complaint filed by area residents. In the event that a valid noise complaint is received, respond promptly through the completion of a noise complaint investigation.

Additional mitigations could be triggered as a result of a noise complaint investigation, such as:

- A common source of annoyance is 'back-up beeper' warning devices. A broad-band beeper can be used instead of pure-tone devices which have been more common, as these have been found to be effective in reducing potential annoyance.
- Acoustical screening from berms to shield receivers from equipment noise.

6 NOISE MANAGEMENT

Noise management consists of noise monitoring, a Noise Disturbance Notification and Registry process, and a reporting process.

6.1 NOISE MONITORING

6.1.1 Previous Monitoring

For the period from April 2013 to November 2014, a total of 31 monitoring events were carried out. AKHM has monitored noise at the five locations selected in the NIA (R01 to R05 – see Figure 1) as being potential noise receptors within the 2 km radius study area around Keno City. Starting in November 2013, noise has also been monitored at the Keno City campground. All readings were taken using an Extech integrating sound level datalogger model 407780 to measure average dBA over 10 minutes. All results were found to be below 70 dBA, and only occasionally exceeded 50 dBA. Results were however difficult to generalize due to the short sampling period, and interpretation can be confounded by extraneous events contaminating the noise record.

6.1.2 Updated Monitoring Plan

As of December 2014, noise monitoring was converted to 24-hr periods on a monthly basis, using a Casella CEL-63X Sound Level Meter and Casella CEL-495 Microphone (which includes a wind screen for outdoor use). Longer sampling periods were recommended by PAAE (2014), as well as measurement of Leq, percentile noise levels, octave and 1/3 octave band readings recorded. The isolation of contaminated noise sources is facilitated by the use of statistical noise levels in addition to Leq. This instrument also allows for the monitoring of low frequency noise (C-scale), which can now also be considered when assessing noise impacts.

In addition, noise monitoring will also be carried out on site to evaluate occupational exposure of workers.

Additional changes to the monitoring plan include detailed recording of mining intensity and wind conditions at time of noise measurements, and use of weather-proof cases in the event of cold temperatures to maintain the calibration of the meter.

Additionally, AKHM will conduct instantaneous monitoring at specific locations, if it is warranted by a noise complaint.

6.2 NOISE DISTURBANCE NOTIFICATION

In accordance with term and condition #47 of the YESAB Decision Document for project 2011-0315, AKHM provided Keno City residents with a means to formally complain of noise disturbance. AKHM has created a Noise Disturbance Register to track noise disturbance claims. Appendix B presents a Noise Disturbance Notification Form for residents. Copies of the Noise Disturbance Notification Form are available at the Elsa Camp Administration Building, or will be sent to Keno City residents upon request. Residents can request a form by calling (867) 996-2330 or emailing campservice@alexcoresource.com. Forms will be sent to Keno City residents either by direct delivery, email or fax.

Noise disturbance incidents are investigated on a case-by-case basis. Responses to a noise disturbance claim will be based on the nature of the claim and may include (but are not limited to):

- AKHM will record the noise disturbance claim in the Noise Disturbance Register and will notify the complainant that the claim has been recorded.
- If warranted, AKHM personnel will conduct an onsite visit to further investigate the noise disturbance.
- AKHM personnel will attempt to link the identified noise disturbance with a source (a specific event or activity conducted as part of mining or construction), and will determine what measures may be taken to lessen the noise generation.
- If warranted, AKHM will conduct a follow-up visit over the duration of the noise generating event to determine whether the noise levels have been sufficiently decreased.

6.3 REPORTING

Noise monitoring results are summarized and reported on a quarterly basis and provided to Keno City residents, YG Energy Mines and Resources and YG Tourism and Culture Branch. A summary of the noise complaints recorded over the same time period in the Noise Complaint Registry will be included with the monitoring results.

Based on the results of the monitoring and in discussion with the above-listed parties, additional mitigation measures, or adaptive management strategies will be identified and implemented as required.

6.4 EFFECTS MONITORING

Decision Document term and condition #45 stipulates effects monitoring of noise emissions in relation to impacts to local businesses. As detailed in Section 6.1 and 6.3, ongoing noise monitoring within Keno City is carried out and results submitted to stakeholders on a quarterly basis. The proposed noise monitoring stations are located throughout Keno City and in proximity to local businesses, providing sufficient coverage to effectively monitor noise within the community. Furthermore, the Noise Disturbance Notification form includes a field for the complainant to describe any effect on his/her business deriving from a specific noise event. Section 6.2 above describes the measures that will be undertaken to address a noise disturbance claim.

Based on the results of the monitoring and in discussion with the above-listed parties, additional mitigation measures, or adaptive management strategies will be identified and implemented as required.

7 REFERENCES

Patching Associates Acoustical Engineering Ltd. (PAAE). 2014a. Noise Impact Assessment Update, Alexco Keno Hill Mining Corp., Proposed Flame and Moth Mine Project, Yukon Territory. Prepared for Yukon Environmental and Socio-Economic Assessment Board (YESAB), September 23, 2014.

Patching Associates Acoustical Engineering Ltd. (PAAE). 2014b. Review of Report from Access Consulting Group On Behalf of Alexco Resource Corp. Flame and Moth Project And June 12, 2014 Response to YESAB IR, With Review of the Keno Noise Monitoring Document Review - YESAB March 2009. July 10, 2014.

YESAB. 2014. Decision Document. Flame and Moth Development and Production Program. Project number 2013-0161.

APPENDIX A

**NOISE IMPACT ASSESSMENT – KENO HILL SILVER DISTRICT OPERATIONS (PATCHING
ASSOCIATES ACOUSTICAL ENGINEERING, 2014)**



**Noise Impact Assessment
Alexco Keno Hill Mining Corp.
Keno Hill Silver District Operations
Yukon Territory**

Rev 1

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Notice

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Executive Summary

Patching Associates Acoustical Engineering Ltd. was retained by the Yukon Environmental and Socio-Economic Assessment Board (YESAB) to evaluate and predict the noise level from the existing and proposed Alexco Keno Hill Silver District Operations to be located around the Keno City, 354 km north of Whitehorse, Yukon. Alexco Keno Hill Mining Corp (AKHM) currently operates the Bellekeno mine and Keno District Mill, and proposes to strengthen its operation by incorporating production of Lucky Queen and Onek ore deposits in the Keno Hill Silver District.

The study was conducted in order to:

- Assess the sound data of typical equipment that are currently existing and proposed for AKHM mining operations, which include Bellekeno, Lucky Queen, Onek, the mill operations and the associated trucking activity and traffic noise;
- Predict the noise level from the existing and proposed facilities during mining and mill operations at the potentially most affected receiver locations.

The sound power levels emitted from the existing and proposed facilities were determined through the use of field measurements and theoretical calculations. These values were then used to model the installation and the surrounding area to determine the expected noise level at the Keno City residences and nearby area. The modeling was performed using the CadnaA noise-modeling package.

The following tables summarise the predicted noise levels based on the daytime and nighttime normal operations of the project in the Keno City district mining area.

Summary of Predicted Noise Levels Generated by AKHM Current Mining Operations under Downwind Conditions (Daytime)

Residence	Predicted Facility Noise Levels Day-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Day-Time plus Ambient Sound Levels (dBA)
R01	29	39	39
R02	30	35	36
R03	30	27	32
R04	31	34	36
R05	31	32	34

Summary of Predicted Noise Levels Generated by AKHM Current Mining Operations under Downwind Conditions (Nighttime)

Residence	Predicted Facility Noise Levels Night-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Night-Time plus Ambient Sound Levels (dBA)
R01	19	38	38
R02	15	28	28
R03	23	26	28
R04	24	30	31
R05	13	--	--



Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Daytime)

--(Onek Sign Post Portal Option and Proposed North Bypass Road)

Residence	Predicted Facility Noise Levels Day-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Day-Time plus Ambient Sound Levels (dBA)
R01	29	39	39 (0)*
R02	30	35	36 (0)
R03	32	27	33 (1)
R04	35	34	38 (2)
R05	32	32	35 (1)

* The number in bracket is the predicted noise level increase based on current noise level

Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Nighttime)

--(Onek Sign Post Portal Option and Proposed North Bypass Road)

Residence	Predicted Facility Noise Levels Night-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Night-Time plus Ambient Sound Levels (dBA)
R01	20	38	38 (0)
R02	17	28	28 (0)
R03	25	26	28 (0)
R04	30	30	33 (2)
R05	23	--	--

* The number in bracket is the predicted noise level increase based on current noise level

Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Daytime)

--(Onek 990 Portal Option and Proposed Keno City Bypass Road)

Residence	Predicted Facility Noise Levels Day-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Day-Time plus Ambient Sound Levels (dBA)
R01	30	39	39 (0)*
R02	30	35	36 (0)
R03	31	27	32 (0)
R04	32	34	36 (0)
R05	31	32	35 (1)

* The number in bracket is the predicted noise level increase based on current noise level



Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Nighttime)

--(Onek 990 Portal Option and Proposed Keno City Bypass Road)

Residence	Predicted Facility Noise Levels Night-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Night-Time plus Ambient Sound Levels (dBA)
R01	21	38	38 (0)
R02	18	28	28 (0)
R03	24	26	28 (0)
R04	27	30	32 (1)
R05	19	--	--

* The number in bracket is the predicted noise level increase based on current noise level

The results of this assessment indicate that the AKHM current with proposed future mining and mill operations is expected to have minor noise level increase under downwind conditions compared with current situation. This assumed all of the equipment running simultaneously and proposed noise control measures AKHM will implement in the Onek Sign Post portal site. Both the current and future mining operations will have only minor noise impacts on the Keno City residences. The most impacted residence assessed R04, which is also the closest residence to Onek portal site, will have 3-4 dBA increase of sound level based on measured ambient sound pressure level and 2 dBA increase based on current noise level. The total noise level with the current and /or future facility is low.

The proposed Onek 990 portal and Keno City bypass road will have less noise emission and almost the same noise emission with or without the surface transfer from 990 portal site to the mill.



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Introduction and Scope-of-Work

Patching Associates Acoustical Engineering Ltd. was retained by the Yukon Environmental and Socio-Economic Assessment Board to evaluate and predict the noise level from the existing and proposed Alexco Keno Hill Silver District Operations to be located around the Keno City, 354 km north of Whitehorse, Yukon. Alexco Keno Hill Mining Corp (AKHM) currently operates the Bellekeno mine and Keno District Mill and proposes to strengthen its operation by incorporating production of Lucky Queen and Onek ore deposits in the Keno Hill Silver District.

The study was conducted in order to:

- Assess the sound data of typical equipment that are currently existing and proposed for AKHM mining operations, which include Bellekeno, Lucky Queen, Onek, the mill operations and the associated trucking activity and traffic noise;
- Predict the noise level from the existing and proposed facilities during mining and mill operations at the potentially most affected receiver locations.

Noise Criteria

Relative noise Level Increase

A variety of sources in natural, industrial, and community settings generate sound/noise. In general, noise is defined as unwanted sound. Hearing damage is the most serious effect of noise, but the nuisance of particular sound characteristics may diminish the quality of life for those affected by the noise.

Research into the human perception of changes in sound level indicates the following:

- A 3-dB change is just perceptible,
- A 5-dB change is clearly perceptible, and
- A 10-dB change is perceived as being twice or half as loud.

A doubling or halving of acoustic energy will change the resulting sound level by 3 dB, which corresponds to a change that is just perceptible. In practice, this means that a doubling of traffic volume on a roadway, doubling the number of people in a stadium, or doubling the number of wind turbines in a wind farm will, as a general rule, only result in a 3 dB, or just perceptible, increase in noise.

In order to facilitate design and discuss the potential impact for this project and in recognition of the suburban (semirural) nature of the immediate area near the existing and proposed mining operation, all the typical equipment for the current and future mining operations need to be considered, which include Bellekeno, Lucky Queen, Onek, the mill operations and the associated trucking activity and traffic noise. The sound level increase from current mining operations will be quantified to evaluate



the noise impact to the Keno City residents. The total sound level experienced in the Keno City residential area will be mining facility level combined with measured ambient noise level. The future mining operations should not cause significant noise level increase.

Transient vs. Continuous Noise (L_{eq} average)

The Sound Level is a L_{eq} value, which is the equivalent-continuous sound level. This index is an energy average of the varying sound levels over a specified period. The use of this index permits the description of a varying sound level environment as a single number. As the L_{eq} is an “average” level, the measured sound level may exceed the criterion level for a short period, provided that the duration is limited. Transient factors such as equipment start-ups, shut-downs, back-up beeping or unstable environmental propagation may cause the sound level to fluctuate and potentially exceed the criterion level for short periods. The L_{eq} value considers both the sound level and the length of time that the sound level occurs and higher level periods are acceptable as long as the duration is short. All of the sound levels discussed in this study are L_{eq} sound levels and the values presented and the “average” sound level a receiver would experience from day to day, night to night, and month to month. Appendix A provides a detailed explanation of the L_{eq} index.

Project Study Area

The project study area is located around Keno City, 354 km north of Whitehorse, Yukon. The terrain cover around the facility is mainly forested. Alexco Keno Hill Mining Corp (AKHM) currently operates the Bellekeno mine and Keno District Mill and proposes to strengthen its operation by incorporating production of two new (Lucky Queen and Onek) ore deposits in the Keno Hill Silver District. These mining operations are located around the Keno City residential area. There is Lightning Creek running along the south side of the Keno City.

This study assesses the noise levels of the current and future facility at five receivers representing potential noise sensitive areas in the Keno City residential area, which are listed in table 1.

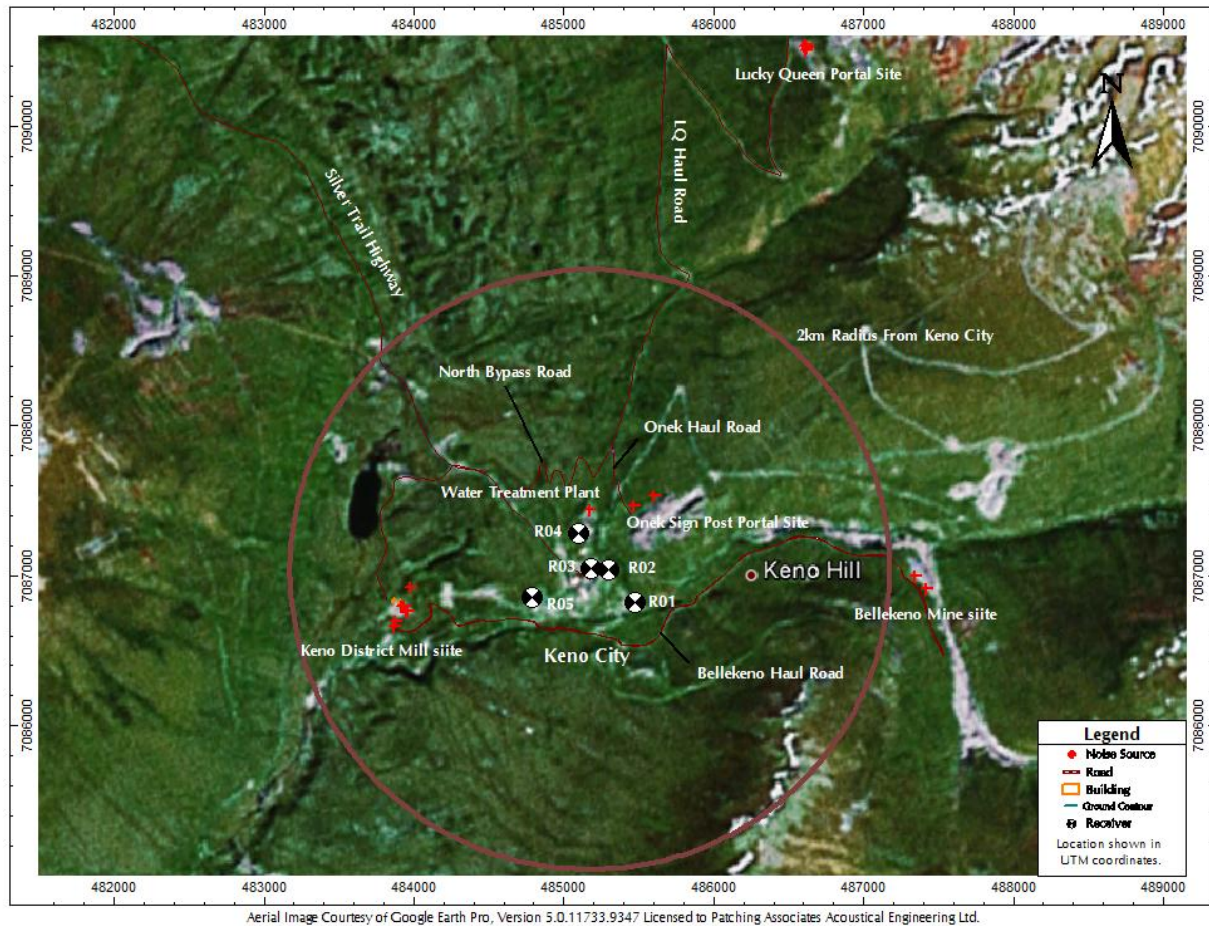
Table 1 – Representative Residence Locations Assessed in the Keno City

Residence	GPS Location	Description
R01	N63.90827 W135.29599	East end Residence, north side of Lightning Creek Road
R02	N63.91019 W135.29968	Residence, east side of Sign Post Road
R03	N63.91023 W135.30205	Town Center, north from the Snack Bar
R04	N63.91239 W135.30376	Residence, west side of Wernecke Road, closest to the proposed Onek Sign Post portal location
R05	N63.90851 W135.30993	Residence, about 850m east from the Mill

Figure 1 presents an overview of the project study area.



Figure 1: Overview of the project study area.



Current and Proposed Major Operations

The existing and proposed AKHM mining operations include three major operations, which are existing and proposed mine site operations, mill site operation, and transportation along haul roads. The facility equipment details are shown in Table 2.



Table 2: Major Equipment Details

Equipment Description	Equipment Details
Existing and proposed Bellekeno Mine Site Facility and transportation	<ul style="list-style-type: none"> • Existing Sullair LS-25S compressor unit • Existing fresh Air Intake • Currently Total 44 round trips along Bellekeno haul road daytime (0700-1900), 30kph, which include 22 light trucks and 22 heavy trucks (ore trucks, heavy trucks and buses), no transportation nighttime • Future Proposed Total 62 round trips daytime, 30kph, which include 22 light trucks and 40 heavy trucks (ore trucks, heavy trucks and buses),no transportation nighttime • Noise emission from the light truck and heavy truck assumed equal to current light truck and haul truck, measured by PAAE staff between June 25th and 29th ,2012
Existing and Proposed Mill site Operation	<ul style="list-style-type: none"> • Crusher, full load operation, currently running every other day, daytime operation • Cat 930G front-end Loader Loading rock for crusher, daytime operation • Mill Building, Internal equipment running day and night • Dry stack tailings facility (DSTF) area (one Packer Cat CS543E and one Backhoe daytime operation) • Noise emission from the above equipment measured by PAAE staff between June 25th and 29th ,2012
Existing and Proposed Lucky Queen Portal Facility and Transportation	<ul style="list-style-type: none"> • Existing 500 kW Cummins genset • Existing Gardner-Denver D800 compressor unit • Existing fresh air intake • Noise emission from the above equipment measured by PAAE staff between June 25th and 29th ,2012 • Proposed Cat 930G front-end Loader, 40% usage, daytime operation • Proposed Tandem axle dump truck (12 yard truck) , 40% usage, daytime operation • Proposed 15-ton underground haul truck, 40% usage, daytime operation • Total 27 Round trips daytime, 40 kph, which include 6 light trucks and 21 heavy trucks (ore trucks, heavy trucks and buses), no transportation nighttime. The route will follow Wernecke road and proposed updated north bypass road.



Table 2 (Cont.): Major Equipment Details

Equipment Description	Equipment Details
<p>Proposed Onek Facility and Transportation – Sign Post Portal</p>	<ul style="list-style-type: none"> • Proposed 200 Hp electric driven Ingersoll Rand R150IU rotary screw compressor, housed in sound dampening enclosure, assumed open area less than 1.5% • Proposed ventilation fan, 30 Hp, 36” Diameter, assumed 1274rpm, less than 12000 fpm tip speed. There will be inlet and exhaust sound dampeners, will decrease noise by about 10 dBA • Proposed Cat 930G front-end Loader, 40% acoustical usage, daytime operation • Proposed Tandem axle dump truck (12 yard truck) , 40% acoustical usage, daytime operation • Proposed 15-ton underground haul truck, 40% acoustical usage, daytime operation • Total 37 Round trips daytime, 40 kph, which include 6 light trucks and 31 heavy trucks (ore trucks, heavy trucks and buses), no transportation nighttime • A 80m long x 4m high x 5m wide sound berm will be constructed along the west side of Sign Post Portal Pad to deflect noise, or an equivalent sound curtain will be installed. The route will cross the Sign Post Road and Wernecke Road, and follow the proposed updated north bypass road.
<p>Proposed Water Treatment Plant</p>	<ul style="list-style-type: none"> • 5Hp water pump, assumed 3600 RPM • 3 Hp compressor, assumed 1800 RPM • Both equipment run continuously, housed in insulated sea cans, assumed open area less than 1.5%.
<p>Proposed Onek Facility and Surface Transportation –990 Portal</p>	<ul style="list-style-type: none"> • Proposed compressor, ventilation fan, Cat 930G front-end Loader, Tandem axle dump truck (12 yard truck) , 15-ton underground haul truck, keep the same running situation as Sign Post portal option. • Total 37 Round trips daytime, 40 kph, which include 6 light trucks and 31 heavy trucks (ore trucks, heavy trucks and buses), no transportation nighttime • The haul route will be developed from Onek 990 Portal, crossing Lightning Creek Road and the Onek Access Bridge across Lightning Creek to the Bellekeno Haul Road.



Table 2 (Cont.): Major Equipment Details (990 Portal Option)

Equipment Description	Equipment Details
Proposed Onek Facility and Underground Transportation –990 Portal	<ul style="list-style-type: none">• Proposed compressor, ventilation fan, Cat 930G front-end Loader, Tandem axle dump truck (12 yard truck) , 15-ton underground haul truck, keep the same running situation as Sign Post portal option.• Total 37 Round trips daytime, 40 kph, which include 6 light trucks and 31 heavy trucks (ore trucks, heavy trucks and buses), no transportation nighttime• Ore haul trucks will transport ore directly from underground to mill (no surface ore transfer)

Proposed Operations Schedule

AKHM will run the mining and mill operations with the equipment shown in table 1. There will be no loader and truck operation at the portal site and no transportation during the nighttime (1900-0700).

The background noise levels for the Keno City residential area will vary considerably depending on location and local activities. Mining project operations will be in addition to the normal fluctuations in background noise levels. Relative humidity, temperature, temperature inversions, the number and varied noise sources are some of the factors that affect sound level and sound propagation.

Method

The distance to the residences and facility physical layout information were obtained from the YESAB, satellite photos and field reconnaissance performed by Patching Associates Acoustical Engineering Ltd. staff. Sound power levels were determined for all of the major noise sources at the existing and proposed facility. Sound propagation calculations were then undertaken to determine the sound pressure level that will exist at the most impacted residences from the mining and mill facility. All calculations were undertaken in octave bands.

The octave band sound power level for each source that will exist at the facility was obtained or calculated field measurements, from manufacturer’s data, acoustical reference literature or previous studies. The results of the sound propagation calculations were compared to the recommended permissible sound level to determine if the current and future facility will cause higher noise level to the Keno City residential area.



Sound Power Level Calculations

Octave band sound power levels were calculated for all of the major noise sources that are present at the current and future facility. These octave band sound power levels and the source of the data are presented in Table 3.

Table 3 – Source Octave Band Sound Power Levels

Source Description	Data Source	Linear Octave Band Centre Frequency (dB, ref 1 pW)									Total (dBA)	Total (dBC)
		31.5	63	125	250	500	1k	2k	4k	8k		
Bellekeno Mine Fresh Air Intake	Field Measurements	86	92	98	103	110	110	102	97	83	112	114
Mill Crusher in full operation	Field Measurements	118	113	111	110	110	107	105	98	89	112	120
Lucky Queen Portal Genset Exhaust	Field Measurements	107	113	118	112	112	105	101	87	71	112	120
Lucky Queen Portal Genset wall	Field Measurements	109	114	119	114	108	103	99	90	87	110	121
Lucky Queen Portal Genset Open Door	Field Measurements	107	107	111	111	107	105	103	95	86	110	116
Mill DSTF Track Excavator	Field Measurements	131	108	116	107	105	105	95	96	88	109	128
Lucky Queen Portal Genset Exhaust Muffler	Field Measurements	104	106	111	110	109	100	98	86	71	109	116
Bellekeno Mine Compressor Unit	Field Measurements	90	90	105	107	105	105	98	90	83	108	112
Lucky Queen Portal Air Inlet	Field Measurements	79	94	87	92	103	104	101	95	85	108	108
Lucky Queen Portal Genset Air Outlet	Field Measurements	96	102	108	107	104	102	100	92	83	107	112
Lucky Queen Portal Compressor Wall	Field Measurements	98	107	106	105	102	99	101	93	87	106	112



Table 3 (Cont.) – Source Octave Band Sound Power Levels

Source Description	Data Source	Linear Octave Band Centre Frequency (dB, ref 1 pW)									Total (dBA)	Total (dBC)
		31.5	63	125	250	500	1k	2k	4k	8k		
Lucky Queen Portal Compressor Open Door	Field Measurements	86	97	93	96	94	98	99	93	88	103	104
Mill DSTF Packer	Field Measurements	129	113	105	100	100	99	95	87	81	103	126
Lucky Queen Portal Gen doors closed	Field Measurements	95	106	110	103	99	96	93	88	80	102	112
Bellekeno Haul Volvo Truck	Field Measurements	103	101	99	100	96	95	93	87	80	100	107
Mill Cat 930G Wheel Loader	Field Measurements	106	110	99	92	95	98	91	79	8	100	111
Mill Building wall	Field Measurements	111	111	104	98	93	94	5	5	5	97	113
Onek Comp Bldg. Open Area (Doors Closed)	Theoretical	85	83	87	87	89	90	91	87	80	96	97
Onek Portal Haul Truck	Field Measurements	99	97	95	96	92	91	89	83	76	96	103
Onek Dump Truck	Field Measurements	99	97	95	96	92	91	89	83	76	96	103
LQ Portal Haul Truck	Field Measurements	99	97	95	96	92	91	89	83	76	96	103
LQ Dump Truck	Field Measurements	99	97	95	96	92	91	89	83	76	96	103
Onek Fan Package	Theoretical	101	102	101	98	93	90	83	79	73	96	106
Onek Cat 930G Wheel Loader	Field Measurements	102	106	95	88	91	94	87	75	4	96	107
LQ Cat 930G Wheel Loader	Field Measurements	102	106	95	88	91	94	87	75	4	96	107
Mill Air Bag Exhaust	Field Measurements	91	98	88	88	89	88	88	89	88	95	100
Mill South Open Door	Field Measurements	96	92	86	82	81	85	83	82	76	90	97
Mill Bldg Open Doors	Field Measurements	94	87	84	83	83	81	84	82	73	89	94
Onek Comp Bldg. Wall	Field Measurements	103	95	93	90	90	77	77	67	59	89	102
Light truck	Field Measurements	92	92	91	87	84	81	80	70	5	87	96
East End Bldg	Field Measurements	104	97	89	84	84	79	74	5	5	85	102
Mill Bldg Louvers	Field Measurements	85	84	81	80	76	77	76	72	65	82	89



Table 3 (Cont.) – Source Octave Band Sound Power Levels

Source Description	Data Source	Linear Octave Band Centre Frequency (dB, ref 1 pW)									Total (dBA)	Total (dBC)
		31.5	63	125	250	500	1k	2k	4k	8k		
WTP Facility Bldg. Open Area (Doors Closed)	Theoretical	68	66	70	71	72	73	74	70	63	79	80
WTP Facility Bldg. Wall	Theoretical	86	79	76	73	72	60	60	49	42	72	85
Bellekeno Proposed Total Daytime (12h),1m	Field Measurements/ Theoretical	52	50	49	49	45	44	42	36	28	49	56
Onek Proposed Total Daytime (12h),1m	Field Measurements/ Theoretical	50	49	47	48	43	42	40	35	27	47	54
Bellekeno Current Total Daytime (12h),1m	Field Measurements/ Theoretical	50	48	47	46	42	41	39	34	26	46	54
LQ Proposed Total Daytime (12h),1m	Field Measurements/ Theoretical	48	47	45	46	42	41	39	33	26	46	53

Sound Propagation Calculations

The sound propagation calculations were undertaken using the noise modeling software package CadnaA by Datakustik. CadnaA bases its calculation algorithms on ISO 9613 and the ground cover was modeled as mixed ground between the operations and residential areas, with consideration of some deciduous trees in the area. Octave-band sound power level information was used for the major noise sources for the proposed project. The frequency dependency of sound propagation calculations such as ground absorption, air absorption and elevation relative to the sound source, and barrier effects are considered in the model. The weather condition modeled was 10° C temperature and 80% relative humidity; the temperature and humidity values are conditions with a minimum value of air absorption, and so constitute a “worst case” condition. The CadnaA model calculates the contribution level of each noise source at each receiver location in octave bands as well as the overall dBA level.



Modeling Results

The objective of this study was to predict the noise level from the existing and proposed mining and mill operations at the potentially most affected receiver locations. The predictions based on the CadnaA model for this facility are summarized in Tables 4-9 along with the PSL.

Table 4 - Summary of Predicted Noise Levels Generated by AKHM Current Mining Operations under Downwind Conditions (Daytime)

Residence	Predicted Facility Noise Levels Day-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Day-Time plus Ambient Sound Levels (dBA)
R01	29	39	39
R02	30	35	36
R03	30	27	32
R04	31	34	36
R05	31	32	34

Table 5 - Summary of Predicted Noise Levels Generated by AKHM Current Mining Operations under Downwind Conditions (Nighttime)

Residence	Predicted Facility Noise Levels Night-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Night-Time plus Ambient Sound Levels (dBA)
R01	19	38	38
R02	15	28	28
R03	23	26	28
R04	24	30	31
R05	13	--	--

Table 6 - Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Daytime)

--(Onek Sign Post Portal Option and Proposed North Bypass Road)

Residence	Predicted Facility Noise Levels Day-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Day-Time plus Ambient Sound Levels (dBA)
R01	29	39	39 (0)*
R02	30	35	36 (0)
R03	32	27	33 (1)
R04	35	34	38 (2)
R05	32	32	35 (1)

* The number in bracket is the predicted noise level increase based on current noise level



Table 7 - Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Nighttime)

--(Onek Sign Post Portal Option and Proposed North Bypass Road)

Residence	Predicted Facility Noise Levels Night-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Night-Time plus Ambient Sound Levels (dBA)
R01	20	38	38 (0)
R02	17	28	28 (0)
R03	25	26	28 (0)
R04	30	30	33 (2)
R05	23	--	--

* The number in bracket is the predicted noise level increase based on current noise level

Table 8 - Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Daytime)

--(Onek 990 Portal Option and Proposed Keno City Bypass Road)

Residence	Predicted Facility Noise Levels Day-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Day-Time plus Ambient Sound Levels (dBA)
R01	30	39	39 (0)*
R02	30	35	36 (0)
R03	31	27	32 (0)
R04	32	34	36 (0)
R05	31	32	35 (1)

* The number in bracket is the predicted noise level increase based on current noise level

Table 9 - Summary of Predicted Noise Levels Generated by AKHM Current and Proposed Mining Operations under Downwind Conditions (Nighttime)

--(Onek 990 Portal Option and Proposed Keno City Bypass Road)

Residence	Predicted Facility Noise Levels Night-Time (dBA)	Measured Ambient Sound Levels (dBA)	Predicted Noise Levels Night-Time plus Ambient Sound Levels (dBA)
R01	21	38	38 (0)
R02	18	28	28 (0)
R03	24	26	28 (0)
R04	27	30	32 (1)
R05	19	--	--

* The number in bracket is the predicted noise level increase based on current noise level

The results of this assessment indicate that the AKHM existing and proposed facilities during mining and mill operations is expected to have minor noise level increase under downwind conditions. This assumed the equipment running simultaneously and proposed noise control measures AKHM will implement in the Onek Sign Post portal site. Both the current and future



mining operations will have only minor noise impacts on the Keno City residences. The most impacted residence assessed, R4, which is also the closest residence to Onek portal site, will have 3-4 dBA increase of sound level based on measured ambient sound pressure level and 2 dBA increase based on current noise level. The total noise level with the current and /or future facility is low.

The proposed Onek 990 portal and Keno City bypass road will have less noise emission and almost the same noise emission with or without the surface transfer from 990 portal site to the mill.

During the field diagnosis study on the mill facility, the working Cat 930G Wheel Loader, STF Packer and DSTF Track Excavator were fitted with back up beepers, which contribute a high frequency noise signal. Even though the beeper noise didn't cause annoyance for the community due to the short duration of the beeper's signals and the significant distance from the residential area, considering that more similar equipment will be used on Lucky Queen and Onek mining operation, broadband alarms are recommended to be an effective option to reduce potential noise complaints from the community.

Figures 2 and 7 show the predicted sound levels for the area during mining and mill operations. The labeled sound levels are the predicted sound levels from only the facility (ambient sound level is not included). The scales on the figures are the Universal Transverse Mercator (UTM) coordinates in zone 11U.



Figure 2 – Predicted Existing Daytime Facility Sound Contours

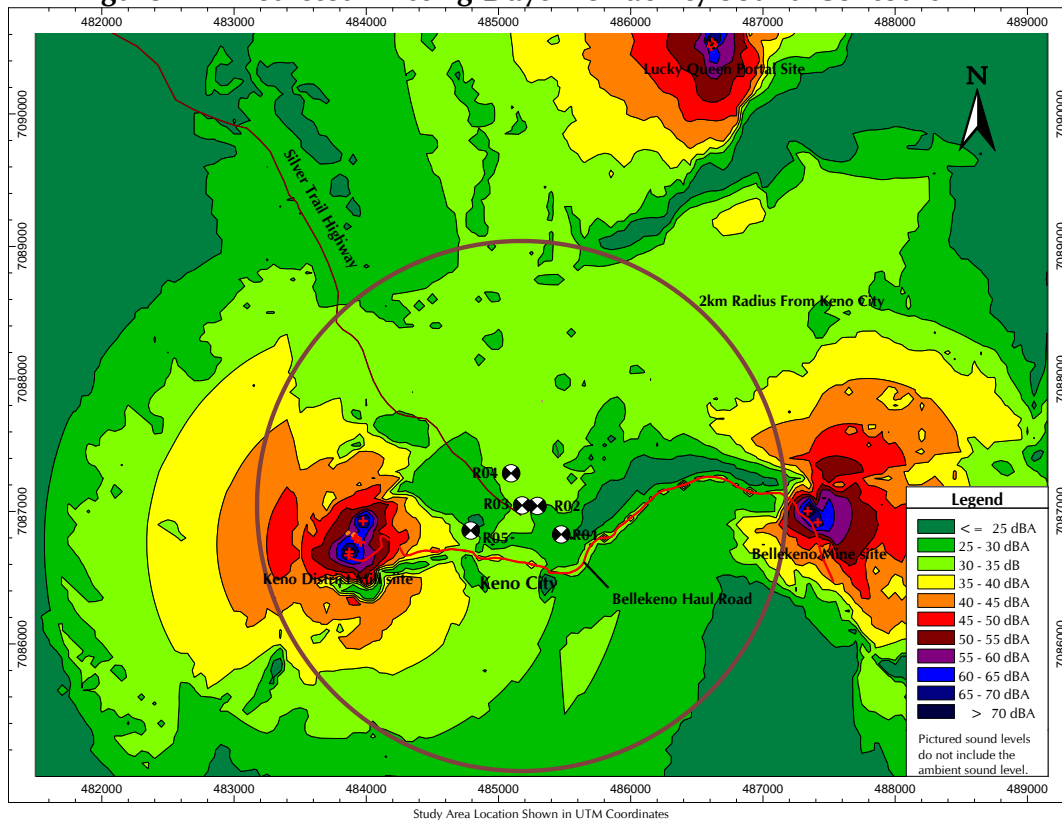


Figure 3 – Predicted Existing Nighttime Facility Sound Contours

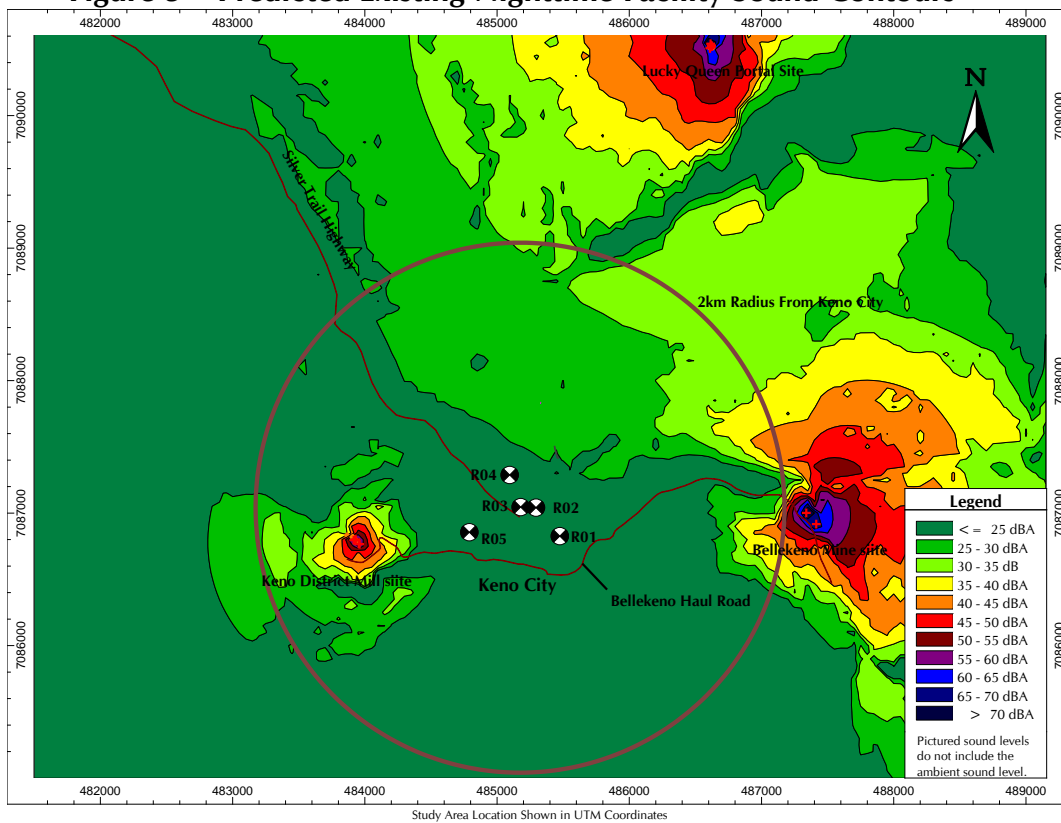




Figure 4 – Predicted Existing and Proposed Daytime Facility Sound Contours
–(Onek Sign Post Portal Option and Proposed North Bypass Road)

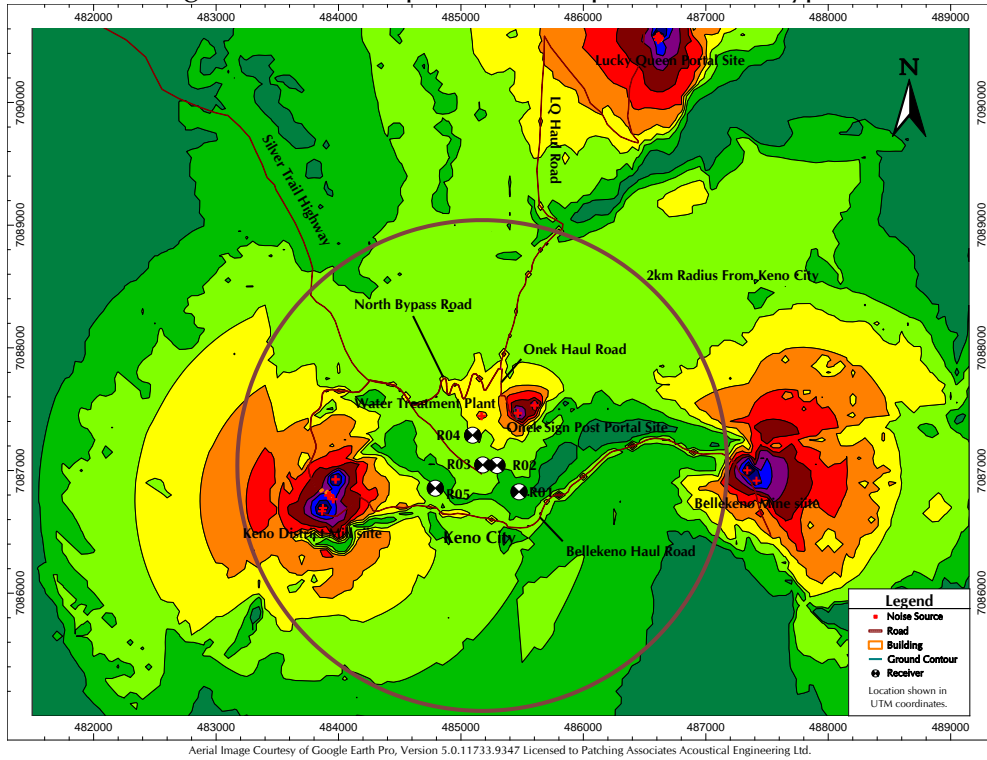


Figure 5 – Predicted Existing and Proposed Nighttime Facility Sound Contours
–(Onek Sign Post Portal Option and Proposed North Bypass Road)

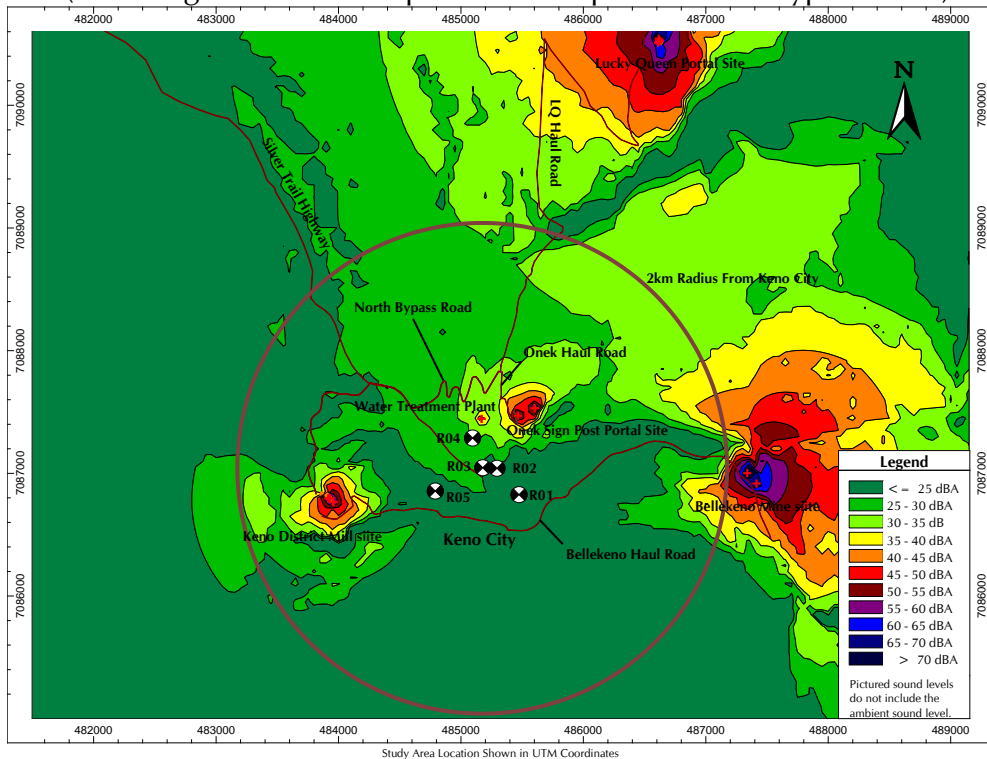




Figure 6 – Predicted Existing and Proposed Daytime Facility Sound Contours
--(Onek 990 Portal Option and Proposed Keno City Bypass Road)

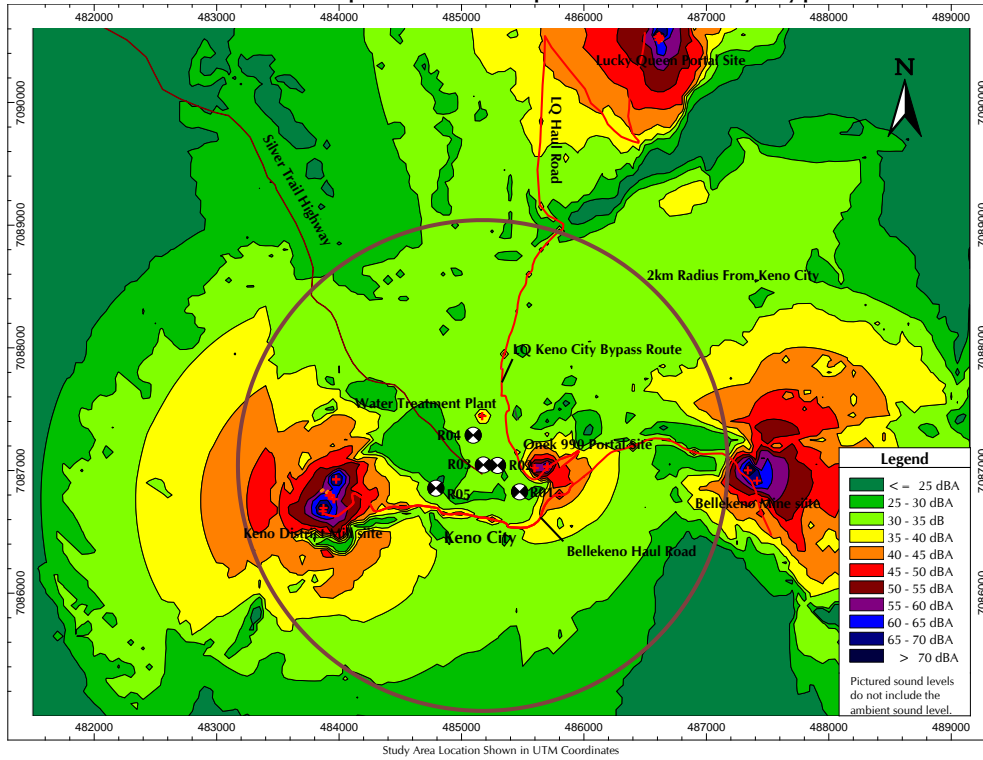
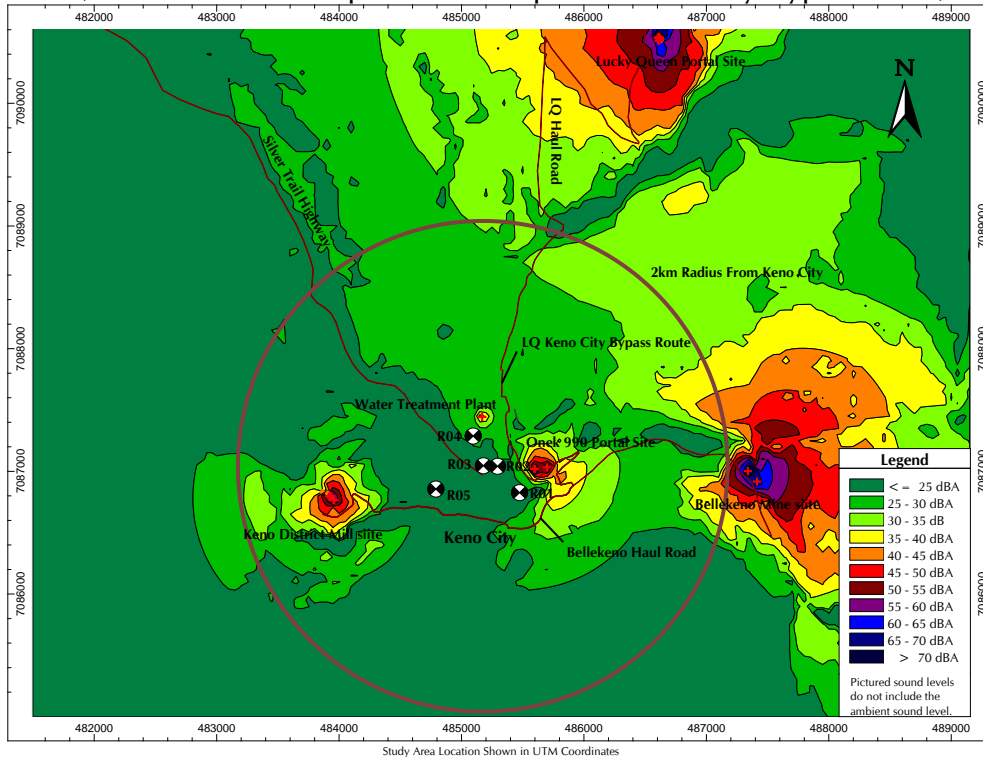


Figure 7 – Predicted Existing and Proposed Nighttime Facility Sound Contours
--(Onek 990 Portal Option and Proposed Keno City Bypass Road)





Source Order Rankings

Based on the CadnaA model, the sound sources can be ranked by the sound levels at the receivers. The source order ranking for the daytime and nighttime scenarios are shown in Tables 10 and 13 for conditions with a wind from the operational areas to the most impacted residence from the current and proposed facility, which is residence R04 located about 384 meters from the proposed Onek Sign Post Portal facility.

Table 8 – Source Order Ranking for Current and Proposed Mining and Mill Operations

– Onek Sign Post Portal, Receiver R04, Downwind Condition (Daytime)

Source	Levels (dBA)
Crusher in full operation	29
Onek Cat 930G Wheel Loader	26
Onek Portal Haul Truck	26
Onek Dump Truck	26
Onek Fan Package	26
Mill DSTF Track Excavator	25
WTP Facility Bldg. Open Area (Doors Closed)	22
Onek Comp Bldg. Open Area (Doors Closed)	21
Lucky Queen Portal Genset Exhaust	19
Mill DSTF Packer	18
Lucky Queen Portal Gen wall	18
Onek Comp Bldg. Wall	17
Mill Cat 930G Wheel Loader	16
Lucky Queen Portal Genset Exhaust Muffler	15
Lucky Queen Portal Genset Air Outlet	14
WTP Facility Bldg. Wall	14
Mill Building wall	13
Lucky Queen Portal Air Inlet	12
Onek Sign Post Haul Route	9
Lucky Queen Portal Gen doors closed	9
LQ Haul Route	8
Lucky Queen Portal Compressor Wall	7
Bellekeno Haul Road	6
Mill Air Bag Exhaust	5
Mill East End Bldg	0
Lucky Queen Portal Genset Open Door	0
LQ Portal Haul Truck	0
LQ Dump Truck	0
LQ Cat 930G Wheel Loader	-1
Lucky Queen Portal Compressor Open Door	-1
Bellekeno Mine Fresh Air Intake	-1
Bellekeno Mine Compressor Unit	-1
Mill Bldg Open Doors	-4
Mill Bldg Louvers	-9
Mill South Open Door	-15
Total Facility Sound Level	35
Average Ambient Level	34
Total Facility Plus Ambient	38



Table 9 – Source Order Ranking for Current and Proposed Mining and Mill Operations
 – Onek Sign Post Portal, Receiver R04, Downwind Condition (Nighttime)

Source	Levels (dBA)
Onek Fan Package	26
WTP Facility Bldg. Open Area (Doors Closed)	22
Onek Comp Bldg. Open Area (Doors Closed)	21
Lucky Queen Portal Genset Exhaust	19
Lucky Queen Portal Gen wall	18
Onek Comp Bldg. Wall	17
Lucky Queen Portal Genset Exhaust Muffler	15
Lucky Queen Portal Genset Air Outlet	14
WTP Facility Bldg. Wall	14
Mill Building wall	13
Lucky Queen Portal Air Inlet	12
Lucky Queen Portal Gen doors closed	9
Lucky Queen Portal Compressor Wall	7
Mill Air Bag Exhaust	5
Mill East End Bldg	0
Lucky Queen Portal Genset Open Door	0
Lucky Queen Portal Compressor Open Door	-1
Bellekeno Mine Fresh Air Intake	-1
Bellekeno Mine Compressor Unit	-1
Mill Bldg Open Doors	-4
Mill Bldg Louvers	-9
Mill South Open Door	-15
Total Facility Sound Level	30
Average Ambient Level	30
Total Facility Plus Ambient	33



Table 10 – Source Order Ranking for Current and Proposed Mining and Mill Operations

– Onek 990 Portal, Receiver R04, Downwind Condition (Daytime)

Source	Levels (dBA)
Crusher in full operation	29
Mill DSTF Track Excavator	25
WTP Facility Bldg. Open Area (Doors Closed)	22
Lucky Queen Portal Genset Exhaust	19
Mill DSTF Packer	18
Lucky Queen Portal Gen wall	18
Mill Cat 930G Wheel Loader	16
Lucky Queen Portal Genset Exhaust Muffler	15
Lucky Queen Portal Genset Air Outlet	14
Onek Comp Bldg. Wall	14
WTP Facility Bldg. Wall	14
Mill Building wall	13
Lucky Queen Portal Air Inlet	12
Onek Comp Bldg. Open Area (Doors Closed)	11
LQ Keno City Bypass Route	11
Lucky Queen Portal Gen doors closed	9
Lucky Queen Portal Compressor Wall	7
Bellekeno Haul Road	6
Mill Air Bag Exhaust	5
Onek 990 Route	5
Onek Fan Package	4
Onek Cat 930G Wheel Loader	3
Onek Portal Haul Truck	3
Onek Dump Truck	3
Mill East End Bldg	0
Lucky Queen Portal Genset Open Door	0
LQ Portal Haul Truck	0
LQ Dump Truck	0
LQ Cat 930G Wheel Loader	-1
Lucky Queen Portal Compressor Open Door	-1
Bellekeno Mine Fresh Air Intake	-1
Bellekeno Mine Compressor Unit	-1
Mill Bldg Open Doors	-4
Mill Bldg Louvers	-9
Mill South Open Door	-15
Total Facility Sound Level	32
Average Ambient Level	34
Total Facility Plus Ambient	36



Table 11 – Source Order Ranking for Current and Proposed Mining and Mill Operations

– Onek 990 Portal, Receiver R04, Downwind Condition (Nighttime)

Source	Levels (dBA)
WTP Facility Bldg. Open Area (Doors Closed)	22
Lucky Queen Portal Genset Exhaust	19
Lucky Queen Portal Gen wall	18
Lucky Queen Portal Genset Exhaust Muffler	15
Lucky Queen Portal Genset Air Outlet	14
Onek Comp Bldg. Wall	14
WTP Facility Bldg. Wall	14
Mill Building wall	13
Lucky Queen Portal Air Inlet	12
Onek Comp Bldg. Open Area (Doors Closed)	11
Lucky Queen Portal Gen doors closed	9
Lucky Queen Portal Compressor Wall	7
Mill Air Bag Exhaust	5
Onek Fan Package	4
Mill East End Bldg	0
Lucky Queen Portal Genset Open Door	0
Lucky Queen Portal Compressor Open Door	-1
Bellekeno Mine Fresh Air Intake	-1
Bellekeno Mine Compressor Unit	-1
Mill Bldg Open Doors	-4
Mill Bldg Louvers	-9
Mill South Open Door	-15
Total Facility Sound Level	27
Average Ambient Level	30
Total Facility Plus Ambient	32



Conclusion

The results of this assessment indicate that the AKHM current with proposed future mining and mill operations is expected to have minor noise level increase under downwind conditions compared with current situation. This assumed all of the equipment running simultaneously and proposed noise control measures AKHM will implement in the Onek Sign Post portal site. Both the current and future mining operations will have only minor noise impacts on the Keno City residences. The most impacted residence assessed R04, which is also the closest residence to Onek portal site, will have 3-4 dBA increase of sound level based on measured ambient sound pressure level and 2 dBA increase based on current noise level. The total noise level with the current and /or future facility is low.

The proposed Onek 990 portal and Keno City bypass road will have less noise emission and almost the same noise emission with or without the surface transfer from 990 portal site to the mill.



APPENDIX A

Explanation of Technical Details Regarding Sound Measurement and Analysis



Technical Details

Sound is the phenomena of vibrations transmitted through air, or other medium such as water or a building structure. The range of pressure amplitudes, intensities, and frequencies of the sound energy is very wide, and many specialized fields have developed using different ranges of these variables, such as room acoustics and medical ultrasound.

Due to the wide range of intensities, which are perceived as sound, standard engineering units become inconvenient. Sound levels are commonly measured on a logarithmic scale, with the level (in decibels, or dB) being proportional to ten times the common logarithm of the sound energy or intensity. Normal human hearing covers a range of about twelve to fourteen orders of magnitude in energy, from the threshold of hearing to the threshold of pain. On the decibel scale, the threshold of hearing is set as zero, written as 0 dB, while the threshold of pain varies between 120 to 140 dB. The most usual measure of sound is the sound pressure level (SPL), with 0 dB SPL set at 2.0×10^{-5} N/m² (also written 20 μ Pa), which corresponds to a sound intensity of 10^{-12} Watts/m² (or 1 picoWatt/m², written 1 pW/m²).

Normal human hearing spans a frequency range from about 20 Hertz (Hz, or cycles per second) to about 20,000 Hz (written 20 KHz). However, the sensitivity of human hearing is not the same at all frequencies. To accommodate the variation in sensitivity, various frequency-weighting scales have been developed. The most common is the A-weighting scale, which is based on the sensitivity of human hearing at moderate levels; this scale reflects the low sensitivity to sounds of very high or very low frequencies. Sound levels measured on the A-weighted scale are written in A-weighted decibels, commonly shown as dBA or dB(A).

When sound is measured using the A-weighting scale, the reading is often called the “Noise level”, to confirm that human sensitivity and reactions are being addressed. A table of some common noise sources and their associated noise levels are shown in Table A1.

When the A-weighting scale is not used, the measurement is said to have a “linear” weighting, or to be unweighted, and may be called a “linear” level. As the linear reading is an accurate measurement of the physical (sound) pressure, the term “Sound Pressure Level”, or SPL, is usually (but not universally) reserved for unweighted measurements.

Noise is usually defined as “unwanted sound”, which indicates that it is not just the physical sound that is important, but also the human reaction to the sound that leads to the perception of sound as noise. It implies a judgment of the quality or quantity of sound experienced. As a human reaction to sound is involved, noise levels are usually given in A-weighted decibels (dBA). An alternate definition of noise is “sound made by somebody else”, which emphasizes that the ability to control the level of the sound alters the perception of noise.



Table B1- Noise Levels of Familiar Sources

Source Or Environment	Noise Level (dBA)
High Pressure Steam Venting To Atmosphere (3m)	121
Steam Boiler (2m)	90-95
Drilling Rig (10m)	80-90
Pneumatic Drill (15m)	85
Pump Jack (10m)	68-72
Truck (15m)	65-70
Business Office	65
Conversational Speech (1m)	60
Light Auto Traffic (30m)	50
Living Room	40
Library	35
Soft Whisper (5m)	20-35

The single number A-weighted level is often inadequate for engineering purposes, although it does supply a good estimate of people’s reaction to a noise environment. As noise sources, control measures, and materials differ in the frequency dependence of their noise responses or production, sound is measured with a narrower frequency bandwidth; the specific methodology varies with the application. For most work, the acoustic frequency range is divided into frequency bands where the center frequency of each band is twice the frequency of the next lower band; these are called “Octave” bands, as their frequency relation is called an “Octave” in music, where the field of acoustics has its roots. For more detailed work, the octave bands, and certain standard octave and 1/3 octave bands have been specified by international agreements.

Where the noise at the receiver is steady, it is easy to assess the noise level. However, both the production of noise at the source and the transmission of noise can vary with time; most noise levels are not constant, either because of the motion of the noise source (as in traffic noise), because the noise source itself varies, or because the transmission of sound to the receiver location is not steady as over long distances. This is almost always the case for environmental noise studies. Several single number descriptors have been developed and are used to assess noise in these conditions.

The most common is the measurement of the “equivalent continuous” sound level, or L_{eq} , which is the level of a hypothetical source of a constant level which would give the same total sound energy as is measured during the sampling period. This is the “energy” average noise level. Typical sampling periods are one hour, nighttime (9 hours) or one day (24 hours); the sampling period used must be reported when using this unit.

The greatest value of the L_{eq} is that the contributions of different sources to the total noise level can be assessed, or in a case where a new noise source is to be added to a proposed environment, the total noise level from new and old sources can be easily calculated. It is also sensitive to short term high noise levels.



Statistical noise levels are sometimes used to assess an unsteady noise environment. They indicate the levels that are exceeded a fixed percentage of the measurement time period measured. For example, the 10%-ile level, written L_{10} , is the levels exceeded 10% of the time; this level is a good measure of frequent noisy occurrences such as steady road traffic. The 90% level, L_{90} , is the level exceeded 90% of the time, and is the background level, or noise floor. A steady noise source will modify the background level, while an intermittent noise source such as road or rail traffic will affect the short-term levels only.

One disadvantage with the L_{eq} measure, when used alone, is that nearby loud sources (e.g. dogs barking, or birds singing) can confuse the assessment of the situation when it is the noise from a distant plant that is the concern. For this reason, the equivalent level and the statistical levels can be used together to better understand the noise environment. One such indication is the difference between the L_{eq} and the L_{90} levels. A large difference between the L_{eq} and L_{90} , greater than 10 dB, indicates the intrusion of short-term noise events on the general background level. A small difference, less than 5 dB, indicates a very steady noise environment. If the L_{eq} value exceeds the L_{10} value this indicates the presence of significant short-term loud events.

For most noise measurement, instruments are adjusted so that the time response of the instrument is similar to the response of the human ear; this is the “Fast” setting. Measurement with the “Fast” setting therefore assesses the sound environment according to the way humans would hear it and react to it. Where the noise level varies substantially and an average level is wanted without the complexity of and L_{eq} or statistical measurement, the “Slow” setting is used on the sound level meter. The “Slow” setting is also typically used in industrial settings where hearing damage is a concern. Where the noise level changes very rapidly, for example due to impacts or detonations, the “Fast” and “Slow” settings do not respond quickly enough to assess the maximum levels, and the “Impulse” meter setting is used.

The Sound Power Level (abbreviated L_w , SWL or PWL) is the decibel equivalent of the total energy emitted from a source in the form of noise. The reference level for the sound power is 10^{-12} Watts, or 1 pWatt (abbreviated pW). The sound power level is given by:

$$L_w, \text{ SWL, PWL} = 10 \times \log_{10} (\text{Emitted Power} / 1 \text{ pW}) \text{ dB}$$

Therefore, a source emitting 1 Watt of power in the form of sound would have a sound power level of 120 dB. Sound power levels can be expressed in terms of frequency bands, an overall linear-weighted level or A-weighted, as is the case for sound pressure levels. However, sound power levels are inherent to the source of noise, whereas the sound pressure level is dependent on the source, but also on the distance from the source and other environmental factors.

APPENDIX B

NOISE DISTURBANCE NOTIFICATION FORM

NOISE DISTURBANCE NOTIFICATION FORM
ALEXCO KENO HILL MINING CORP. – KENO HILL SILVER DISTRICT MINING OPERATIONS

Name of Complainant:

Phone Number & Address of Complainant:

Date	Start Time/ End Time	Location	Description of Noise (e.g. likely source, magnitude, duration, pitch, ongoing or isolated noise incident)	How did the noise disturbance disrupt your life and/or your business/livelihood?

This form has been created for Keno Residents to formally complain of noise disturbance associated with Alexco Keno Hill Mining Corp.'s Keno Hill Silver District Operations. Please complete all fields. Return completed forms to campservice@alexcoresource.com, directly to the Elsa Camp Administration Building or call (867) 995-3113.

Signature:

Date: