Report on the Existing Noise Levels in the Vicinity of the Fred Hill Materials Operations at Shine, Washington

Produced for Fred Hill Materials Inc.
Poulsbo, WA.

By

Environalysis
Seattle, WA.

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1.0 INTRODUCTION

The Jefferson County Department of Community Development has asked the Fred Hill Materials Company to respond to citizens' complaints of noise originating from a sand and gravel pit located in Shine, Washington. Fred Hill Materials requested that Environalysis perform noise monitoring of existing conditions and determine the potential for the Shine pit operations to cause noise impacts at residential neighborhoods.

This document is an in-depth look at the existing noise levels in the pit's vicinity and the impacts the pit might have upon the nearest residential neighborhoods. This report will present the results of noise monitoring of existing conditions and an assessment of the pit's impacts using a combination of on-site noise measurements and noise prediction software.

1.1 METHODOLOGY

The analysis of existing noise and project impacts involved two distinct phases: 1) the measurement of existing background and pit operation noise levels and 2) computer modeling of the pit's impacts at the nearest residences.

The first phase consisted of taking simultaneous noise measurements at the pit's eastern boundary and five residential locations most likely to be sensitive to noise transmitted from the pit. In general these locations were the closest residences with a direct-line-of-sight (or nearly so) of the pit's working face. These measurements ranged from 24 to 48 hours in length, with data stored every minute. Larson-Davis models 814 and 820 integrating Type 1 sound level meters were used to measure existing noise levels. The calibration of the meters was checked before and after the measurements with an acoustic calibrator, itself calibrated to a known source.

The second phase involved using noise prediction software to determine the pit's noise impacts at the residential locations where noise was measured in phase 1. This computer modeling was necessary because it was not possible to determine the pit's noise impacts at the nearest residential areas by simply measuring noise there, due to the fact that the nearest residential land uses are more than ¾ mile from the Shine pit operation and they receive noise from sources much closer, such as Highway 104 and other local roads, that could obscure noise coming from the pit. In other words, when one simultaneously measures noise at the pit and a residence, the noise one measures at the residence may not be coming from the pit. But by modeling the pit's noise at each residential measurement site, one can determine how much of the measured noise comes from the pit.

The noise prediction software used was a comprehensive noise prediction computer program known as the Environmental Noise Model (ENM). This program required noise measurements of all major machinery used at the pit. Other inputs included detailed topographical information digitized from topological project site maps, the locations of the mining machinery and local meteorological data. The noise modeling assumed a general pit layout identical to that now existing.

Distance from a noise source and physical buffers affect noise levels and how it is perceived. Noise levels decrease as the distance from the source increases. As the distance from a point source, such as a rock crusher doubles the noise levels will decrease by 6 dBA. Noise reduction (attenuation) is greater over soft or rough ground compared to hard smooth surfaces such as concrete, asphalt or water. Dense trees can reduce noise levels if their trunks and branches completely block the view between source and receptor and/or their roots loosen the soil. A dense and deep (100 meters) buffer of evergreen vegetation can reduce noise by a maximum of 10 dBA.

1.3 REGULATION OF NOISE

Introduction

This project is subject to State and local noise regulations. Typically the noise emitted by a project is calculated at its property lines and compared to these regulations. In addition, Jefferson County prohibits activities that cause noise disturbances, but these activities are generally loud music or racing cars, not normal commercial or industrial operations.

State and Local Regulations

The Washington State Department of Ecology (Ecology) has developed maximum permissible environmental noise levels that a noise source may cause at its property line. The permitted levels vary depending upon the land uses of the noise source and the receiving property. Jefferson County has adopted the State standards by reference. These standards are shown in Table 2 and those most applicable to the Proposal are shown in **bold.** The maximum permissible noise levels are the limits a project can generate at its boundary with other land uses-- they are not the sum of a project and the background non-project sound levels.

TABLE 2
WASHINGTON STATE MAXIMUM PERMISSIBLE SOUND LEVELS in dBA

Land Use of Source:	Land Use of Receiving Property		
	Class A	Class B	Class C
Class A (Residential)	55	57	60
Class B (Commercial)	57	60	65
Class C (Industrial)	**60**	65	**70**

Notes:
Between the hours of 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. during weekends, the maximum limits for rural and residential receivers are to be reduced by 10 dBA within residential receivers. For noises of short duration these limits can be exceeded by a maximum of 5 dBA for 15 minutes/hour, 10 dBA for 5 minutes/hour or 15 dBA for 1.5 minutes/hour.

Motor vehicle traffic traveling on public roads is exempt from the noise regulations summarized in Table 2; however, the project's onsite traffic is subject to the State's standards.

2.0 EXISTING NOISE ENVIRONMENT

Noise levels at the eastern property line of the Shine Pit and at four residential locations were measured to assess existing conditions, both with the pit operating and when shut down. Measurements were taken on two successive days at four of the six sites. Two residential sites was measured for one-day (24 hours). The sites were selected after a through examination of the area. In general, they must appear to be sensitive (i.e. readily impacted by) noise from the Shine pit. The criteria for selection of the sites included the following:

- On residential property (or as close to residential property as was practical to setup noise meters with the assurance that the meters would be secure and un-tampered with.)
- Residential properties close to the pit
- Residential sites located in areas with few other loud noise sources
- Residential sites less close to the pit but having a clear line-of-site to some part of the Shine pit

Table 3 describes the noise measurement sites.

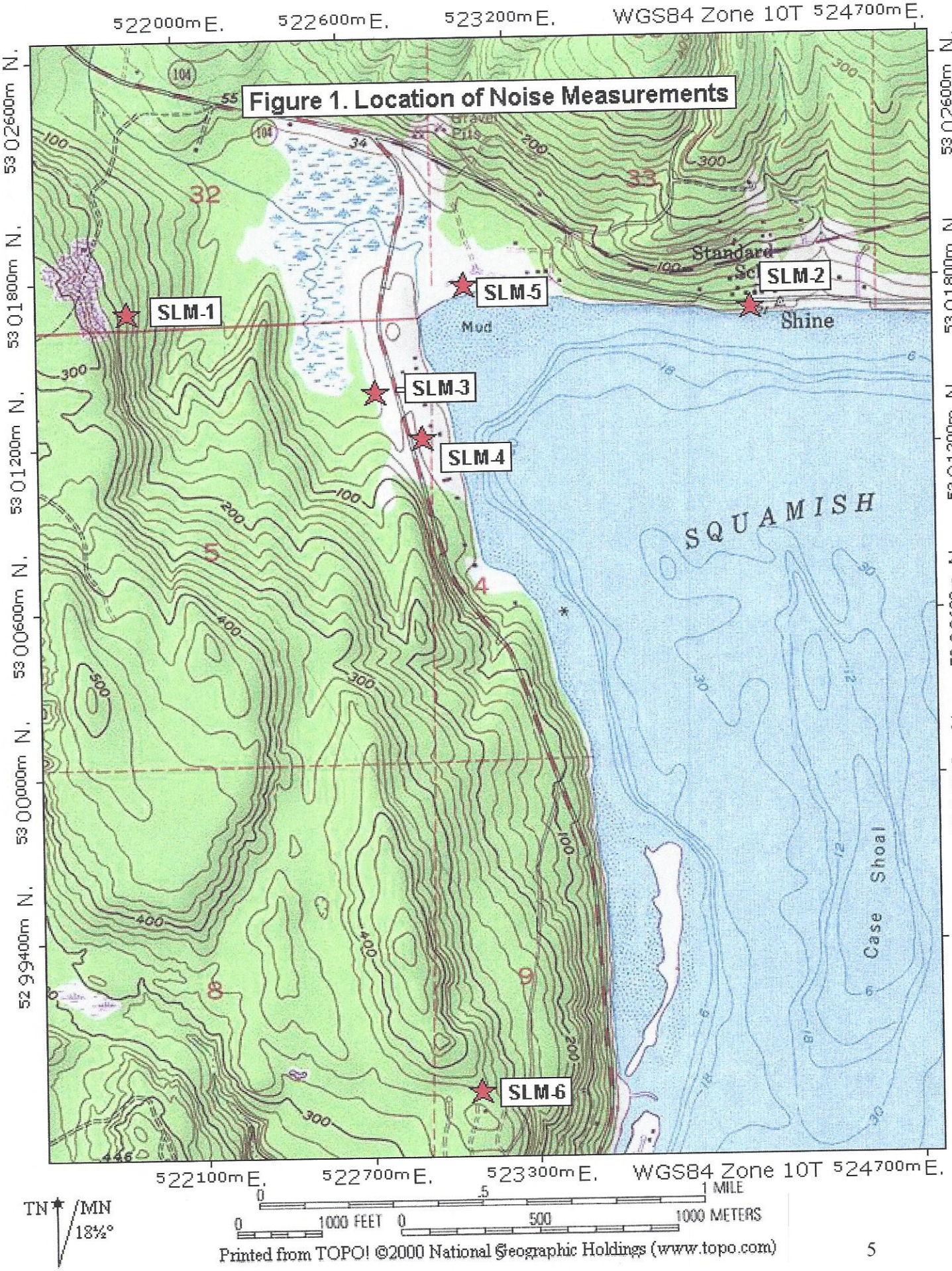
TABLE 3
NOISE MONITORING SITES

Site	Starting Time & Date	Location	Land Use
SLM-1	5:15 p.m., 8-20-02	East edge of Shine pit lease	Commercial forestry
SLM-2	4:00 p.m., 8-20-02	South side of Shine Road	Across road from residential
SLM-3#1	2:15 p.m., 8-20-02	West side of South Point Road	Across road from residential
SLM-3#2	2:00 p.m., 10-1-02	West side of South Point Road	Across road from residential
SLM-4	3:22 p.m., 8-20-02	East side of South Point Road	Residential
SLM-5	2:35 p.m., 8-26-02	Vacant lot on Merridith Street	Residential
SLM-6	3:00 p.m., 9-25-02	214 Eagle View Lane	Residential

Details of site location:

SLM 1 - 900' east of primary crusher on a berm at edge of reclaimed area
SLM 2 – 25' south of Shine Road opposite a residence at 301 Shine Road
SLM 3 – 150' west of South Point Road in grassy field. The second measurement taken Oct.1-2 was approximately 30' south of the first measurement.
SLM 4 – 75' east of South Point Road at 491 South Point Road
SLM 5 – 75' south of Merridith Street in vacant lot adjacent to 261 Merridith Street
SLM 6 – NW of house at 214 Eagle View Lane

The measurement locations described above are shown in Figure 1.



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The noise level measurements are summarized in Table 4 and are shown graphically in Figures 2 to 8.

TABLE 4
MEASURED SOUND PRESSURE LEVELS (in dBA)

Monitoring Location	Length of Measurement Hours:minutes:seconds	Minimum	Maximum	Leq For duration of measurement	L2.5	L8.3	L25
SLM-1	47:10:00	24.4	77.3	44.4	49.5	47.9	44.9
SLM-2	41:07:58	29.1	83.2	53.3	57.7	55.0	51.7
SLM-3 #1	49:01:56	18.9	112.6	65.1(60 dBA minus the high events)	52.5	47.6	42.6
SLM-3 #2	24:00	24.1	74.0	43.6	50.2	47.7	44.3
SLM-4	48:57:15	19.8	91.3	44.3	59.2	53.9	44.8
SLM-5	24:00:00	25.5	78.9	48.7	53.2	50.6	46.6
SLM-6	24:00:00	23.6	70.3	40.6	47.2	41.3	37.7

Note: The columns headed L2.5, L8.3 and L25 represent the measured noise levels that are exceeded 2.5%, 8.3% and 25% of the time that noise was measured. These numbers can be compared to the short-term allowable exceedances of the State's Maximum Permissible Environmental Noise Levels of L2.5 (day/night) = 75/65 dBA, L8.3 (day/night) = 70/60 dBA, L25 (day/night) = 65/55 dBA.

Discussion of Table 4

One of the things Table 4 shows is the large variability in the existing sound pressure levels-between the minimum and maximum readings (especially at SLM-3.) At most of the sites this variability is typical of rural/residential areas that are very quiet at night but experience higher noise levels during the peak commute periods. Site SLM-3 #1 shows show anomalous noise readings. The high maximum reading is not due to a loud noise event, but is probably due to an animal rubbing against the microphone or wind periodically causing a branch to touch the microphone. These high levels are of very short duration (as can be seen in Figure 5) and add very little to the overall noise energy recorded at SLM-3 (as shown in the Leq of 65.1 dBA with the high readings and 60 dBA with the highest readings removed). Measurements were repeated at SLM-3 for 24 hours and shown above as "SLM-3#2" and in Figure 5a. The second measurement attempt at SLM-3 does not exhibit the unusual spikes of the first one and appears more typical of the sound environment at this location.

Figure 2. Maximum Noise Levels at SLM-1 East Boundary Aug. 20-21

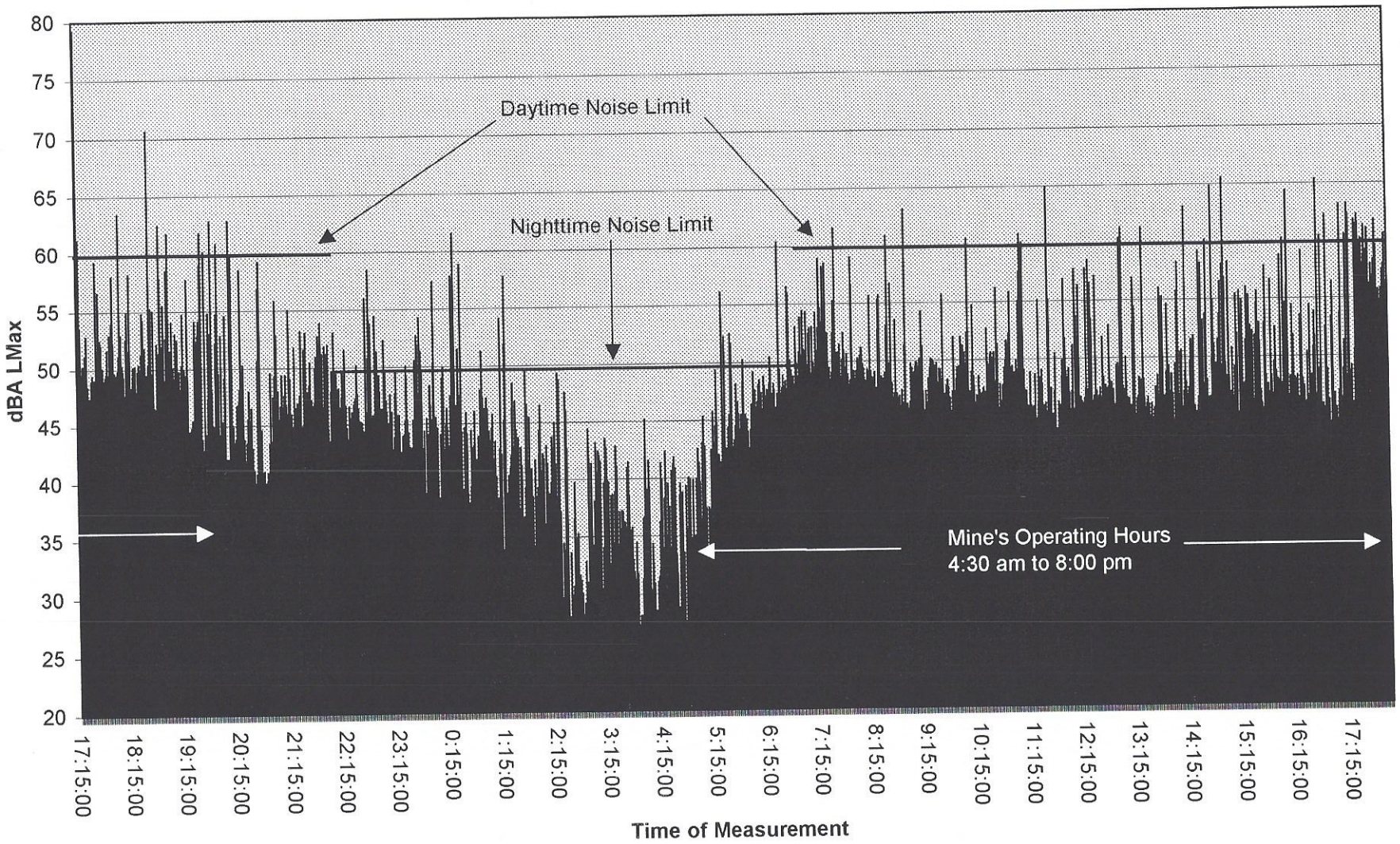


Figure 3. Maximum Noise Levels at SLM-1 East Boundary Line Aug. 21-22

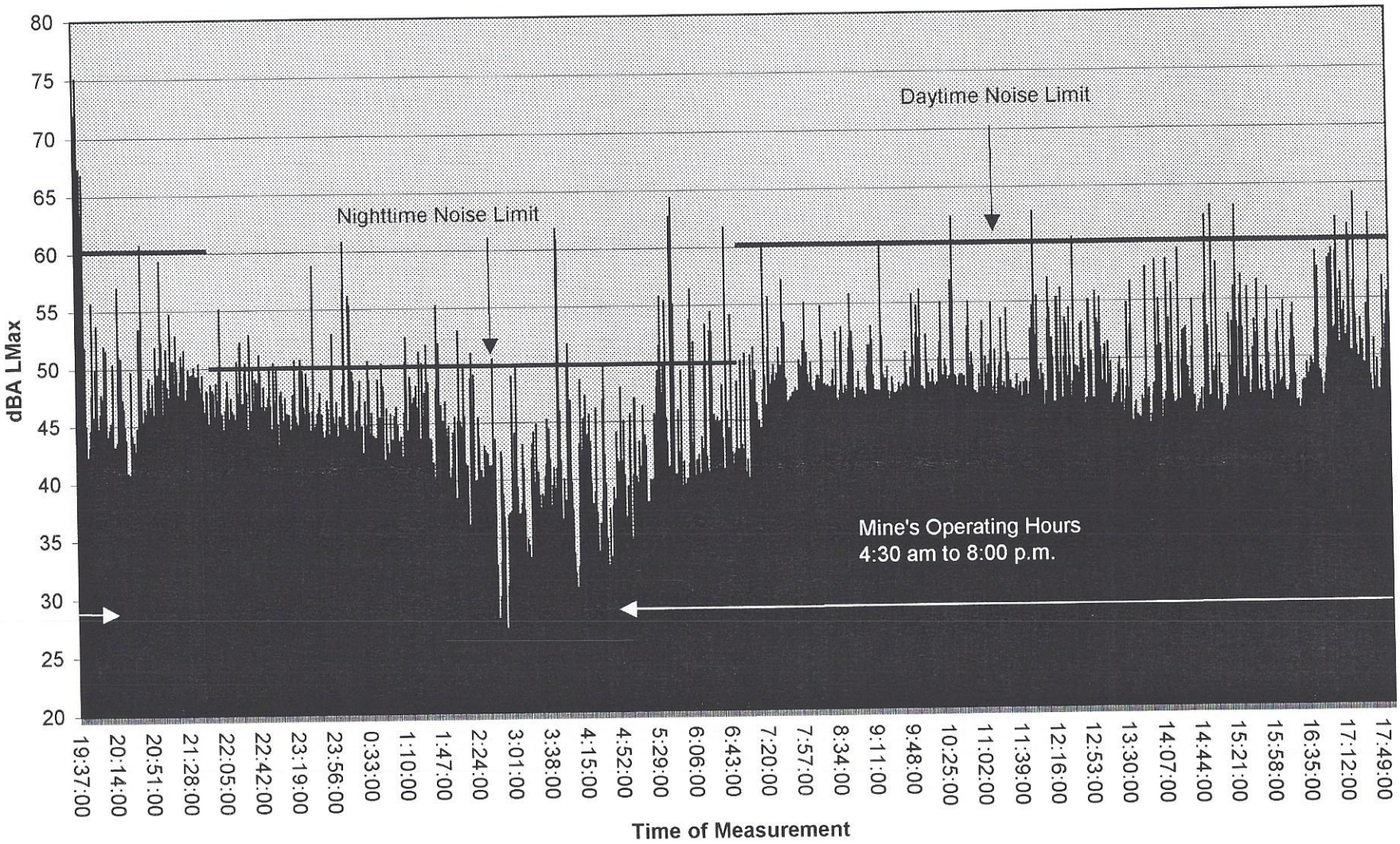


Figure 4. Maximum Noise Levels at SLM-2 301 Shine Road Aug. 20-22

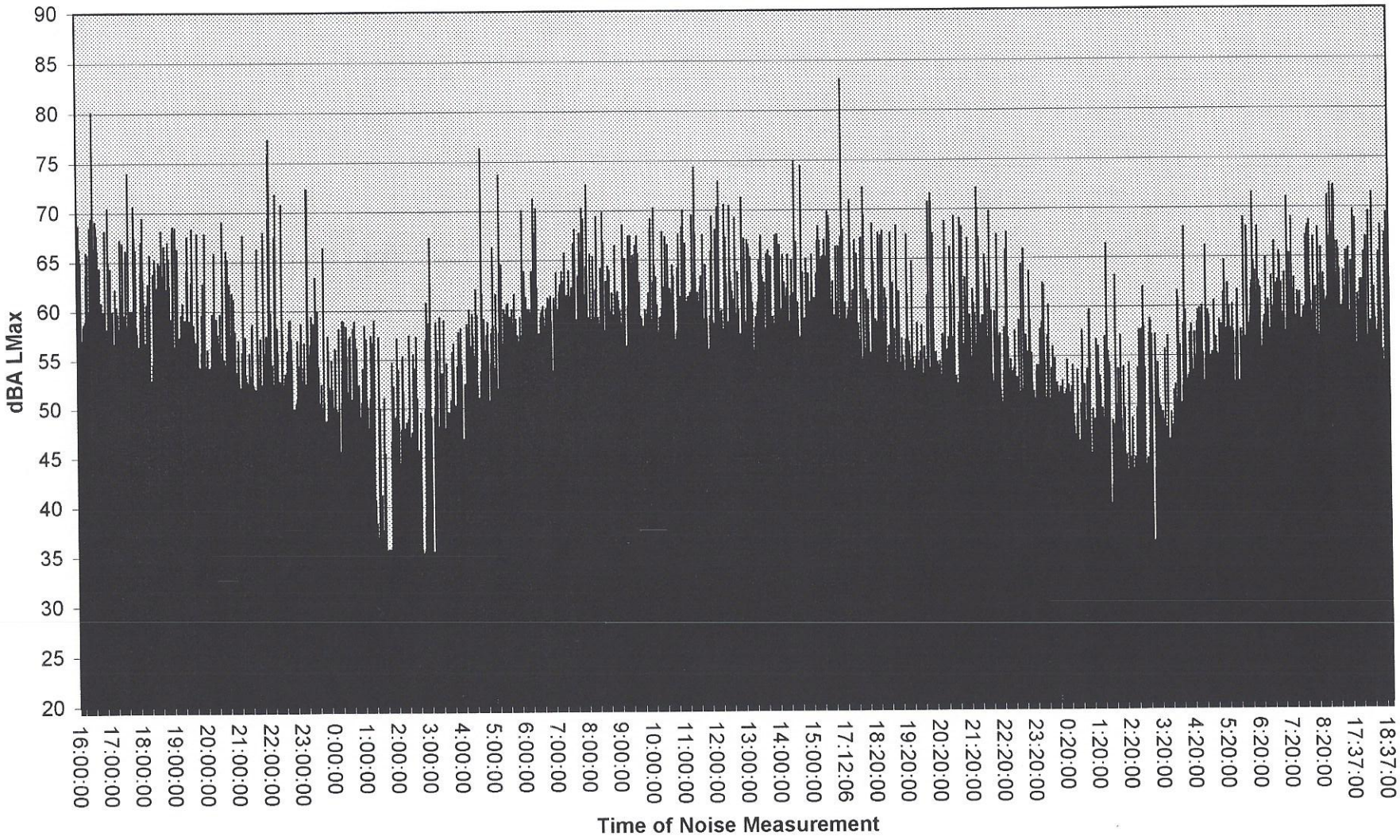
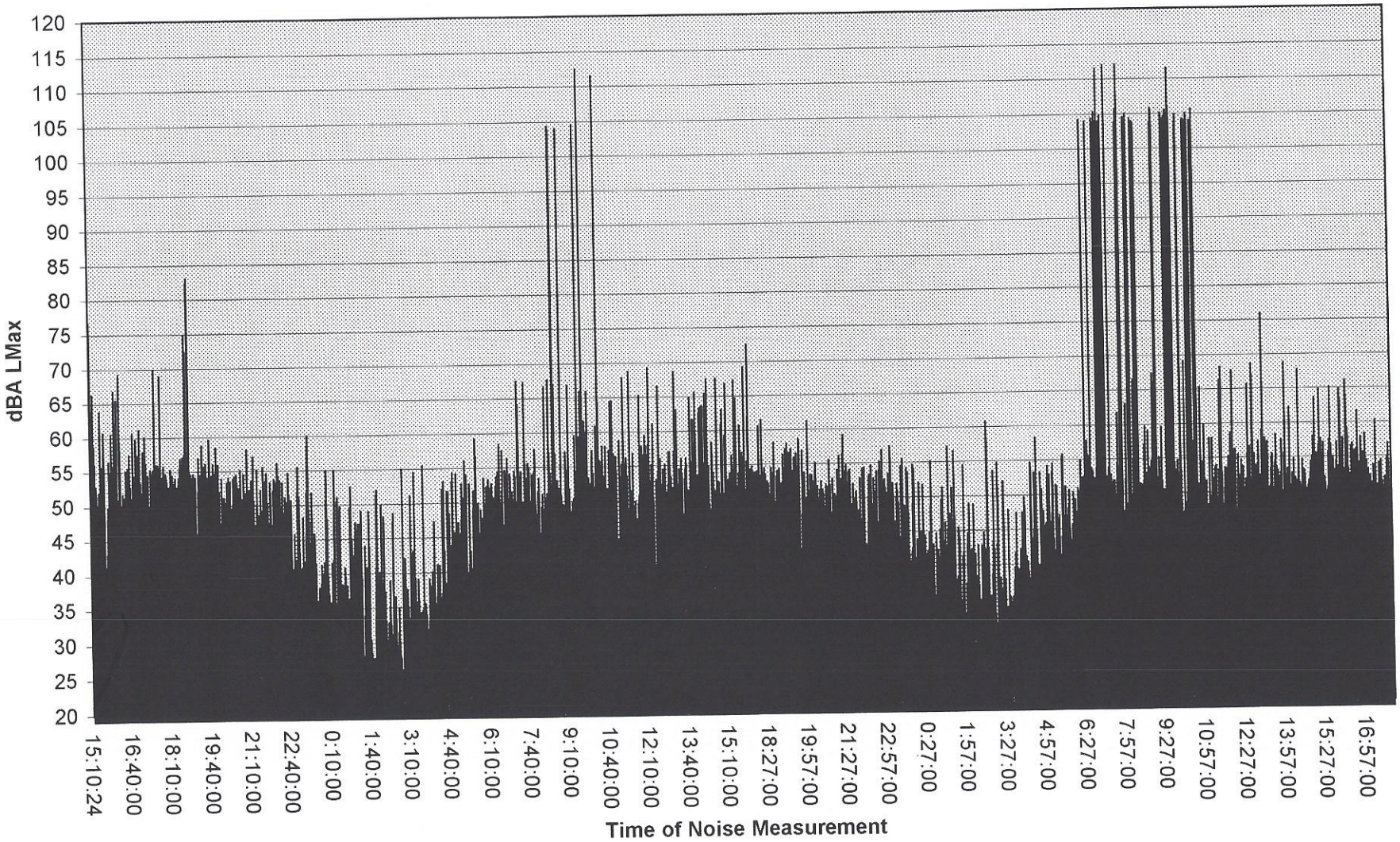


Figure 5. Maximum Noise Levels at SLM-3 South Point Road Aug. 20-22



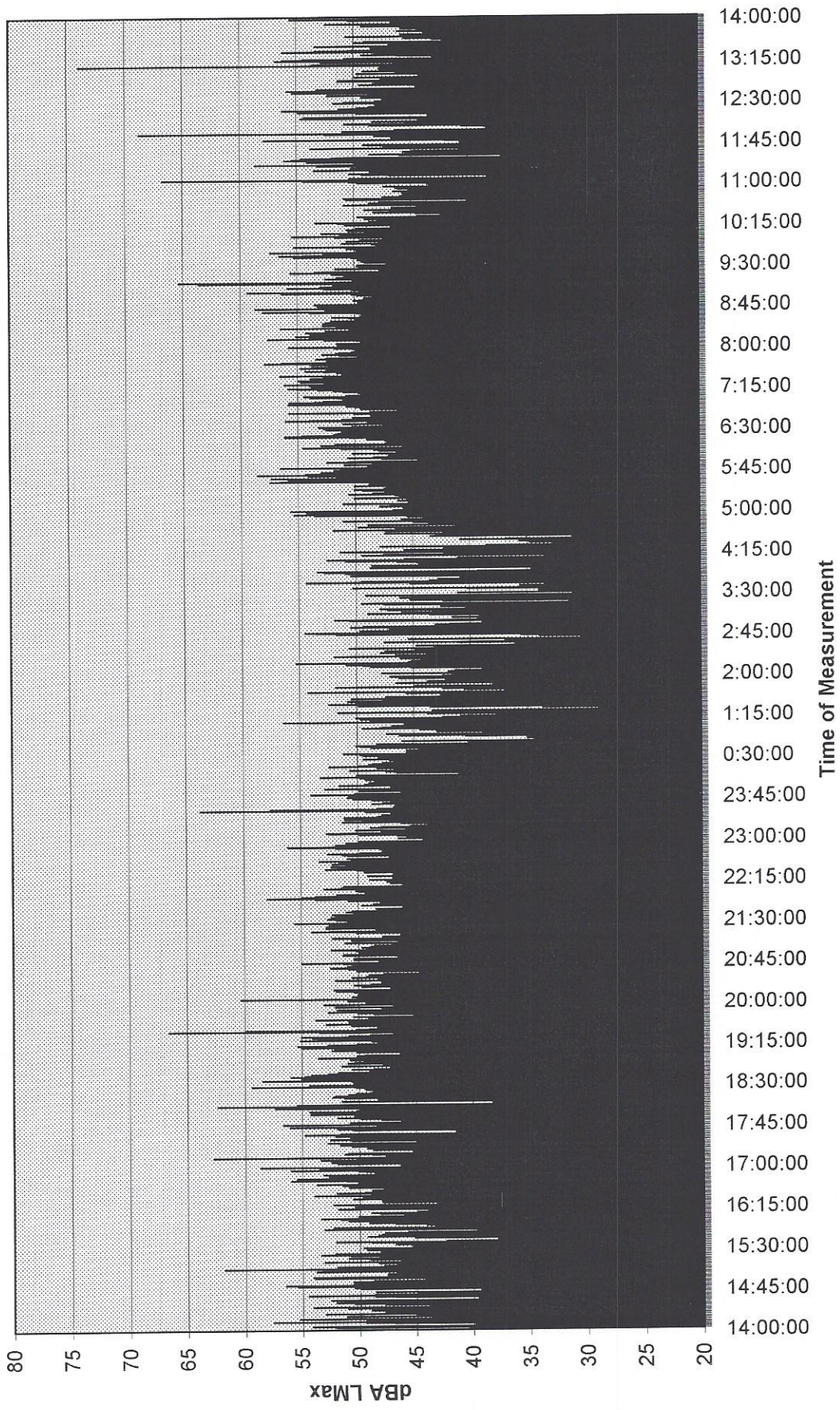


Figure 5a. Maximum Noise Levels at SLM-3 Oct.1-2

Figure 6. Maximum Noise Levels at SLM-4 South Point Road Aug. 20-22

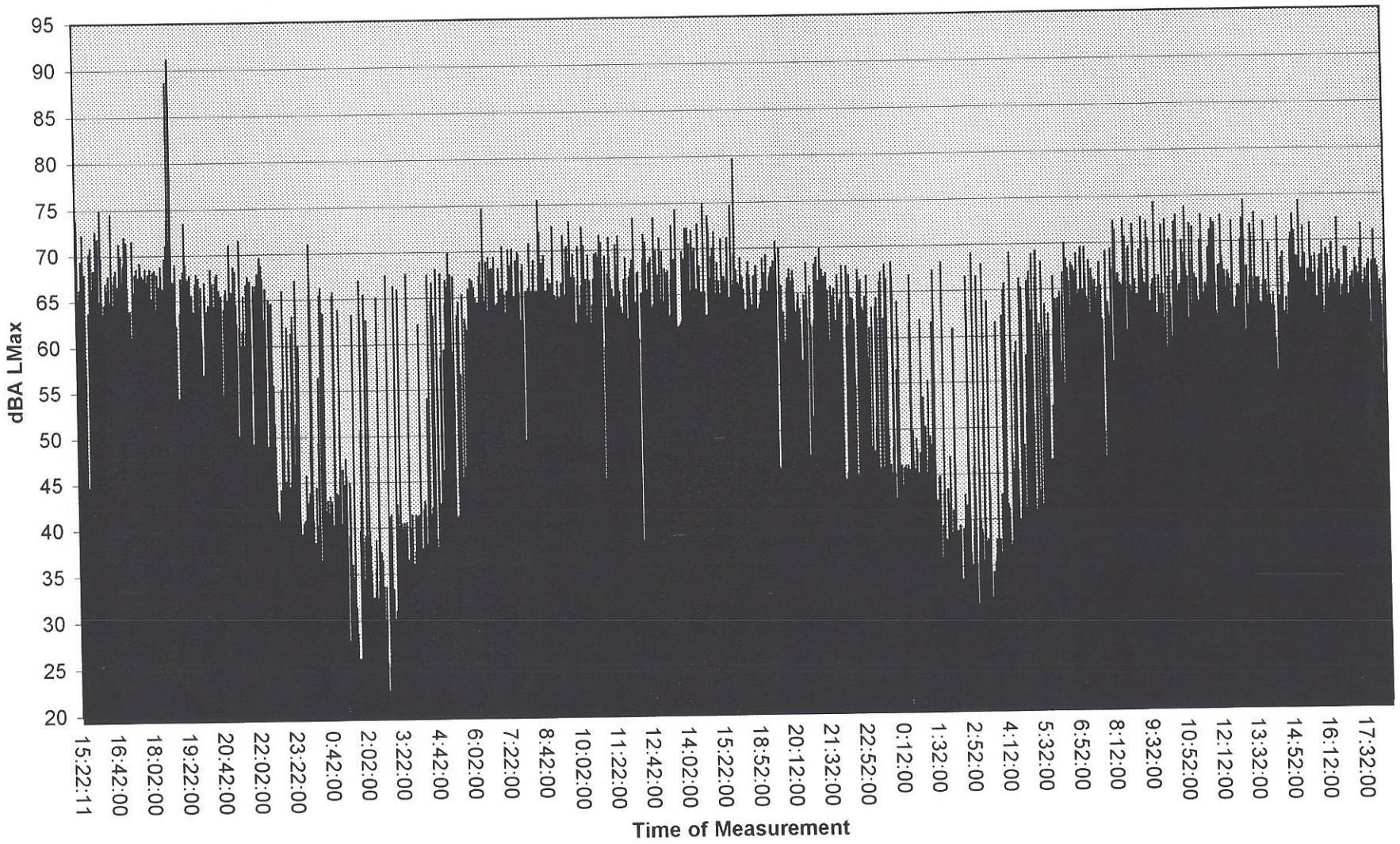


Figure 7. Maximum Noise Levels at SLM-5 Merridith St. Aug. 26-27

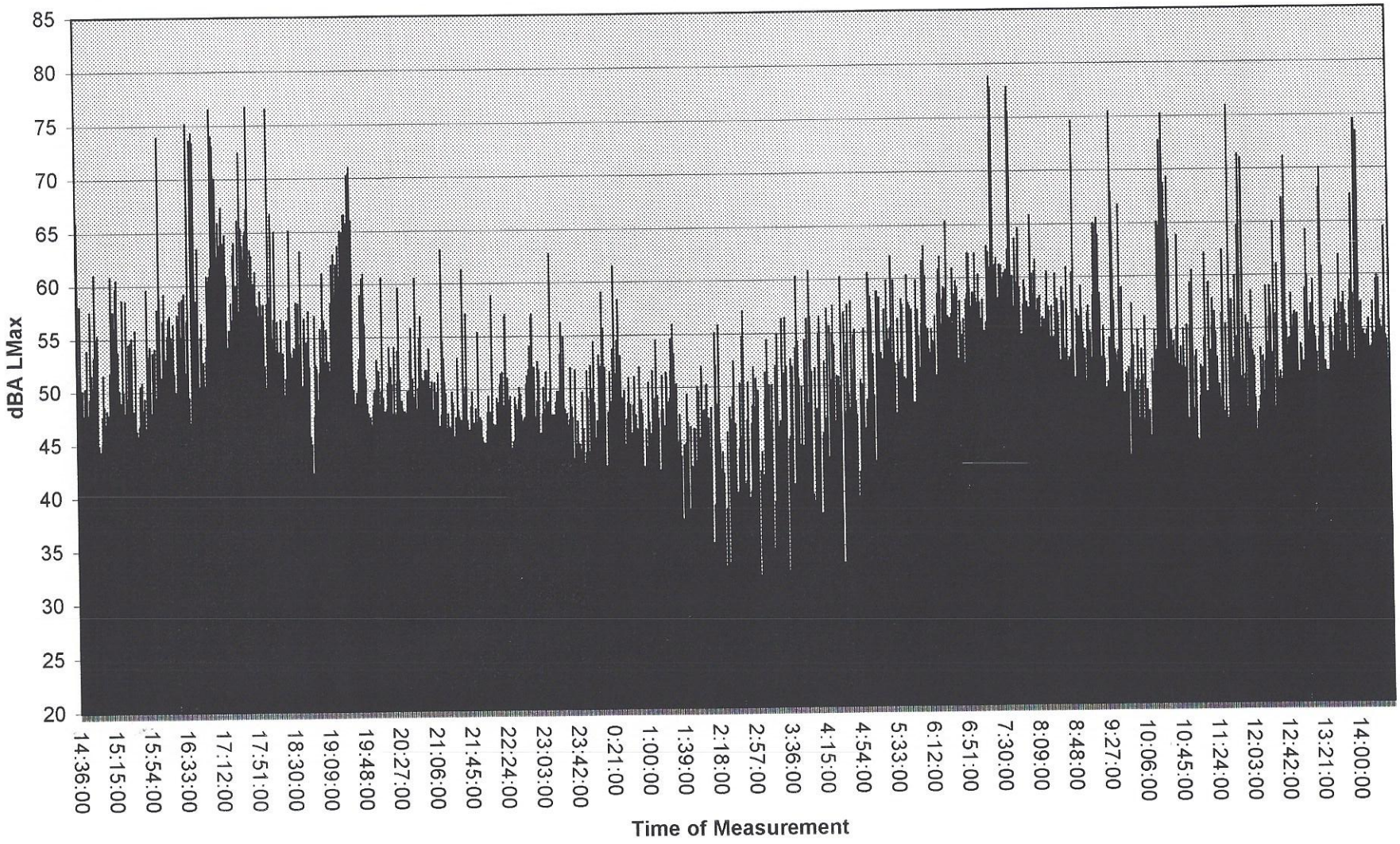
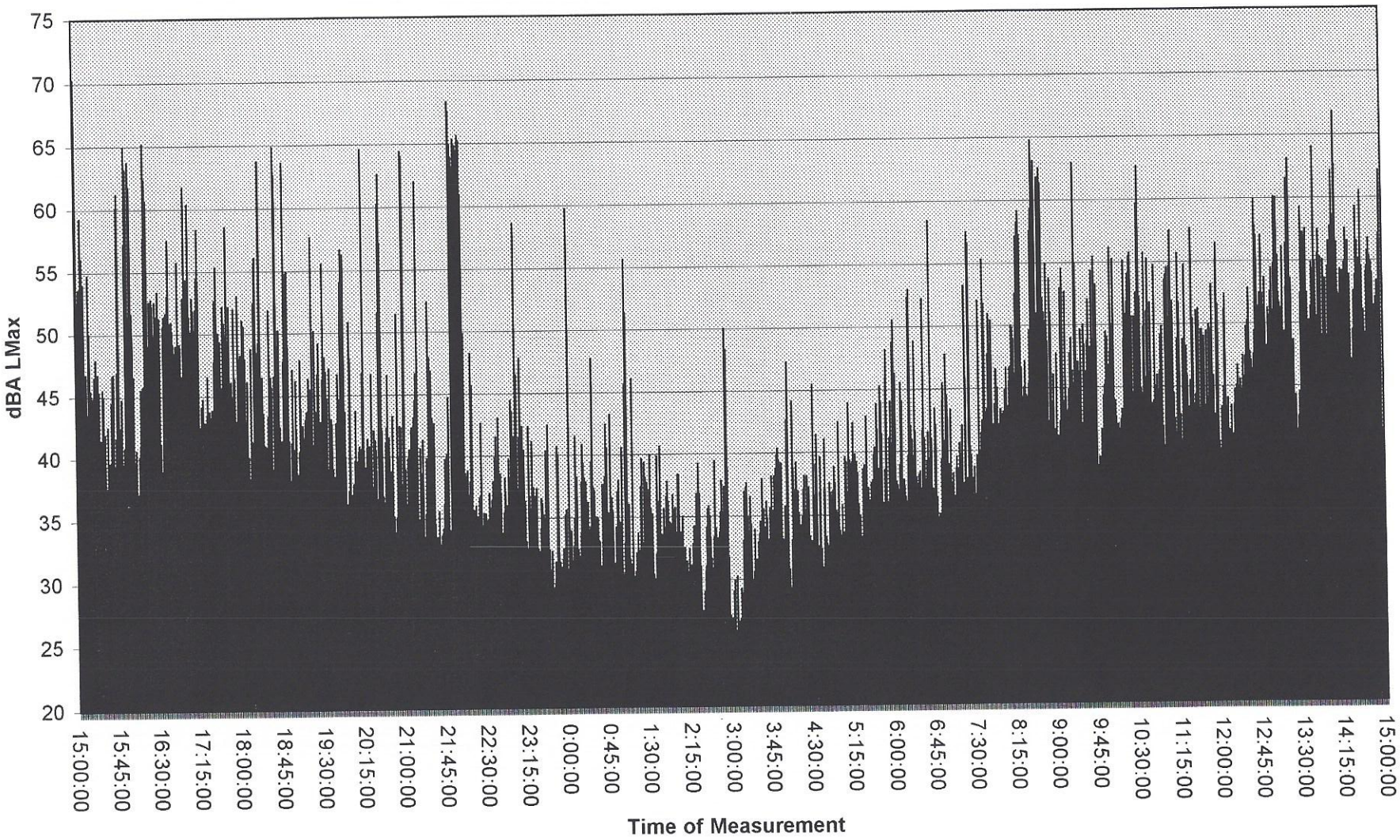


Figure 8. Maximum Noise Levels at Eagle View Lane Sept. 25-26



Discussion of Figures 4 to 8

Figure 4 (Shine Road) shows a fairly steady pattern of noise with very brief periods of low noise levels lasting no more than 3 hours in the very early morning hours. This is a pattern typical of areas affected by regional (rather than local) highways with high and steady volumes of vehicles.

Figure 5 (South Point Road) illustrates a pattern typical of rural/residential areas close to small roads with a distinctly quiet period. Most of the high noise spikes are probably caused by animals or tree branches touching the microphone rather than loud events typical of this site's noise environment. Nearly all of these spikes are not repeated at other monitoring locations.

Figure 5a (South Point Road) illustrates a pattern typical of rural/residential areas close to small roads with a distinctly quiet period. The anomalous spikes of Figure 5 are not evident in this re-measurement.

Figure 6 (South Point Road) demonstrates the same pattern as Figure 5, with a higher general noise level but without the prominent spikes. These two locations are within 1000 feet of each other, with Figure 6 being closer to South Point Road.

Figure 7 (Merridith Street) shows a fairly quiet site with the quietest periods louder than Figures 5 and 6 and a pattern similar to Figure 4, i.e. affected by Highway 104 traffic. The Figure 7 site is on the waterfront and is affected by boat noise and activities on the west side of Squamish Harbor.

Figure 8 (Eagle View Lane) illustrates a pattern typical of rural/residential areas close to small roads with a distinctly quiet period.

Discussion of Figures 2 and 3

The noise measurement location most relevant to determining if the Shine Pit operation is causing exceedances of the State's noise standards is SLM-1, the eastern edge of the pit's lease. This location is close to the mining machinery and much more likely to receive noise from the pit (rather than from highways or other sources) than any of the other sites where noise measurements were taken. An examination of Figures 2 and 3 shows that the SLM-1 site did indeed exceed the State's Maximum Permissible Environmental Noise Limits for an industrial source upon a residential receiver. (In reality, the property bordering the Shine Pit to the east is commercial timberland but by pretending it is residential we are analyzing a "worst-case" situation—as if a residential development were to be built here.) Figures 2 and 3 also reveal that the exceedances were sporadic, i.e. they were isolated events, or "noise spikes". Such "noise spikes" also occurred when the pit was not operating and appear (by a visual examination of Figures 2 and 3) to have occurred only slightly less frequently when the pit was closed as than when it was open. It is not known what caused these maximum sound pressure levels so much higher than the general levels; during pit operating hours we will assume that they are due to events at the pit; when the operation is closed perhaps birds or animals close to the noise meters' microphones caused them.

The State's Maximum Permissible Environmental Noise Limits allow short-term exceedances in order to account for the variability inherent in the noise generated by many commercial and

industrial facilities. When the noise measurements illustrated in Figures 2 and 3 are examined, minute-by-minute, to determine how often and by how much the noise standards were exceeded the data summarized in Table 5 emerges. The column headings "daytime" and "nighttime" refer to the State's definition of daytime as from 7 AM to 10 PM (weekdays) and nighttime as 10 PM to 7 AM (weekdays). The decibel levels in parentheses are the short-term exceedances allowed under State code. Every hour during the entire noise measurement in which there was a short-term exceedance is listed in Table 5.

TABLE 5
THE NUMBER OF HOURLY EXCEEDANCES OF WAC 173-60-040 AT SITE SLM-1

Date, Scenario & Time	**+5 dBA (65/55 dBA)**		**+10 dBA (70/60 dBA)**		**+15 dBA (75/65 dBA)**		**Exceedance of State Standards**	
	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
Aug. 20 Pit Operating								
5:15-6:15 PM	1		1		1		NO	
6:15-7:15 PM	1		1					NO
Aug. 21 Pit Operating								
2:15PM-3:15 PM	2							NO
3:15PM-4:15 PM	1							NO
4:15PM-5:15 PM	3							NO
Aug.21 Pit Closed								
7:37-8:37 PM	6		4			1	**YES**	

Note:
Adherence to WAC 173-60-040 is achieved when (during a daytime hour):

(No. of minutes/hour that noise equals or exceeds (60dBA+15dBA)/1.5)+(No. of minutes/hour that noise equals or exceeds 60dBA+10dBA)/5)+(No. of minutes/hour that noise equals or exceeds 60dBA+5dBA)/15) = less than 1.0

During nighttime hours 60dBA is reduced to 50dBA

Discussion of Table 5

Table 5 demonstrates that the Shine Pit did not generate sufficient noise to cause an exceedance of the State's noise limits during the entire 48-hour measurement period. There was one exceedance of the short-term standards measured at SLM-1. It occurred when the Shine Pit should not have been operating, although maintenance activities could have taken place.

The information in Figures 2-3 and Table 5 answers the question of whether the Shine Pit is likely to exceed State noise standards. However there are two other questions left unanswered:

- "What would the mine's noise impact be under meteorological conditions more adverse than when the monitoring was performed?" The noise monitoring data show that exceedances are unlikely, but the data do not necessarily cover the full range of operating scenarios and meteorological conditions that could occur over the long-term.

- "How much noise from the Shine pit does reach the closest residential neighborhoods?" The noise monitoring indicated total sound levels at various sites but unattended monitoring cannot distinguish between mine-generated noise and noise from other local sources.

The process to answer these questions represents the second phase of this report and is described in "Section 3 Project Noise Impacts."

3.0 PROJECT IMPACTS

The noise impacts of the Shine Pit were analyzed using detailed noise measurements of operating mining equipment and computer simulations. The noise measurements were taken under normal conditions and are summarized in Table 6. The noise measurements of each machine were taken in 1/3-octave band frequencies at a distance of 50 feet and were converted to A-weighted decibels for ease of comparison in Table 6. The measurement data represent the sound pressure level of each machine at a distance of 50 feet from the machine. This data was converted to sound power (the acoustic energy emitted by the machines) using the standard power law formula: Sound power level = sound pressure level + (10*LOG (2*pi*distance^2). For a measurement distance of 50 feet this formula adds 31.6 dBA to the measured sound pressure levels.

TABLE 6 SOUND LEVELS OF PIT MACHINERY in dBA

Process and Equipment	Sound Pressure Level at 50' from equipment	Sound Power Levels used in Modeling
Working face- CAT 980F	83	115
Primary Crusher – screens, conveyors	91	123
Wash Plant	82	114
Concrete Recycling plant	88	120
Asphalt plant	86	118
Gravel truck- loaded tandem on level surface at 25 mph	69	101

In general, the Shine Pit typically operates from as early as 4:30 a.m. to 8:00 p.m. six days a week in the summer and 7 a.m. to 4:30 p.m. in the winter. The 5-7 a.m. period on weekdays and the 5-9 a.m. period on weekends and holidays are considered nighttime operations and are subject to more stringent noise standards. The asphalt plant (not owned or operated by Fred Hill Materials) has State and County approval to operate 24 hours a day for critical State highways projects.

3.1 OPERATIONAL IMPACTS

Modeling of On-Site Equipment

Computer modeling of project-generated noise levels was used to predict its noise impacts at the noise monitoring sites, which are generally so distant from the pit that background sounds obscure the pit's noise. In addition, computer modeling allows the simulation of the pit under a variety of meteorological conditions that could enhance the dispersion of noise from the pit and that may coincide with noise complaints received by the County.

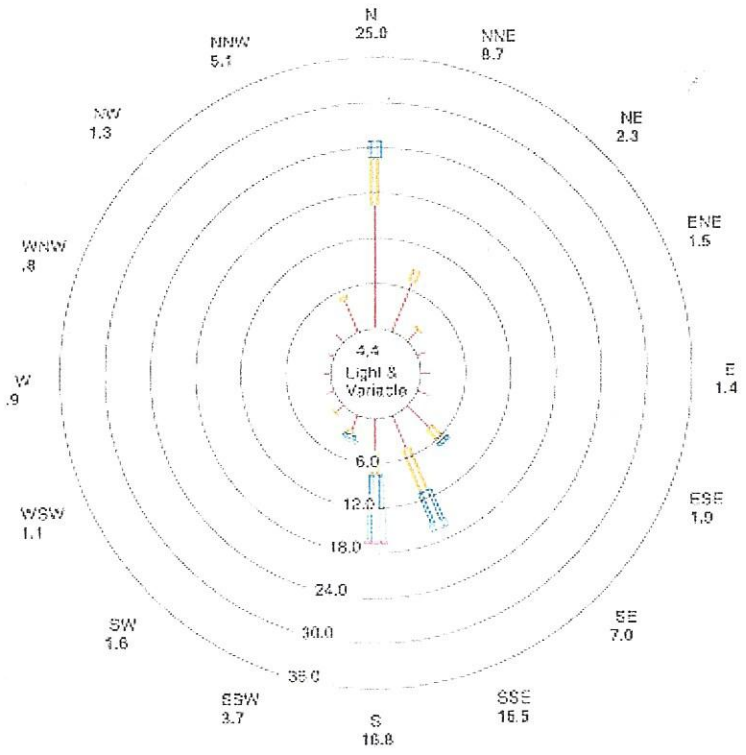
Wind direction, wind speed and atmospheric temperature can have an important impact on the dispersion of noise. Noise radiates spherically from a stationary noise source. Winds blowing from the source to a listener can distort this sphere towards the listener, causing higher noise levels at the ground level. Likewise, winds blowing from a listener to the source will impede noise transmission causing the listener to hear less of the source's noise. Winds higher than about 20 mph raise the level of background noise as much or more than they enhance the transmission of noise from a specific source. In recognition of this fact, Washington State prohibits the measurement of noise for enforcement actions if the wind is greater than 20 mph for close sources and 12 mph for other sources (WAC-173-58-040).

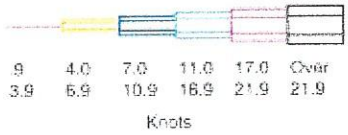
Wind speed and wind direction data were obtained from a meteorological station located near Poulsbo and operated by the Puget Clean Air Agency. Hourly data from 1993 to 1999 were examined. Figure 9 illustrates the frequency of winds from each compass direction.

Figure 9. Distribution of Wind Direction and Wind Speeds

Lions Park

Poulsbo, WA





The length of the vectors on our wind rose graphs show the percentage of time the wind blew from each each direction on a 16-point compass. Wind speed is delineated by color and width of the brackets.

Station location:
Lions Park, 6th Ave NE and Fjord Dr, Poulsbo, WA

Site elevation:
10 feet

Inclusive dates:
September 1, 1993 to February 29, 1999

Total observations:
56,276

It is obvious that winds from the north, northeast, southeast, south-southeast and south comprise almost all of the hourly measurements. The implication of this data for the Shine Pit is that there are very few hours per year when winds would be enhancing noise transmission by blowing from the pit towards adjacent neighborhoods.

This meteorological data was used to determine the wind speed and wind direction inputs for the ENM model, Two general conditions were modeled: (1) the meteorological condition present while the noise measurements were being taken and (2) an inversion condition of a stagnant atmospheric with a light breeze of 2.2 mph. This later condition was modeled to examine a "worst-case" scenario. Inversions and stagnant air are infrequent in the Poulsbo-Hood Canal area (personal conversation M. Hoffman, PSCAA). A good indicator of inversion conditions is whether smog watches or burn bans have been enacted by the Puget Sound Clean Air Agency. Smog watches and burn bans are infrequent; they were in place for Kitsap County twice in 2001 and once in 2000.

Table 7 summarizes the results of the ENM modeling.

TABLE 7 PIT-GENERATED SOUND PRESSURE LEVELS AT THE MEASUREMENT SITES

Receiver Site	Pit Noise Levels In dBA		WAC Noise Standard	King County Standard	Does Pit Exceed Standard?	Existing Noise Levels[1]	Could Pit be Audible?	Could Pit be Audible?
	Typical Conditions Day/Night	Inversion Day/Night	Day/Night	Day/Night	Typical Conditions Day/Night	Typical Conditions Day/Night	Typical Conditions Day/Night	Inversion Conditions Day/Night
SLM-1	47/47	49/48	70/70	70/70	NO/NO	42/42	YES/YES	YES/YES
SLM-2	35/33	41/40	60/50	57/47	NO/NO	48/51	NO/NO	NO/NO
SLM-3	47/46	50/49	60/50	57/47	NO/NO	32/34	YES/YES	YES/YES
SLM-4	29/28	38/33	60/50	57/47	NO/NO	46/47	NO/NO	NO/NO
SLM-5	41/39	46/44	60/50	57/47	NO/NO	44/47	NO/NO	ALMOST/NO
SLM-6	14/10	39/37	60/50	57/47	NO/NO	31/28	NO/NO	YES/YES

Notes:

Typical meteorology is defined as winds of 2 meters/second (4.5 mph) from the south-southeast (157°) in a neutral atmosphere (-1°/100 meters)
Inversion meteorology is defined as winds of 1 meters/second (2.2 mph) from the north in a stagnant atmosphere (4°/ 100 meters

[1] The lowest hourly LEQ for the 7 a.m-10 p.m (day) and 5 a.m- 7 a.m. (night when pit is operating) periods.

Summary of the Project's Operational Impacts

As shown in Table 7, the project's noise levels at any receiver would not exceed the standards set out in the State Noise Code or the more stringent King County Noise Code for an industrial noise source impacting a noise receiver in a residential zone during typical meteorological or inversion conditions. An exceedance of the King County nighttime standard could occur at SLM-3 during an inversion. The potential for noise exceedances during inversions should not considered significant because of the infrequent occurrence of inversions in the Shine area. The pit is likely to be audible if its modeled sound level is more than 3 dBA greater than existing measured levels. The pit may be audible at sites SLM-1 and SLM-3 and SLM-6, the later two are residential receivers. However, the fact that the pit may be audible does not mean it is in exceedance of State noise limits.

4.0 MITIGATION MEASURES

Under typical meteorological conditions no mitigation measures would be required for the pit's operation in order to meet the State's noise standards, as no exceedances are predicted. However, the nighttime standard of 50 dBA could be exceeded in the vicinity of SLM-3 on South Point Road during periods of inversions. The pit may be audible in this vicinity when the background noise is very low. No mitigation measures are recommended for potential exceedances during inversions due to the infrequent occurrence of inversions in the Shine/ Hood Canal area.

Fred Hill Materials should consider establishing a noise- monitoring program, in order to provide a definitive response when local residents call the County with noise complaints. By having at least one on-going noise monitor located on the eastern property line (near site SLM-1) the pit could compare its noise emissions with the date and time of any noise complaints. (The County would need to keep a detailed log of such complaints.) With this information, it could be determined if a noise complaint occurred while the Shine Pit was operating and, if so, how loud the operation was at the time of the complaint.

5.0 REFERENCE

Washington Administrative Code (WAC), *"Sound Level Measurement Procedures,"* Chapter 173-58 WAC 5-18-94.

Washington Administrative Code (WAC), *"Maximum Environmental Noise Levels,"* Chapter 173-60 WAC 12-6-00.

Washington Administrative Code, *"Motor Vehicle Noise Performance Standards,"* Chapter 173-62, WAC 9-30-80.

Personal conversation- Mary Hoffman- Puget Sound Clean Air Agency- 9-10-02

Puget Sound Clean Air Agency. Multiyear Wind Roses. http://www.pscleanair.org/airq/windrose/lions_multi.shtml