Appendix A.8:
Tiller Noise Report

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ZAVORAL MINING AND RECLAMATION PROJECT
NOISE ASSESSMENT

Prepared for the

Tiller Corporation

by

David Braslau Associates, Inc.

15 February 2011
(Revised 26 January 2012)

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1.0 INTRODUCTION

1.1. Introduction and Study Objectives

This *Noise Assessment* report presents findings of a comprehensive study of potential sound levels associated with the proposed Zavoral Site Mining and Reclamation Project located along St. Croix Trail North (State Trunk Highway 95 [TH 95]) near its intersection with State Trunk Highway 97 (TH 97) in the City of Scandia, Minnesota. This noise assessment evaluates potential sound level impacts at both residential land uses in the vicinity of the project in Minnesota and Wisconsin, and recreational land uses within the St. Croix National Scenic Riverway east of the site.

The hours of operation at the site are restricted by the City between 7 a.m.-7 p.m. Therefore, residential land uses are evaluated with respect to the Minnesota daytime noise standards which are applicable between the hours of 7 a.m. and 10 p.m. Since Wisconsin has not adopted statewide noise standards, the Minnesota standards are also applied to residential land uses in Wisconsin.

Daytime noise standards are also applied to recreation and camping areas in the Riverway. Additionally, recreational users (or receptor sites) in the Riverway are also evaluated with respect to the potential audibility of sound associated with site operation. Since audibility is determined by both ambient and intruding sound level, ambient levels in the Riverway have been based upon winter ambient levels measured near the proposed site, adjusted for anticipated summer traffic on TH 95 and TH 97.

This assessment addresses noise associated with an excavator and a front-end loader to be used for mining operations. Haul truck noise is evaluated from operations only within the site since trucks associated with Tiller Corporation already use public roadways in the area.

1.2. Report Components

Section 2.0 describes expected operations at the site including the location of the proposed three phases of mining.

Section 3.0 describes sound level measurements of mining equipment to be used at the Zavoral Site and ambient sound level measurements taken in the vicinity of the site.

Section 4.0 estimates noise associated with the excavator and front-end loader used in mining operations, haul trucks within the site, and potential combined noise impacts relative to the Minnesota noise standards.

Section 5.0 discusses the potential audibility of sound levels from mining operations and haul trucks at receptor sites within the Scenic Riverway relative to estimated ambient sound level spectra.

Section 6.0 presents a summary of findings and recommendations.

2.0 MINING LOCATION AND OPERATIONS

2.1. Site Location and Nearby Noise-Sensitive Receptor Sites

Locations of the Zavoral Site, the homes, and potential receptor sites in the Scenic Riverway for which noise levels have been evaluated are shown in **Figure 2.1.** A more detailed view of the home locations immediately adjacent to the site are shown in **Figure 2.2**.

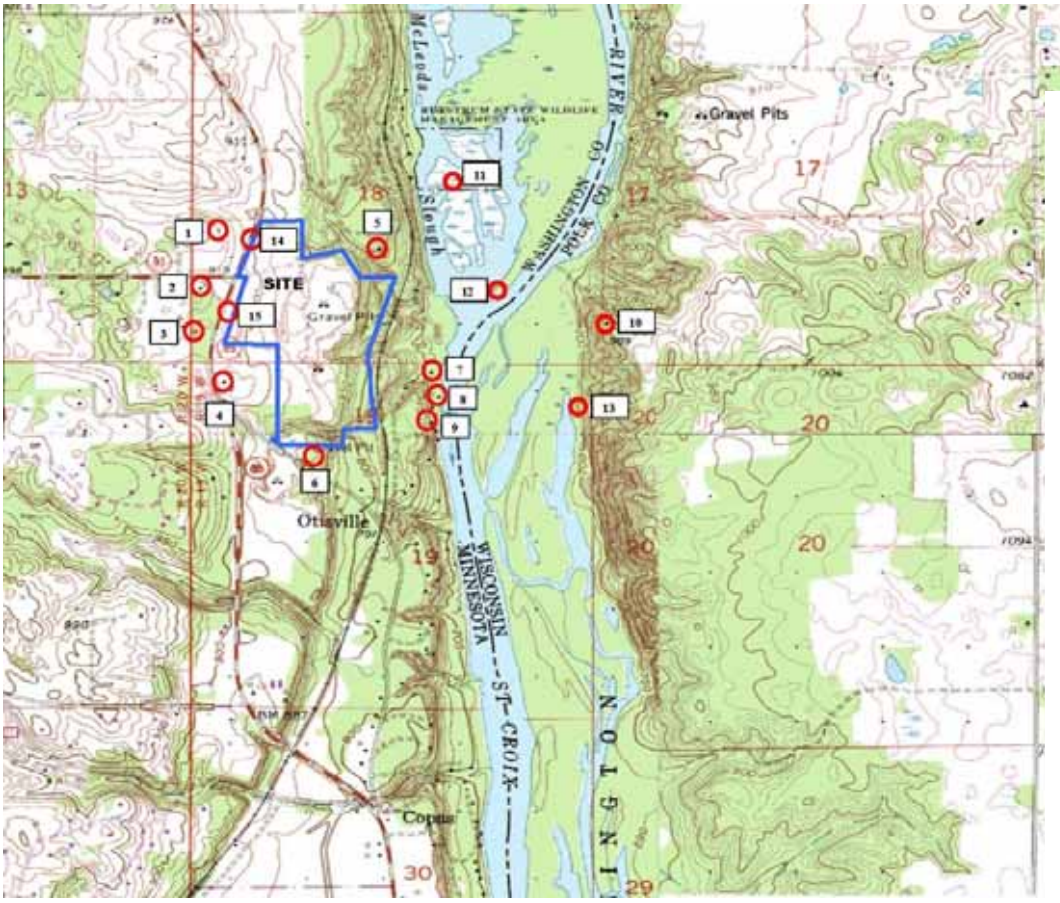
Fifteen representative receptor sites have been selected for noise impact analysis. These are listed in **Table 2.1** along with the applicable Minnesota Pollution Control Agency (MPCA) L10 and L50 noise standards for the given land use or Noise Area Classification (NAC), assuming that the sites in the Scenic Riverway and in Wisconsin are governed by these standards. Residential land uses are included under the NAC-1 land use classification commonly referred to as residential land uses Outdoor recreation other than designated camping and picnicking areas are included under the NAC-2 (or commercial) classification. Receptors 1 through 6 represent homes adjacent to the site. Receptors 7 through 9 represent some of the homes along the river. Receptor 10 represents a home in Wisconsin. Receptors 11 through 13 represent users on the river within the Scenic Riverway. Receptors 14 and 15 represent trail users along TH 95.

Table 2.1 Representative Noise Receptor Sites

Receptor Number	Land Use	Daytime Standard	
and Description	NAC	L10 (dBA)	L50 (dBA)
1-Home	1	65	60
2-Home	1	65	60
3-Home	1	65	60
4-Home	1	65	60
5-Home	1	65	60
6-Home	1	65	60
7-Home on River	1	65	60
8-Home on River	1	65	60
9-Home on River	1	65	60
10-Home (WS)	1	65	60
11-Wildlife Area	2	70	65
12-River Island	2	70	65
13-River Bank (WS)	2	70	65
14-TH95North	2	70	65
15-TH95South	2	70	65

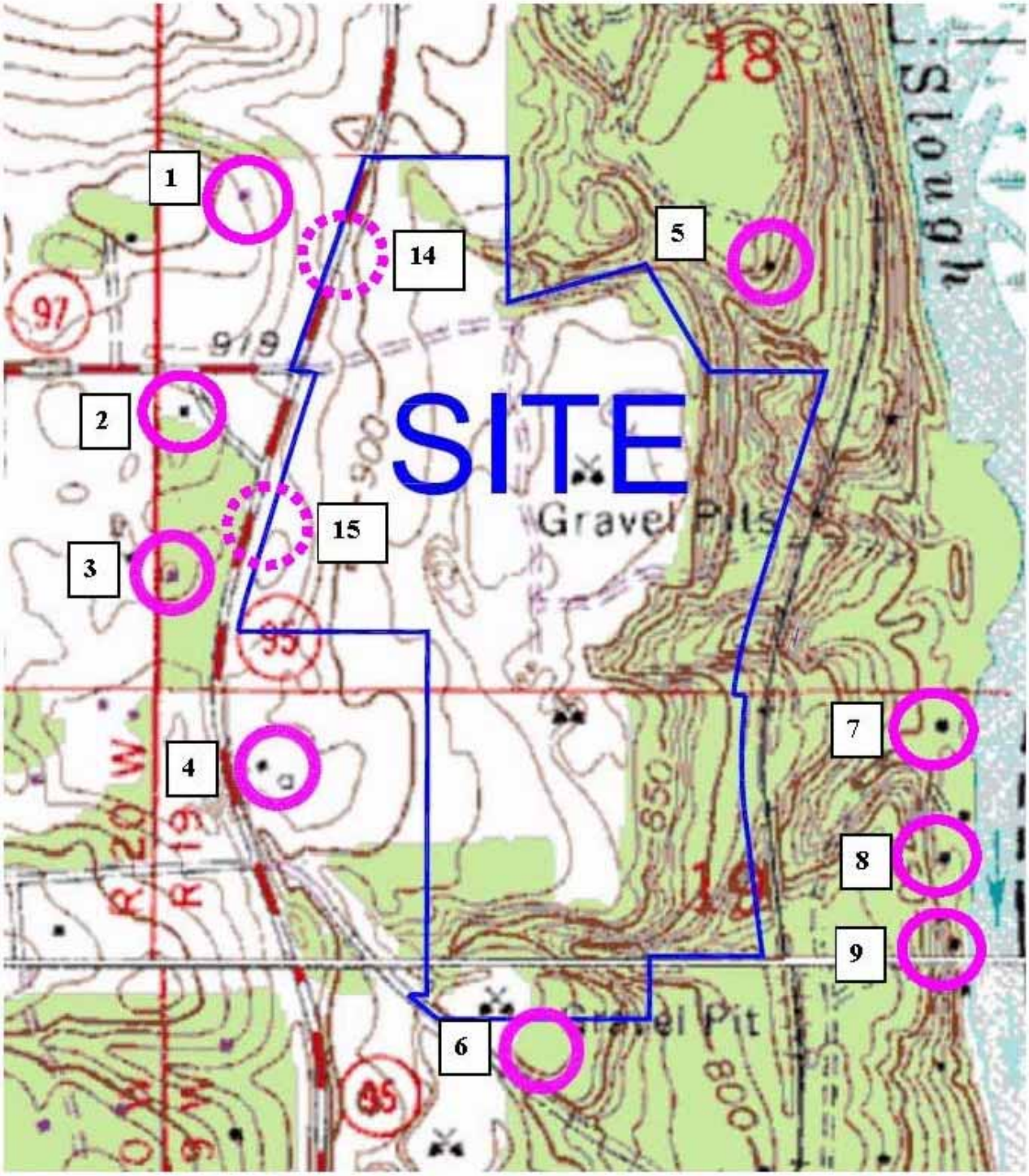
2.2. Mining Phase Boundaries and Associated Internal Haul Roads

Detailed phasing plans for the Zavoral Site that show mine phases, before and after contours and internal haul roads have been developed by Sunde Engineering. The three proposed mining phase boundaries and associated internal haul roads are shown in **Figure 2.3** (Phase 1), **Figure 2.4** (Phase 2) and **Figure 2.5** (Phase 3). Mine floor elevations are assumed to be the same as the restoration contours which represents "worst-case" as the mine floor may extend below the final reclamation grades, further screening operations and shielding noise emissions.

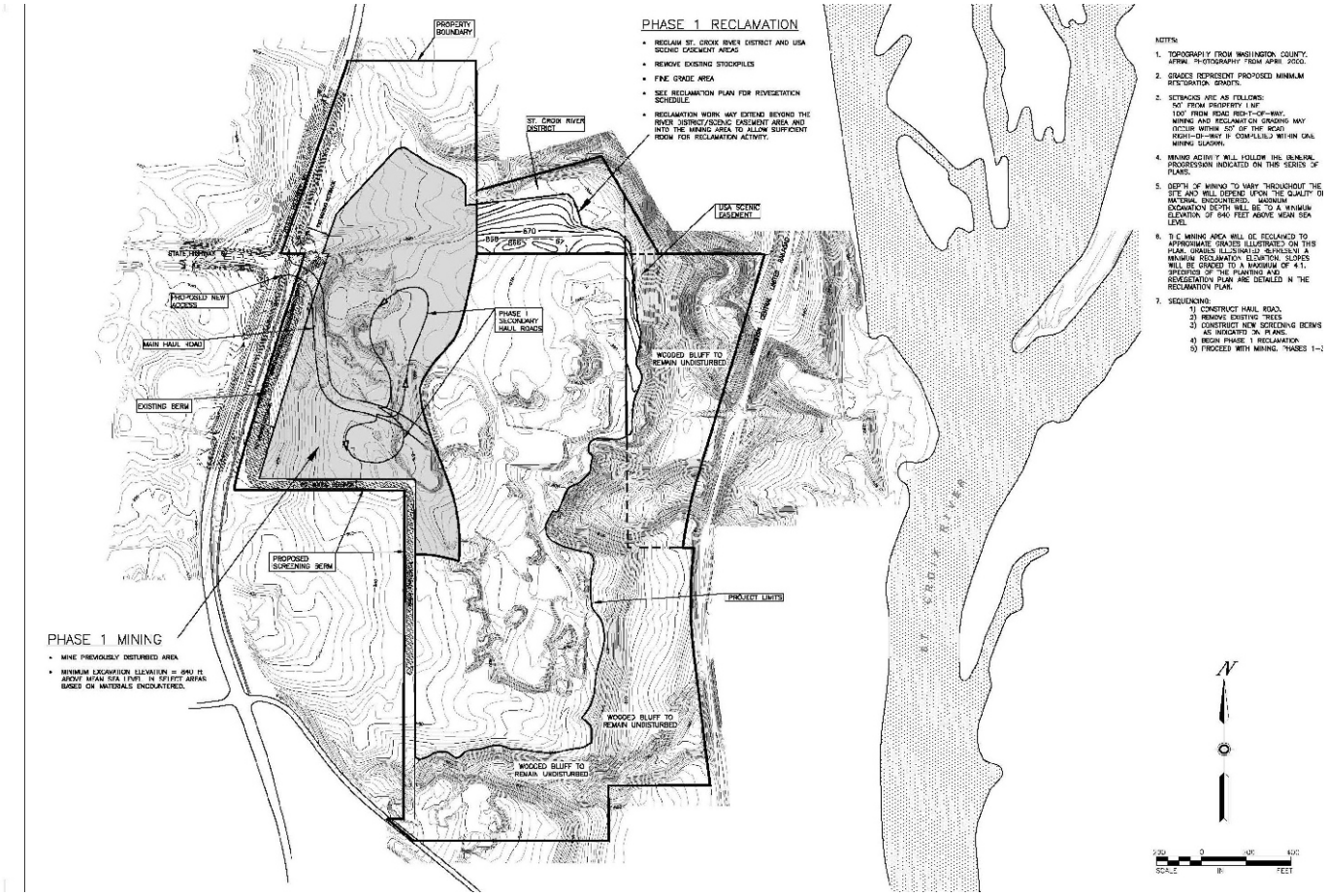


Receptor Number and Description
1-Home
2-Home
3-Home
4-Home
5-Home
6-Home
7-Home on River
8-Home on River
9-Home on River
10-Home (Wisc)
11-Wildlife Area
12-River Island
13-River Bank (Wisc)
14-TH95 North
15-TH95 South

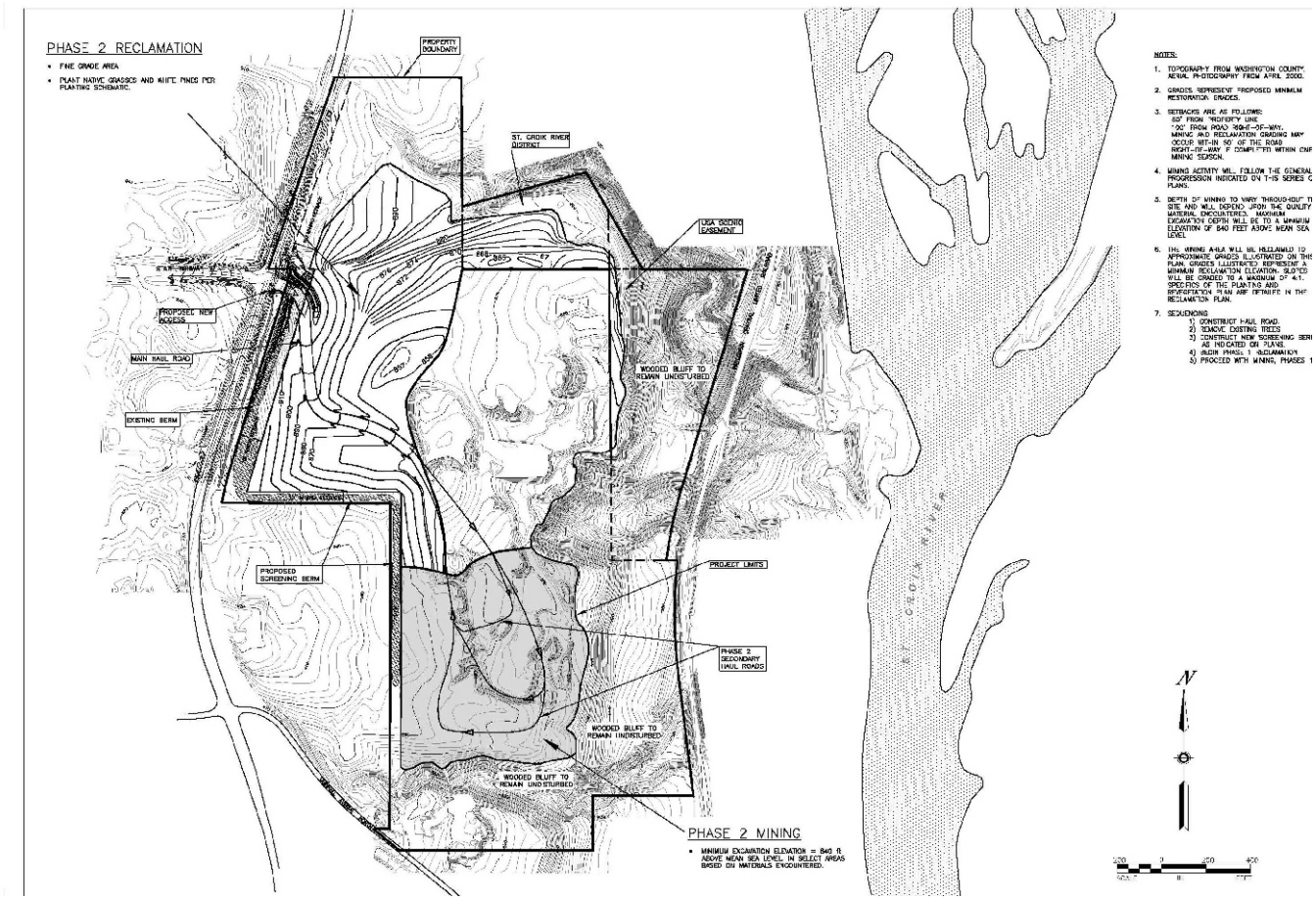
Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 2.1 Study Area Topography and Representative Receptor Sites



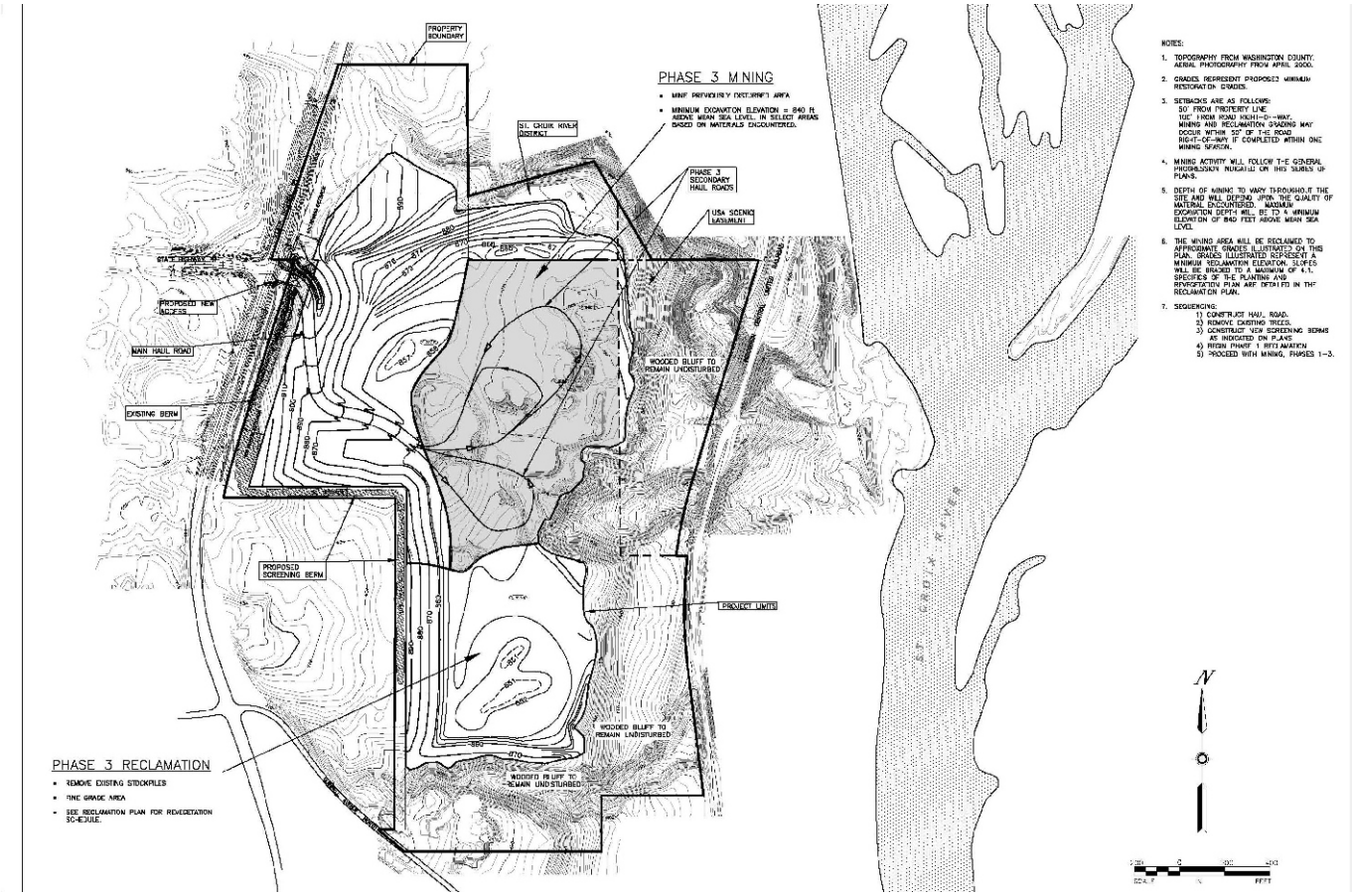
Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 2.2 Zavoral Site and Closest Residential Receptor Sites



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 2.3 Phase 1 Mining Boundary and Haul Roads



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 2.4 Phase 2 Mining Boundary and Haul Roads



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 2.5 Phase 3 Mining Boundary and Haul Roads

3.0 SOUND LEVEL MEASUREMENTS

3.1. Mining Equipment to be Used at the Site

Sound level measurements were taken on 16 December 2009 at the Sunrise Quarry of a CAT 345 excavator during truck loading operations. Similar equipment and operations are expected to be used at the Zavoral Site. Second-by-second octave band readings were taken with a Casella CEL Model 593 Type 1 sound level meter as the trucks approached, were loaded by the excavator and departed. By isolating sound from the excavator alone, it was possible to establish a reliable sound level for use in the noise prediction model. Front-end loader sound levels have been based upon earlier sound level measurements taken at a Tiller operation near Elk River. A photograph of the excavator from one of the sound level positions is shown in **Figure 3.1**

3.2. Ambient Sound Level Measurements Near the Site

Sound level monitoring was performed on Wednesday, 16 December 2009, at two locations at the mine boundary just east of TH 95 as shown on **Figure 3.2**. Larson-Davis Model 700 Type 2 sound level meters were set up at each of these sites. These collected data over 5-minute intervals and provided overall sound level distribution curves from approximately 11:30 a.m. until 3:30 p.m. In addition, more detailed octave band data were collected at the southerly site using 10-second intervals during the period 2:30 p.m. to 3:30 p.m.

Detailed results of the monitoring study were presented in a memorandum included here as **Appendix A**. The Mn/DOT 2006 Trunk Highway Volumes for the area show about 65% more traffic on TH 95 north of its intersection with TH 97 than south, reflecting a flow of commuter traffic to and from the Twin Cities. This difference in flow is reflected in the summary of sound level statistics of the data from the two sites in **Table 3.1**. The 5 dBA difference in the L50 or median level reflects the higher traffic level at the northerly monitoring location.

Table 1 Summary Sound Level Statistics

	Northerly	Southerly
L01	67.0	67.5
L10	58.5	58.0
L50	46.5	41.5
L90	35.5	35.0
L99	33.5	33.5

The background level (normally considered to be the L90 level or level exceeded for 90% of the monitoring period) was 35 dBA at the southerly monitoring site, slightly higher than the 35.5 dBA at the northerly monitoring site, indicating some limited influence by traffic. The background level is seen to drop to 33.5 dBA at both sites when there was no vehicle within about ½ mile of the monitoring sites.

Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 3.1 Photograph of Excavator

Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 3.2 Ambient Sound Level Monitoring Sites

4.0 PROJECTED SOUND LEVELS FROM MINING ACTIVITY

4.1. Sound Propagation Modeling

Sound propagation modeling was based upon procedures outlined in the International Standards Organization (ISO) 9613-1 and 9613-2 standards on outdoor sound propagation. This takes into account source spectral level, distance from source to receiver, atmospheric absorption, shielding by barriers or topography, tree cover absorption and ground effect. Since the ground effect variable is generally small and may not be accurate in highly variable topography such as near the Zavoral Site, this factor was not included in this analysis. Attenuation by tree cover has also not been included since a typical path through trees from the Zavoral Site to the river below will be fairly short. This could be more significant for homes situated above the river, but ignoring this effect will ensure a worst case predicted level at these receptor sites.

The receptor sites that were shown in **Figure 2.1** and **Figure 2.2** are shown here schematically on the noise model layout in **Figure 4.1**.

4.2. Excavating and Loading

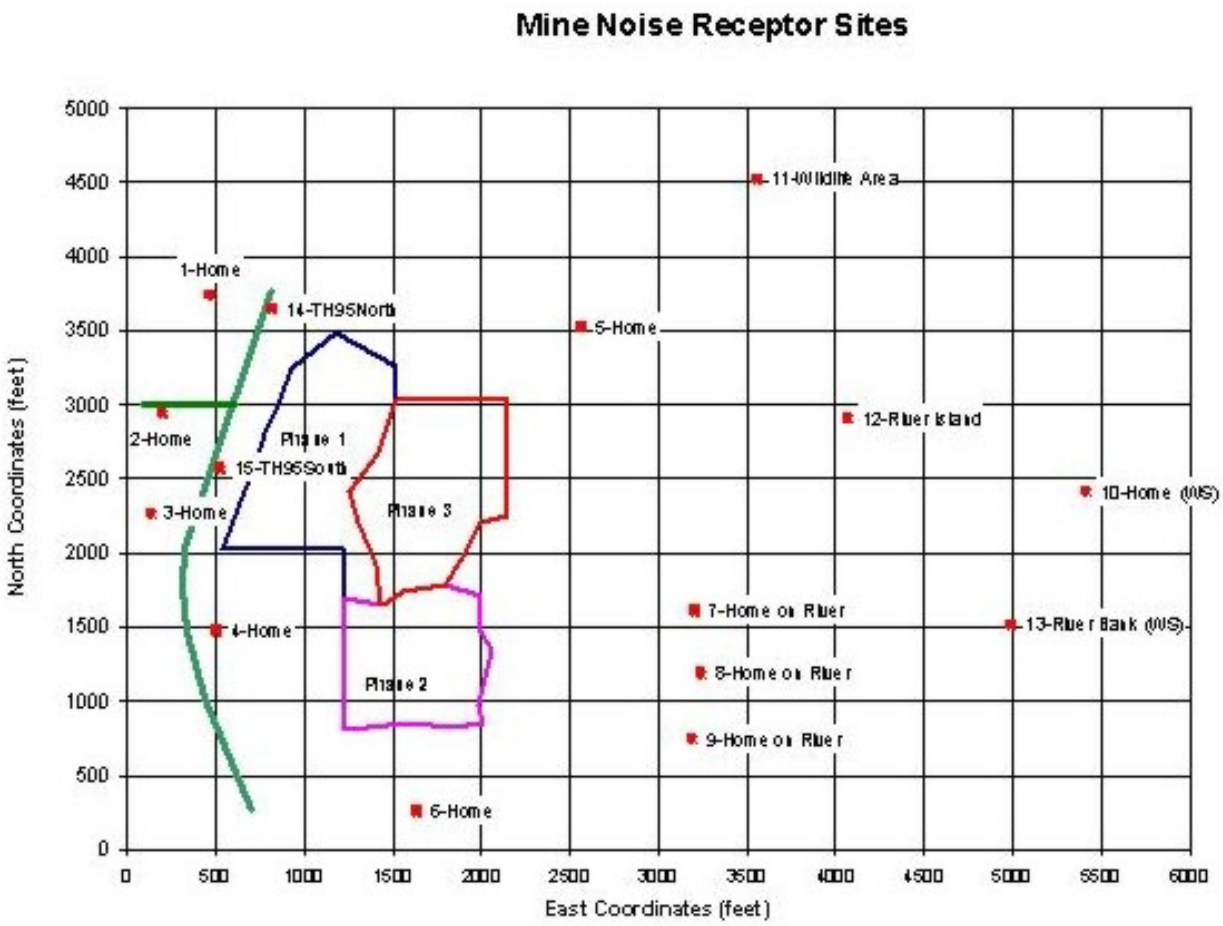
Assumed mining source locations and the surrounding edge of the mined area that will provide some limited shielding of this equipment are shown on **Figure 4.2**, **Figure 4.3** and **Figure 4.4**. The sources are modeled at approximately 100 feet from the mine area boundary. The source spectra for the mining equipment are shown in **Figure 4.5**. It is assumed that the excavator contributes 60% of the sound since it operates more continuously while the front-end loader contributes 40% of the sound. A source height of 13 feet was assumed for both the excavator and the front-end loader.

Based upon sound level measurements at the Sunrise mine, it is estimated that the L10 level associated with mining equipment is only 1 dBA lower than the instantaneous maximum level. An example of the predicted L10 levels associated with the mining equipment for Phase 1 is shown in **Table 4.1**.

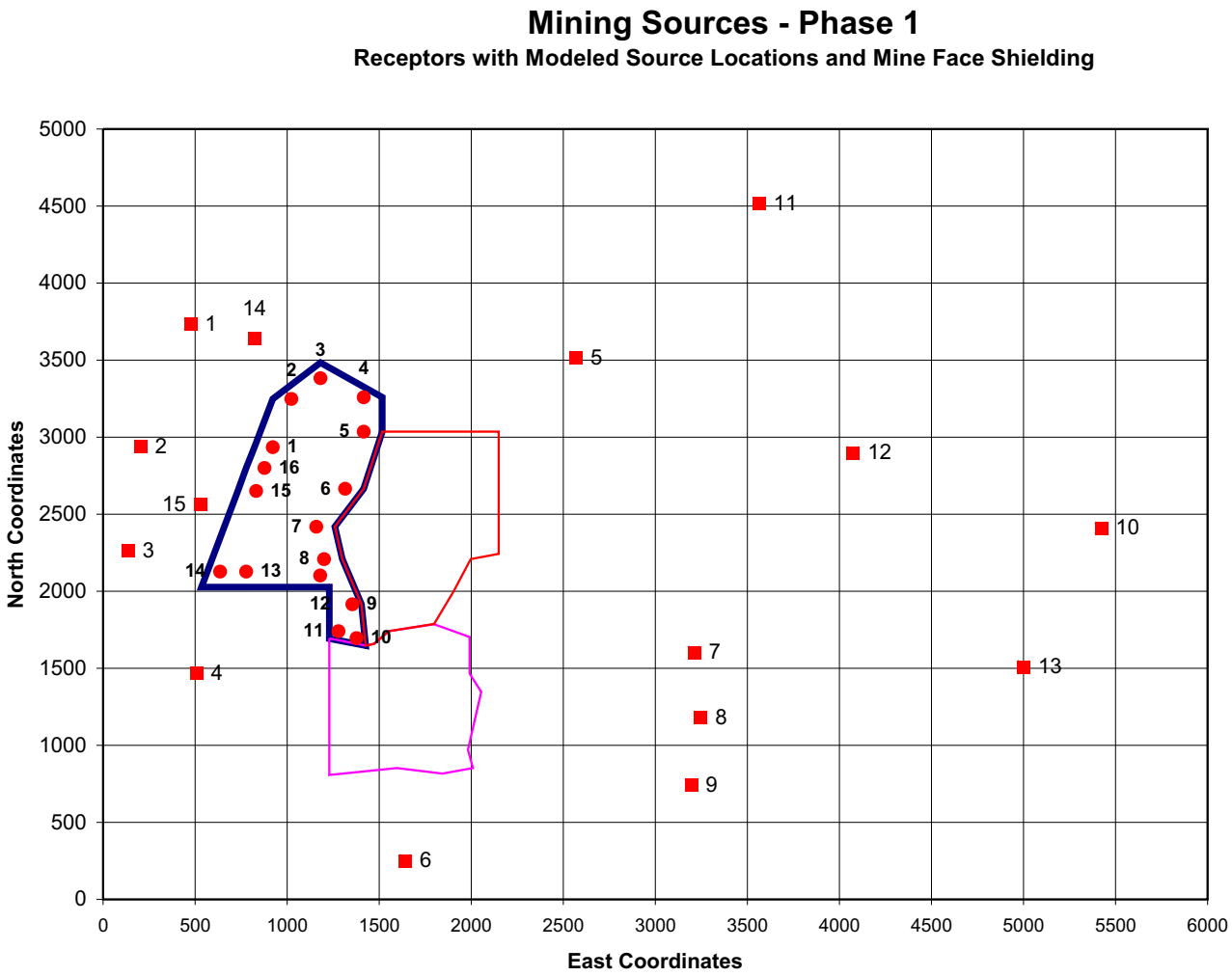
Table 4.1 Predicted Mine Equipment L10 Levels (dBA) for Phase 1

Source	Rec 1	Rec2	Rec 3	Rec 4	Rec 5	Rec 6	Rec 7	Rec 8	Rec 9	Rec 10	Rec 11	Rec 12	Rec 13	Rec 14	Rec 15
1	48.8	51.2	47.6	43.8	42.4	37.5	38.0	37.0	36.1	32.1	30.6	36.4	32.6	51.2	48.8
2	51.0	49.3	45.2	41.8	38.4	36.5	37.6	36.5	35.6	32.2	37.2	28.8	32.6	55.8	49.6
3	41.2	42.2	38.2	40.8	36.8	31.1	30.6	30.6	29.5	26.8	30.6	37.8	27.3	45.6	47.5
4	47.4	40.6	37.6	40.9	36.3	36.6	33.5	32.1	30.8	33.2	29.1	31.3	33.5	45.7	39.6
5	46.4	40.9	37.6	42.0	36.7	31.6	32.6	31.4	30.3	28.1	29.7	29.9	27.6	44.3	41.1
6	44.9	39.5	40.1	44.3	36.8	33.8	34.7	33.5	32.4	33.2	30.0	29.5	28.8	47.1	41.5
7	44.0	41.2	41.7	46.6	36.0	34.2	34.2	33.0	31.9	32.8	29.5	27.0	28.5	45.6	43.0
8	42.7	38.3	41.4	42.2	32.9	34.2	32.4	31.5	30.6	24.7	27.0	25.8	26.9	44.0	41.6
9	40.9	37.3	39.5	43.2	30.5	35.4	33.3	32.5	31.8	23.3	24.9	26.4	27.0	42.0	39.6
10	39.8	36.9	39.9	38.7	31.2	32.0	30.4	29.9	29.5	23.8	25.6	36.6	24.1	40.9	38.6
11	40.2	43.2	45.7	49.9	40.0	43.7	41.3	40.7	40.1	33.0	34.7	36.6	34.3	36.1	40.5
12	42.2	45.5	47.4	48.7	41.1	41.5	40.5	39.7	38.9	32.8	35.3	35.3	33.9	38.4	43.7
13	43.1	48.0	52.0	51.3	39.7	40.6	33.5	33.0	32.2	31.8	28.8	29.8	32.8	43.8	49.0
14	43.2	48.8	54.3	51.8	33.7	40.3	32.3	32.1	31.1	31.5	28.0	35.8	32.4	38.5	50.5
15	46.7	51.5	50.2	46.0	41.3	38.5	38.2	37.3	36.5	31.9	30.3	30.9	32.6	48.1	53.8
16	47.8	51.6	48.8	44.8	36.6	38.0	38.1	37.1	36.3	32.0	30.6	43.4	32.6	49.6	51.0

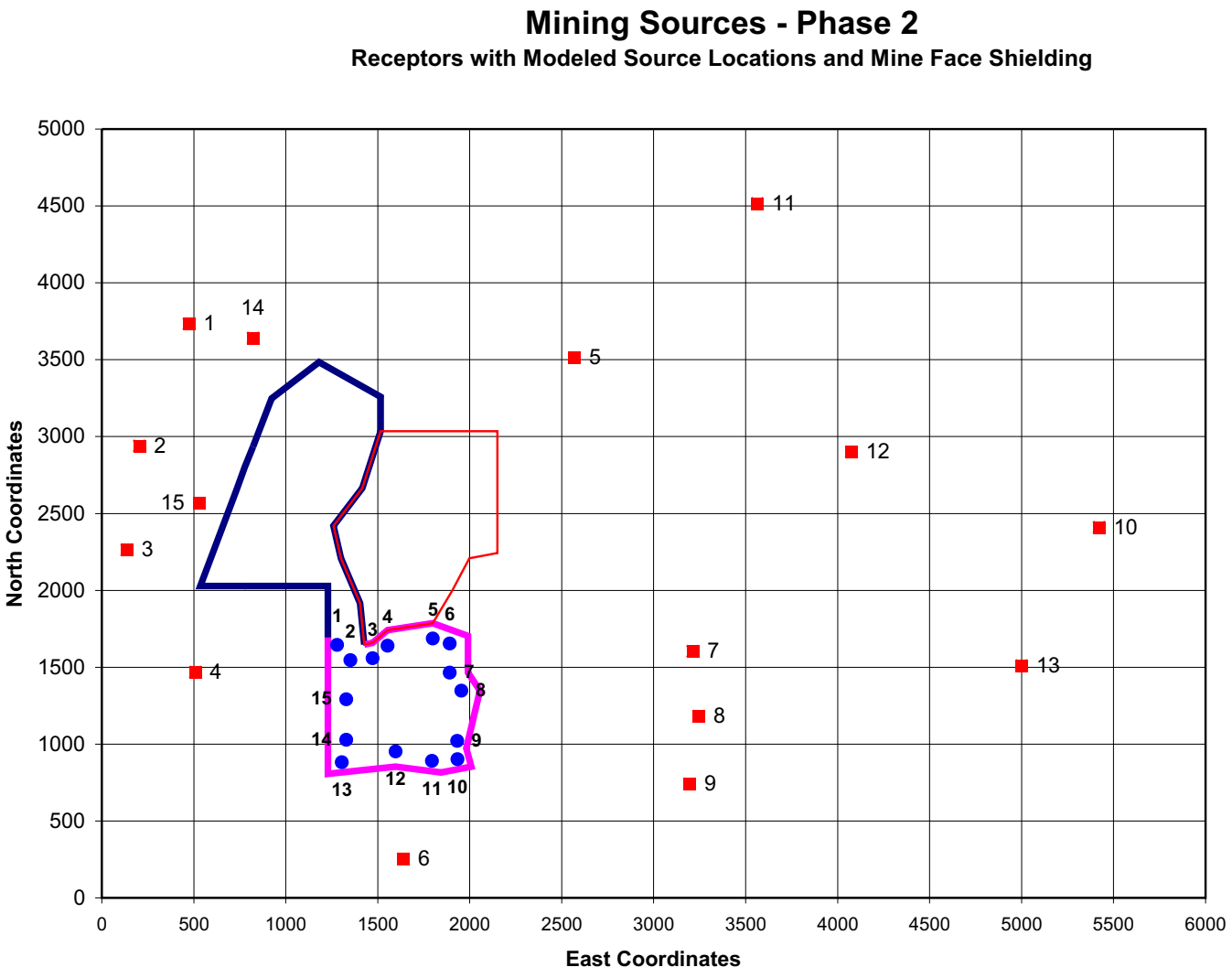
The L10 levels at residential receptor sites (1-10) range from 23.3 to 51 dBA, substantially lower than the L10 65 dBA daytime standard. The Riverway L10 levels (11-13) range from 24.1 to 43.4 dBA, substantially lower than the applicable L10 70 dBA standard. The two trail receptors (14 and 15) are also well below the applicable L10 70 dBA standard.



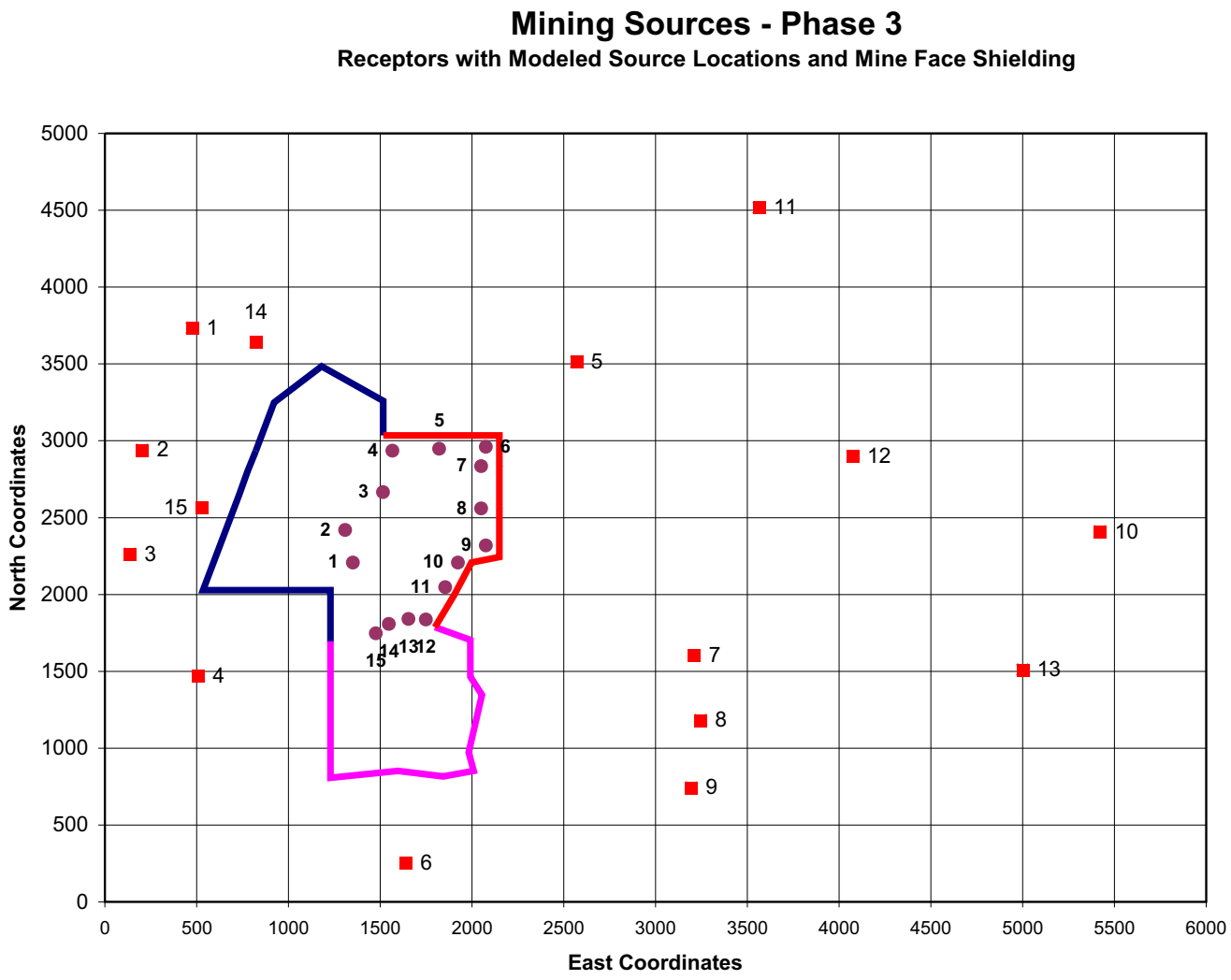
Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.1 Model Layout of Receptor Sites and Mine Phases



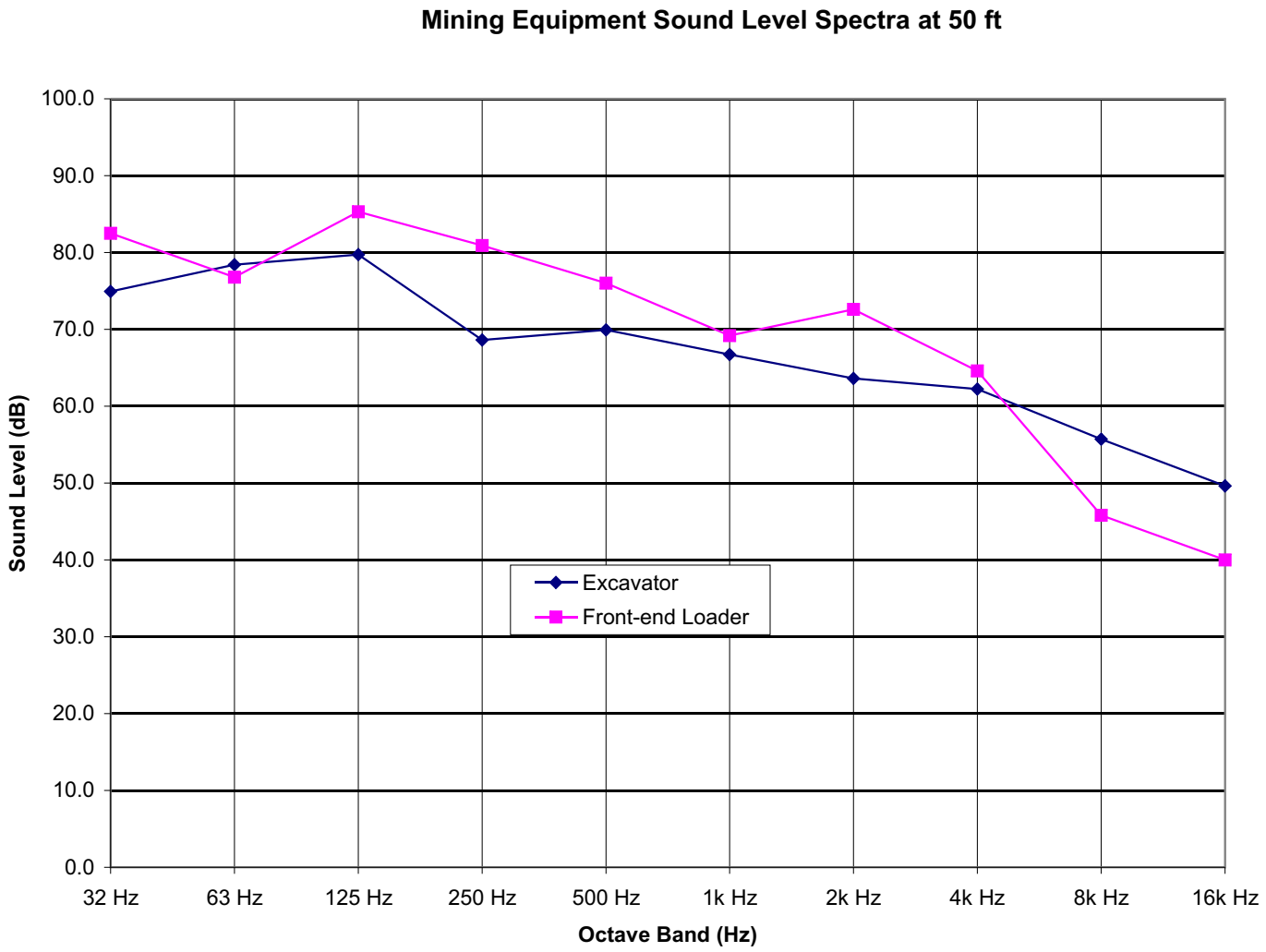
Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.2 Modeled Mining Equipment Sources for Phase 1



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.3 Modeled Mining Equipment Sources for Phase 2



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.4 Modeled Mining Equipment Sources for Phase 3



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.5 Modeled Sound Level Spectra for the Excavator and Front-end Loader

4.3. Haul Trucks

Modeled haul truck routes within the mine and the surrounding edge of the mined area that will provide shielding for some of the haul truck routes are shown in **Figure 4.6**, **Figure 4.7** and **Figure 4.8**. The haul truck spectrum shown in **Figure 4.9** is based upon the assumption that the trucks will meet the 82 dBA level required at 50 feet from the truck by Minnesota Rule 7030.1040 on vehicle noise limits, assuming that trucks may be older than the 1982 model year.

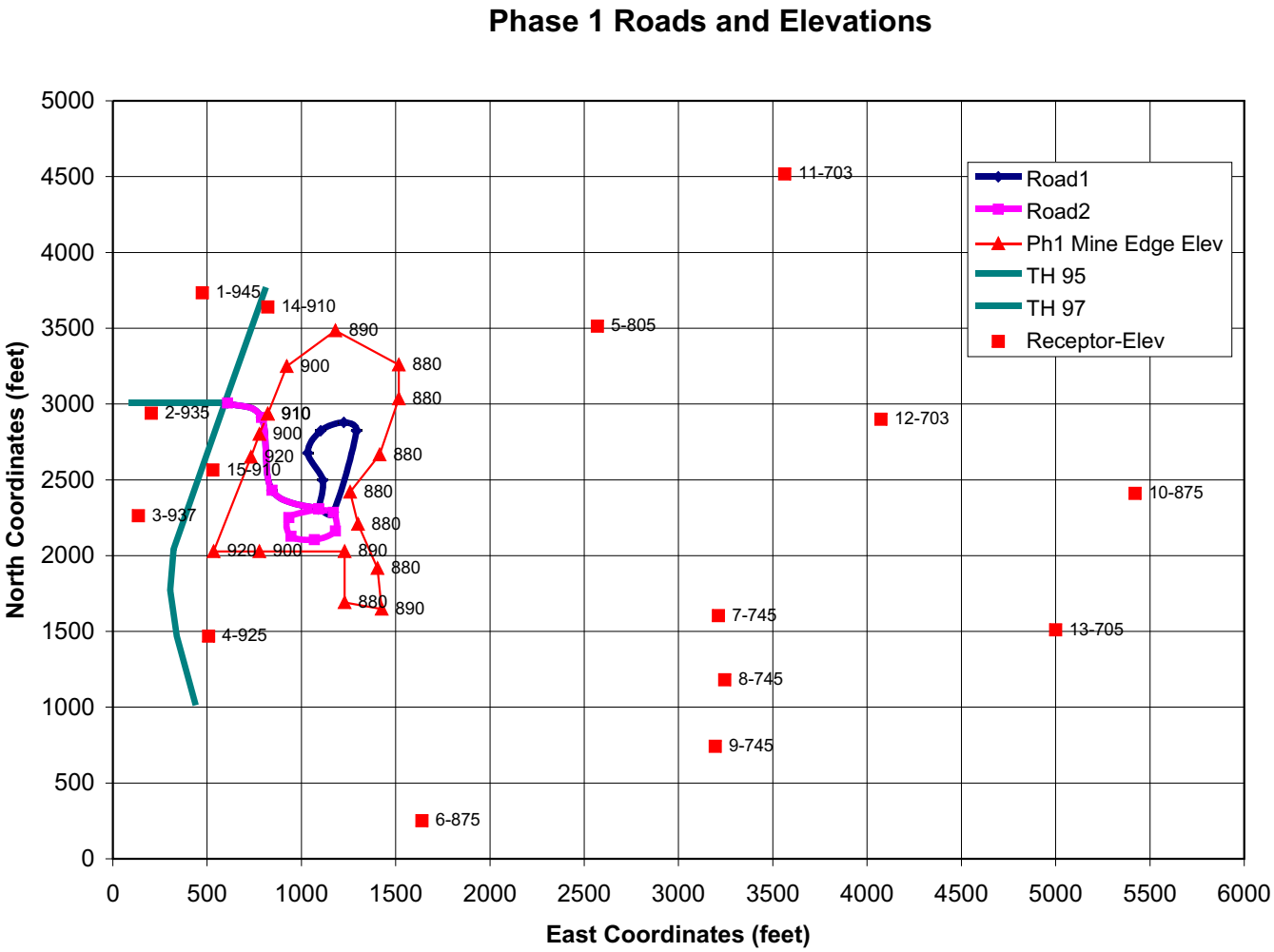
Haul truck sound levels have been estimated using the MinnNoise traffic noise model utilizing a typical and associated sound level at 15 mph. While haul truck levels have been predicted for each route within each phase, the calculated average haul truck L10 levels by phase and receptor are shown in **Table 4.2**. Predicted average L50 levels are shown in **Table 4.3**. Average noise levels for all haul truck locations within each phase are used when combining with mining equipment levels since trucks could be at any location within the mine for a given location of mining equipment.

Table 4.2 Predicted Average Haul Truck L10 Levels (dBA)

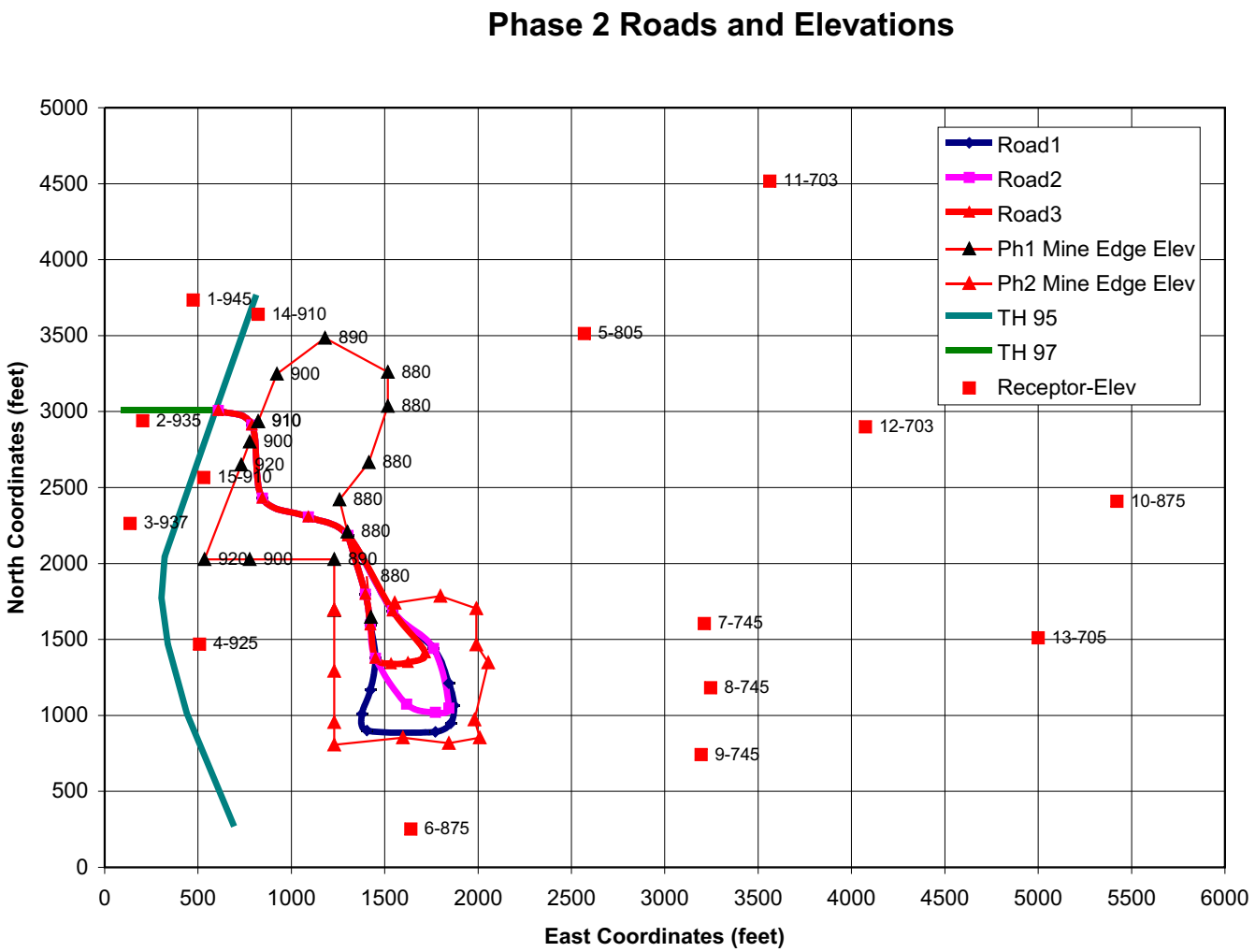
Average Haul Truck L10 by Phase			
Receptor	Phase1	Phase 2	Phase 3
1	46.7	46.4	46.5
2	50.3	50.2	50.3
3	48.0	48.5	48.4
4	47.0	48.6	47.3
5	40.1	41.9	40.4
6	37.9	48.2	41.3
7	36.6	41.4	38.6
8	35.7	40.9	38.5
9	34.9	40.0	37.4
10	30.7	34.0	33.3
11	33.0	35.5	33.7
12	33.9	37.4	35.4
13	31.0	35.4	33.9
14	48.6	48.0	48.3
15	53.9	54.0	53.9

Table 4.3 Predicted Average Haul Truck L50 Levels (dBA)

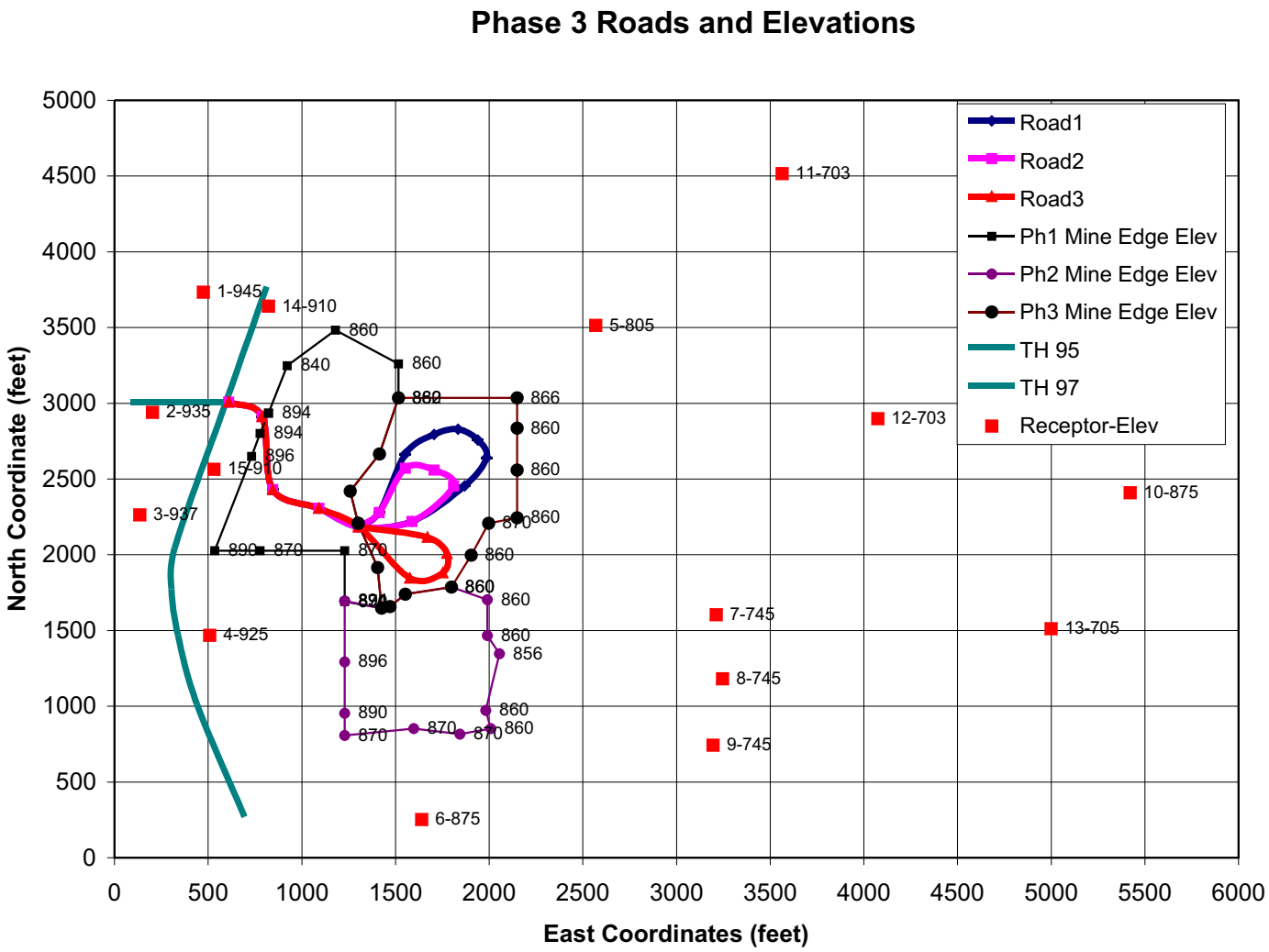
Average Haul Truck L50 by Phase			
Receptor	Phase1	Phase 2	Phase 3
1	40.5	40.3	40.6
2	43.3	43.2	43.3
3	42.1	43.1	42.9
4	41.2	43.8	42.0
5	34.4	37.2	34.8
6	32.2	42.8	36.2
7	30.9	36.4	32.8
8	30.0	35.7	33.0
9	29.2	34.6	31.9
10	25.2	29.5	28.3
11	27.2	30.8	28.1
12	28.2	32.7	29.8
13	25.4	30.8	28.8
14	42.4	41.8	42.4
15	46.3	46.3	46.2



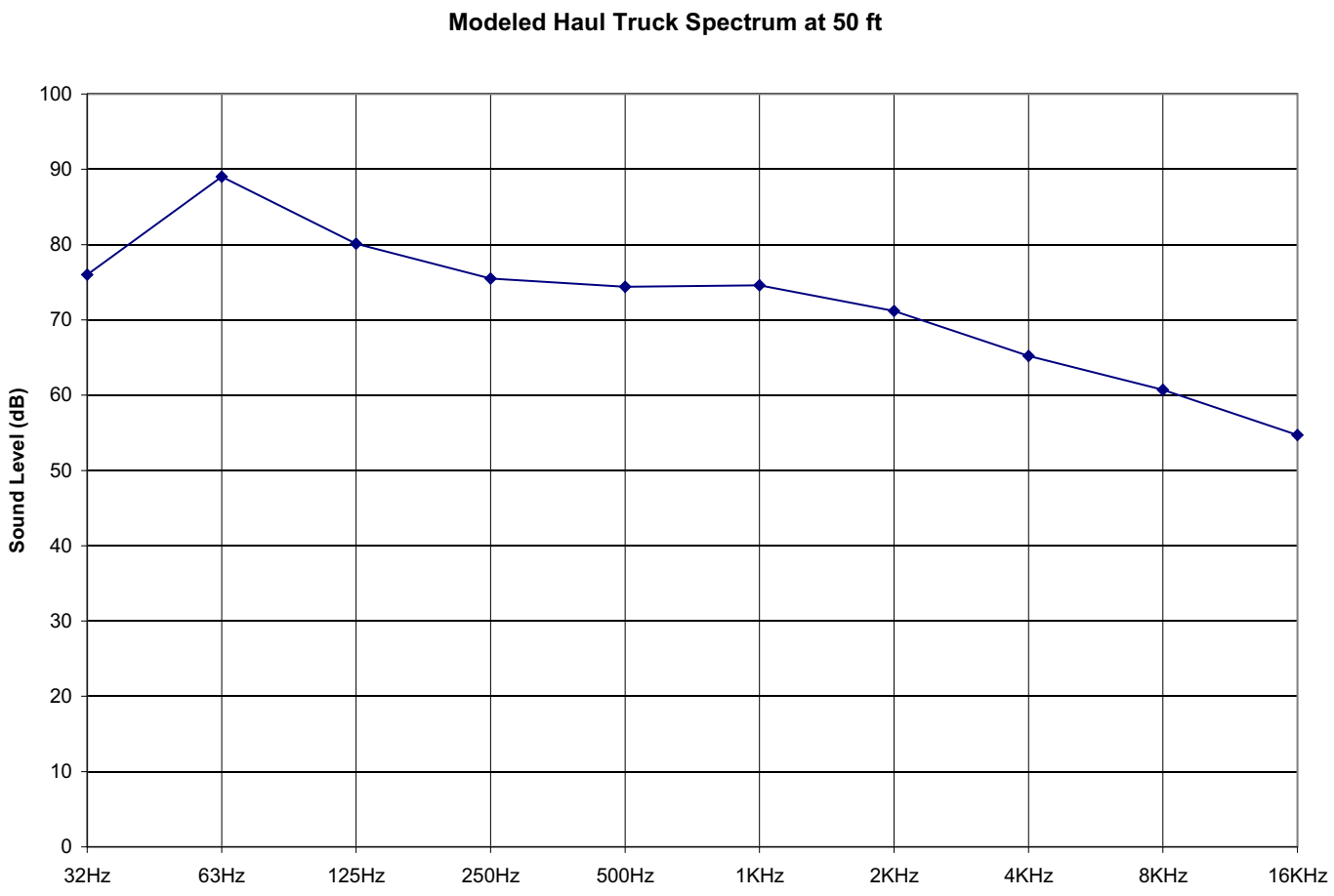
Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.6 Phase 1 Haul Roads



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.7 Phase 2 Haul Roads



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.8 Phase 3 Haul Roads



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 4.9 Modeled Haul Truck Sound Level Spectrum at 50 ft and 15 mph

4.4. Combined Activity Levels

Mining activity will occur simultaneously with haul truck activity. The mining equipment and haul truck levels are combined into an overall L10 level using predicted mining equipment combined with average haul truck L10 levels for each phase. **Table 4.4** shows the maximum expected L10 level at each receptor by phase as well as the average L10 level for mining equipment at all locations around the perimeter of each phase. **Table 4.5** compares predicted L10 levels with the daytime L10 residential noise standard of 65 dBA and shows that predicted levels range from 9.8 dBA to 36 dBA below the applicable standard.

Table 4.4 Combined Mining Equipment and Haul Truck L10 Levels (dBA)

	Phase 1		Phase 2		Phase 3	
Receptor	Maximum	Average	Maximum	Average	Maximum	Average
1	52.3	48.9	47.3	47.0	48.8	47.8
2	54.0	51.7	50.9	50.5	51.4	50.8
3	55.2	50.1	50.2	49.4	49.9	49.3
4	53.0	49.4	52.5	50.6	50.2	48.8
5	44.4	42.0	44.5	43.6	50.0	43.2
6	44.7	40.7	53.5	51.1	45.8	44.1
7	42.5	39.2	46.7	44.4	45.9	42.1
8	41.9	38.3	46.7	44.4	44.3	41.2
9	41.3	37.5	46.6	44.0	42.8	40.0
10	35.2	33.8	37.4	36.9	37.5	36.9
11	38.6	35.0	38.5	37.9	40.6	36.1
12	43.9	36.9	41.0	40.1	42.0	38.4
13	35.9	34.0	38.9	38.2	38.4	36.7
14	56.5	50.6	48.7	48.5	51.0	49.6
15	56.9	54.7	54.2	54.1	54.2	54.1

Table 4.5 Comparison of L10 Levels with Minnesota Noise Standards (dBA)

	Phase 1		Phase 2		Phase 3	
Receptor	Maximum	Average	Maximum	Average	Maximum	Average
1	-12.7	-16.1	-17.7	-18.0	-16.2	-17.2
2	-11.0	-13.3	-14.1	-14.5	-13.6	-14.2
3	-9.8	-14.9	-14.8	-15.6	-15.1	-15.7
4	-12.0	-15.6	-12.5	-14.4	-14.8	-16.2
5	-20.6	-23.0	-20.5	-21.4	-15.0	-21.8
6	-20.3	-24.3	-11.5	-13.9	-19.2	-20.9
7	-22.5	-25.8	-18.3	-20.6	-19.1	-22.9
8	-23.1	-26.7	-18.3	-20.6	-20.7	-23.8
9	-23.7	-27.5	-18.4	-21.0	-22.2	-25.0
10	-29.8	-31.2	-27.6	-28.1	-27.5	-28.1
11	-31.4	-35.0	-31.5	-32.1	-29.4	-33.9
12	-26.1	-33.1	-29.0	-29.9	-28.0	-31.6
13	-34.1	-36.0	-31.1	-31.8	-31.6	-33.3
14	-13.5	-19.4	-21.3	-21.5	-19.0	-20.4
15	-13.1	-15.3	-15.8	-15.9	-15.8	-15.9

Table 4.6 shows the maximum expected L50 level at each receptor by phase as well as the average L50 level for mining equipment at all locations around the perimeter of each phase. **Table 4.7** compares predicted L50 levels with the daytime L50 60 dBA residential noise standard and L50 65 dBA standard for park and recreational users and shows that predicted levels range from 8.3 dBA to 35.2 dBA below the applicable standard. Refer back to **Table 2.1** for the land use classification and the applicable noise standard at each receptor site.

Table 4.6 Combined Mining Equipment and Haul Truck L50 Levels (dBA)[1]

	Phase 1		Phase 2		Phase 3	
Receptor	Maximum	Average	Maximum	Average	Maximum	Average
1	48.7	44.3	41.9	41.4	44.3	42.8
2	49.7	46.0	44.8	43.9	45.7	44.4
3	51.7	45.4	45.8	44.6	45.2	44.4
4	49.5	44.9	48.9	46.5	46.2	44.3
5	40.5	37.5	40.7	39.5	46.7	38.8
6	41.3	36.3	49.9	47.0	42.2	40.1
7	39.0	34.8	43.2	40.5	42.5	37.8
8	38.4	34.0	43.2	40.5	40.8	36.9
9	37.8	33.1	43.2	40.1	39.2	35.6
10	31.4	29.7	33.7	33.1	33.9	33.1
11	35.0	30.4	34.8	34.0	37.2	31.7
12	40.7	32.5	37.4	36.3	38.6	34.1
13	32.3	29.8	35.2	34.4	34.8	32.6
14	53.1	45.7	43.3	42.8	46.7	44.5
15	52.1	48.1	46.9	46.6	46.9	46.5

Table 4.7 Comparison of L50 Levels with Minnesota Noise Standards (dBA)[1]

	Phase 1		Phase 2		Phase 3	
Receptor	Maximum	Average	Maximum	Average	Maximum	Average
1	-11.3	-15.7	-18.1	-18.6	-15.7	-17.2
2	-10.3	-14.0	-15.2	-16.1	-14.3	-15.6
3	-8.3	-14.6	-14.2	-15.4	-14.8	-15.6
4	-10.5	-15.1	-11.1	-13.5	-13.8	-15.7
5	-19.5	-22.5	-19.3	-20.5	-13.3	-21.2
6	-18.7	-23.7	-10.1	-13.0	-17.8	-19.9
7	-21.0	-25.2	-16.8	-19.5	-17.5	-22.2
8	-21.6	-26.0	-16.8	-19.5	-19.2	-23.1
9	-22.2	-26.9	-16.8	-19.9	-20.8	-24.4
10	-28.6	-30.3	-26.3	-26.9	-26.1	-26.9
11	-30.0	-34.6	-30.2	-31.0	-27.8	-33.3
12	-24.3	-32.5	-27.6	-28.7	-26.4	-30.9
13	-32.7	-35.2	-29.8	-30.6	-30.2	-32.4
14	-11.9	-19.3	-21.7	-22.2	-18.3	-20.5
15	-12.9	-16.9	-18.1	-18.4	-18.1	-18.5

[1] Values for Phase 3 have been revised on 26 January 2012

5.0 AUDIBILITY OF MINING ACTIVITY IN THE SCENIC WATERWAY

5.1. Issues Related to the St. Croix Scenic Riverway

The National Park Service has adopted policies related to maintenance of natural soundscapes in parks. The Final Cooperative Management Plan Environmental Impact Statement for the Lower St. Croix National Scenic Riverway (Minnesota and Wisconsin) was reviewed to identify potential concerns regarding noise levels and to identify any information on existing sound levels.

Areas are classified with respect to the potential for noise level expectations of waterway uses. The area by the Zavoral Site is classified in the management plan as "Rural Residential" on the Minnesota side and "Conservation" on the Wisconsin side. These management objectives from the EIS are included below. It can be seen that, with homes and docks on one side of the river, the two objectives are inconsistent.

> Rural Residential (p.49)(text in **bold** for emphasis)
> This area would provide a feeling of being on a river in a sparsely developed landscape. As in the small town management areas, the river, natural features, and man-made features would shape the riverway experience. Users would encounter no large concentrations of development or people — small numbers of people would be the rule in this area, with little or no commercial development. Residential settings would be limited to large lot development scattered along the shore and/or bluffs at a lower density than the small town or river town management areas. Natural vegetation would cover significant portions of the shoreline, with some stretches being largely undisturbed. Riverway users **could anticipate moderate noise levels**. The area would offer abundant opportunities to fish and view wildlife. There might be a few mall public recreational support facilities (e.g.,docks and launches) and some private docks
>
> Conservation (p.53)
> This management area would provide users with a sense of being in a natural setting. Very few signs of development, such as homes, bridges, or agricultural fields, would intrude on this largely natural scene. The river and surrounding biological communities would dominate the user experience. The shoreline would not be disturbed by the few visible signs of development. Forest management would emphasize the undisturbed appearance. This area would provide many opportunities to view wildlife, and there would be abundant opportunities for angling. Access to the river would be limited to a few public carry-in and small craft access points and a very few riparian landowner private docks. Recreational support facilities (e.g., primitive campsites, trails) would be small, limited in number, and largely screened by natural vegetation. With few access points, small numbers of people and infrequent encounters, there would be ample opportunity for quiet and solitude

With motorized boats permitted on this portion of the river and with homes and docks along the Minnesota side of the river, the management objectives indicate that river users can anticipate moderate noise levels.

5.2. Ambient Sound Level in the Scenic Waterway

Figure 5.1 is an estimate of the ambient sound level based upon winter readings on the bluff above the river when no specific non-natural sound sources were audible and combined with predicted average hourly traffic noise on a summer day based upon MnDOT traffic counts and the MinnNoise traffic model, assuming existing haul truck movements on TH 97 and TH 95 north of its intersection with TH 97. It is expected that summer ambient levels without traffic will be the same or higher due to vegetation and users on and adjacent to the river.

5.3. Estimated Mining Activity Sound Level Spectra

Figure 5.2 shows estimated mining activity spectra assuming no attenuation from trees on the bluff slope since these generally lie below the line of sight between the edge of the mine area and the river. These maximum spectra will generally not occur simultaneously although there can be periods when they combine, yielding a slightly higher sound level.

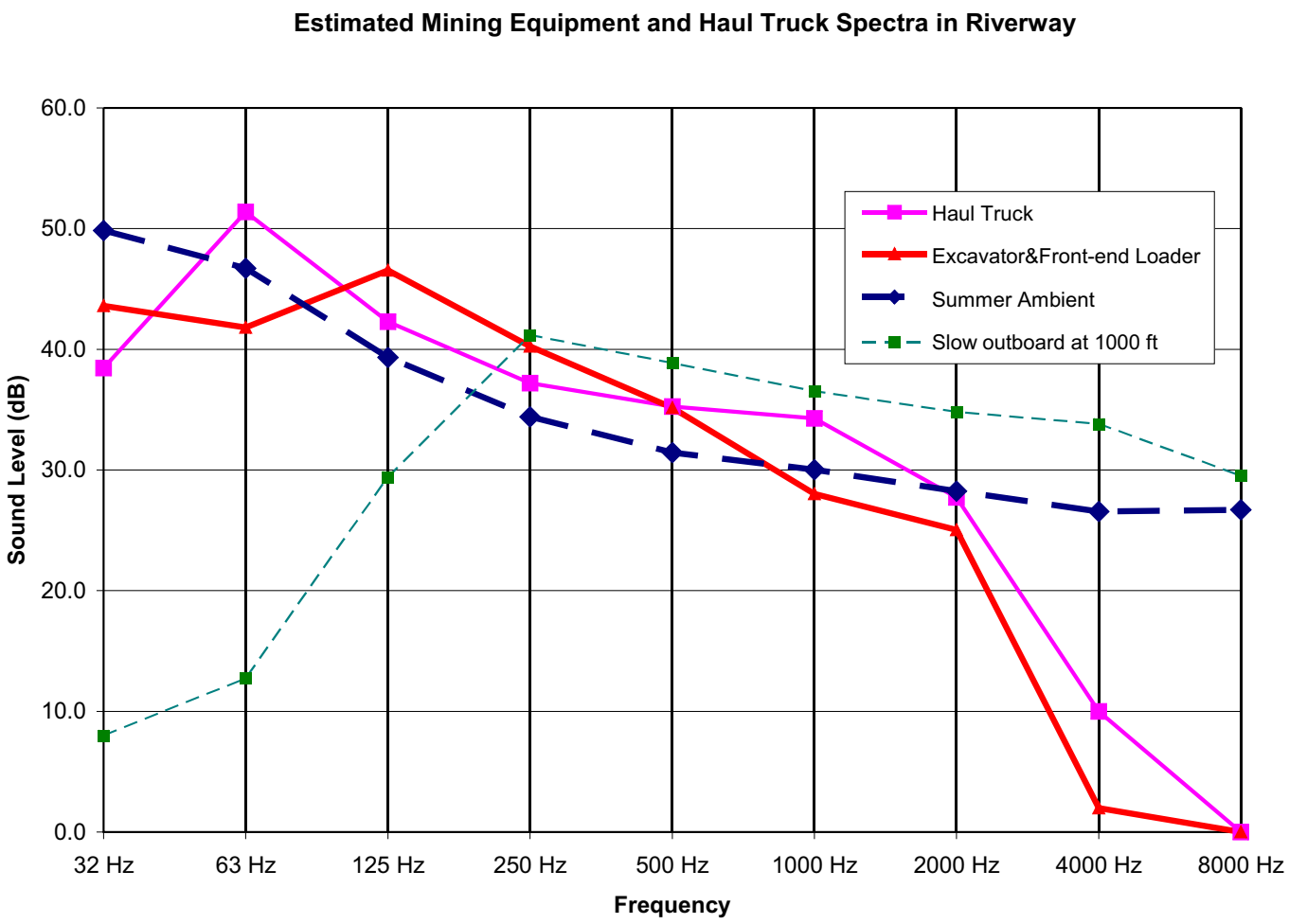
5.4. Potential Audibility of Mining Activities

While there are no standards or quantitative guidelines governing audibility, the concept is addressed here in keeping with the National Park Service concerns with minimizing intrusions in to the natural soundscape. Audibility is normally evaluated using one-third octave rather than octave band data but the concept can be simplified for use with octave band data only. With this simplification, a non-ambient source is considered to be audible when its spectrum level is equal to (just touching the ambient spectrum) or higher than the ambient spectrum at that particular frequency. Thus, from **Figure 5.2,** which also includes the estimated octave band ambient spectrum**,** it can be seen that, without assuming any attenuation from tree cover on the bluff, both the mining equipment and the haul trucks could be audible within the Riverway. For example, the combined excavator and front-end loader spectrum is predicted to exceed the ambient spectrum by five dBA at 125 Hz and 250 Hz, and four dBA at 500 Hz and by the definition above would be audible. Since motorized boats can use this portion of the river, the estimated sound level spectrum of an outboard motor boat moving just above idle speed 1000 feet from a listener on the river is also shown on the chart. With a motorboat in the area, the mining equipment spectrum would be lower than the motorboat spectrum (therefore masked or hidden by the motorboat noise) at 250 Hz and 500 Hz, but audible because the mining equipment spectrum is still 5 dBA above the ambient at 125 Hz. This is consistent with the Scenic Riverway "Rural Residential" management category.

Audibility is not directly related to the relative dBA levels of ambient and non-ambient sources. Here the ambient level is estimated at 36.2 dBA, with the haul truck at 38.2 dBA and the mining equipment at 37.2 dBA. The mining equipment is only 1 dBA above ambient, and from **Figure 5.2** is seen to be clearly audible. The mining equipment (37.2 dBA) is 5.3 dBA below the motorboat (42.5 dBA) but would still be audible relative to the motorboat since the mining equipment spectrum exceeds the motorboat spectrum by 15 dBA at 125 Hz. Therefore, the dBA sound level of a source can be lower than ambient and still be audible.

With overall sound levels associated with the Zavoral Site of only 1 to 2 dBA over ambient, this is consistent with the moderate noise level expected within the Scenic Riverway "Rural Residential" management category.

Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 5.1 Estimated Summer Sound Level Spectra in the Scenic Riverway



Tiller Corporation David Braslau Associates, Inc.	Zavoral Mining and Reclamation Project (Scandia, Minnesota) NOISE ASSESSMENT	FIGURE 5.2 Estimated Mining Equipment and Haul Truck Spectra in the Riverway

6.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

Sound levels associated with mining equipment and haul trucks have been estimated using previously measured source levels from the excavator and front-end loader used at other similar mining operations. The equipment has been modeled to operate at the perimeter of each of the three proposed mining phases to analyze "worst-case" while haul truck routes were determined from anticipated mining phase plans provided by Sunde Engineering.

Sound levels were projected at fifteen representative sensitive receptor sites including homes, sites in the Scenic Riverway, and recreational uses along TH 95. The L10 and L50 sound levels have been estimated for both mining equipment and haul trucks and shown to be well below the Minnesota daytime noise standards for all of these land uses. In fact sound levels at the NAC-2 receptor sites are predicted to be well below the more restrictive NAC-1 standards.

An ambient sound level in the Scenic Riverway has been based upon monitored winter ambient levels near the site combined with estimated traffic noise level for a typical hour in the summer. Predicted spectral levels for mining equipment and haul trucks were compared with this ambient level and determined to probably be audible to users in the Riverway. Audibility is determined by differences in the source and ambient sound level spectra. Here the lower frequencies from the mining equipment engines are higher than the ambient level at these same frequencies.

The sound levels predicted at the Zavoral Site are substantially lower than the applicable standards imposed by the MPCA. The overall sound levels associated with the Zavoral Site are only 1 to 2 dBA over the ambient level. These minor increases are consistent with the moderate noise levels expected within the Scenic Riverway "Rural Residential" classification described in the management objectives contained in the National Park Service Final EIS for the Lower St. Croix National Scenic Riverway.

APPENDIX A NOISE MONITORING MEMORANDUM

db
david braslau associates, incorporated
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telephone: 612-331-4571 • fax: 612-331-4572

21 December 2009

MEMORANDUM

TO: Mike Caron

FROM: Dave Braslau

RE: Zavoral Quarry – Ambient Sound Level Monitoring

Sound level monitoring was performed on Wednesday, 16 December, at two locations at the quarry boundary just east of Highway 95 as shown on **Attachment 1**. Larson-Davis Model 700 Type 2 sound level meters were set up at each of these sites. These collected data over 5-minute intervals and provided overall sound level distribution curves from approximately 11:30 am until 3:30 pm. . In addition, more detailed octave band data were collected at the southerly site using 10-second intervals during the period 2:30 to 3:30 pm.

Since there was no unique activity in the river valley, there were sufficient periods where no traffic noise was clearly identifiable, and snow cover and lack of wind provided conditions for a uniform sound level over the entire area, I decided that no additional monitoring in the river valley was warranted. As you will see from the data, this appears to have been a correct assumption, since the minimum sound level measured by the LD 700 meter (33.5 dBA) was observed at both monitoring sites and detailed data at the south site showed that, this level occurred without any measurable traffic noise. From the reported weather conditions in the Scandia area during the monitoring period (**Attachment 2**), it can be seen that the wind was from the SE (river valley) so that background levels were probably also indicative of levels in the valley.

The sound level distributions over the 4-hour monitoring period are shown in **Attachment 3**. The relatively straight line distribution at the northerly site is representative of the higher traffic volumes occurring on Highway 95 north of Highway 97. This can be seen from the latest MnDOT traffic flow map (2006) of the area in **Attachment 4** that shows about 65% more traffic north of Highway 97. This is also reflected in the summary statistics of the data from the two sites shown below in **Table 1**. The 5 dBA difference in the L50 or median level reflects the higher traffic level at the northerly monitoring location

Table 1 Summary Sound Level Statistics for the Two Monitoring Sites

	Northerly	Southerly
L01	67.0	67.5
L10	58.5	58.0
L50	46.5	41.5
L90	35.5	35.0
L99	33.5	33.5

The minimum level of 33.5 dBA from the LD 700 meters apparently reflects some background noise related to distant traffic flow as well as other man-made noises. The minimum at the northerly site occurred only rarely during the 4-hour monitoring period as can be seen on **Attachment 5.** For the 10-second data at the southerly site (**Attachment 6**) taken with a more accurate Type 1 meter it can be seen that a minimum of 33.1 dBA occurred only once during the just over 1-hour monitoring period. This is can also be seen in the 10-second Lxx data in **Attachment 7.** The almost horizontal distribution at the bottom of the chart represents a time when no nearby sources affected the readings (thus, "background" level). Actually, as noted below, the minimum level observed with the LD 824 meter was 29.6 dBA.

In the absence of local traffic (i.e. in the river valley shielded from the roadway), this would represent the background level. However, because the highway is a line source, it may not always be shielded at any given point in the valley, Therefore, some locations may experience levels slightly above 33 dBA.

Winter levels near the BWCA registered as low as 19 dBA which shows the effect of nearby civilization Minimum levels during the summer months when quarry activity will occur will likely be higher due to higher traffic levels, wind noise in trees, and birds. Noise from trees and birds, however, will not "mask" the lower frequency noise associated with quarry equipment. A brief discussion of frequency data is presented below.

Detailed one-third octave band data were collected at the southerly site for just over an hour. Spectra from the first 42 minutes are shown on **Attachment 8**. The microphone limit was set at 20 dB which turned out to be too high for the observed ambient. However, the difference in overall level between the measured level is estimated to be about 1 dBA if the limit were set even lower.

Attachment 9 shows the average, maximum and minimum octave band spectra from the LD 824 meter for the monitoring period of just over one hour. If necessary, the background sound level spectra could be used to determine the audibility of quarry equipment at the various receptor sites during the day.

In summary, the background monitoring data from the two sites provides detailed data on noise from traffic as well as on the minimum noise level that occurred (with snow cover) in the area. As noted above, the summertime ambient will likely be somewhat higher due to increased traffic, wind noise in trees, birds and insects, although typical rural ambient levels in the summer have been generally measured between 30 and 35 dBA.

Mike Caron on Zavoral Ambient Noise Monitoring
21 December 2009

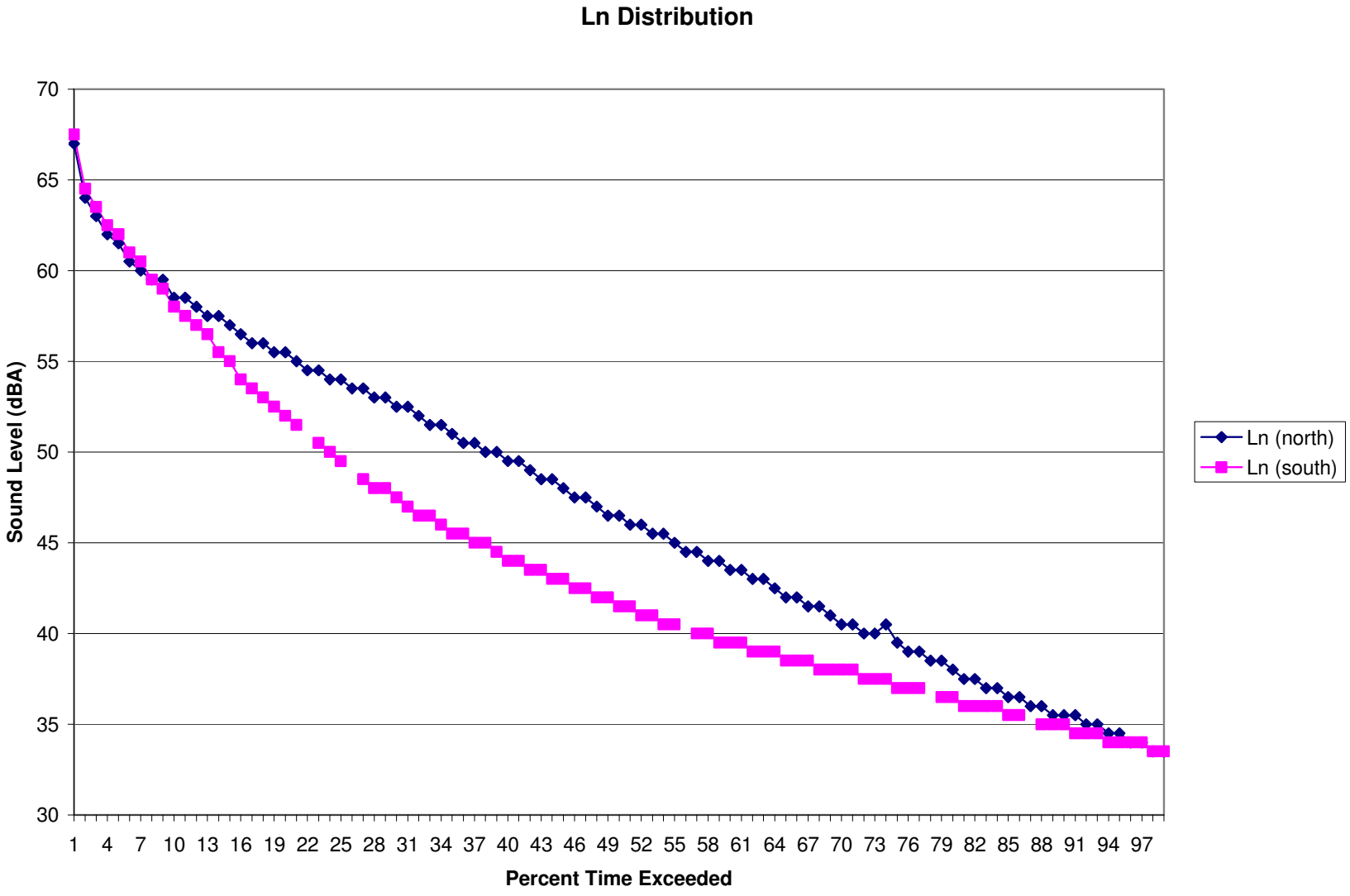
ATTACHMENT 1

Mike Caron on Zavoral Ambient Noise Monitoring
21 December 2009

Time	Condition	Felt like	Dew Point	Rel Hum.	Visib.	Press.	Wind
Sunrise at 7:45 AM							
8:05 AM	Partly Cloudy -2°F	-17°F	-9°F	66%	10.0 miles	30.40 ↓ inches	From ESE 8mph
9:05 AM	Partly Cloudy 0°F	-15°F	-8°F	66%	10.0 miles	30.41 ↑ inches	From SE 8mph
10:05 AM	Partly Cloudy 3°F	-11°F	-6°F	60%	10.0 miles	30.43 ↑ inches	From SE 9mph
11:05 AM	Partly Cloudy 7°F	-8°F	-6°F	49%	10.0 miles	30.42 ↓ inches	From SE 10mph
12:05 PM	Sunny 9°F	-6°F	-2°F	55%	10.0 miles	30.40 ↓ inches	From SE 10mph
1:05 PM	Sunny 10°F	-2°F	-2°F	50%	10.0 miles	30.38 ↓ inches	From SE 8mph
2:05 PM	Sunny 10°F	-3°F	-2°F	50%	10.0 miles	30.36 ↓ inches	From SE 9mph
3:05 PM	Sunny 10°F	-3°F	0°F	55%	10.0 miles	30.37 ↑ inches	From SE 9mph
4:05 PM	Sunny 10°F	-1°F	-2°F	50%	7.0 miles	30.38 ↑ inches	From SE 7mph

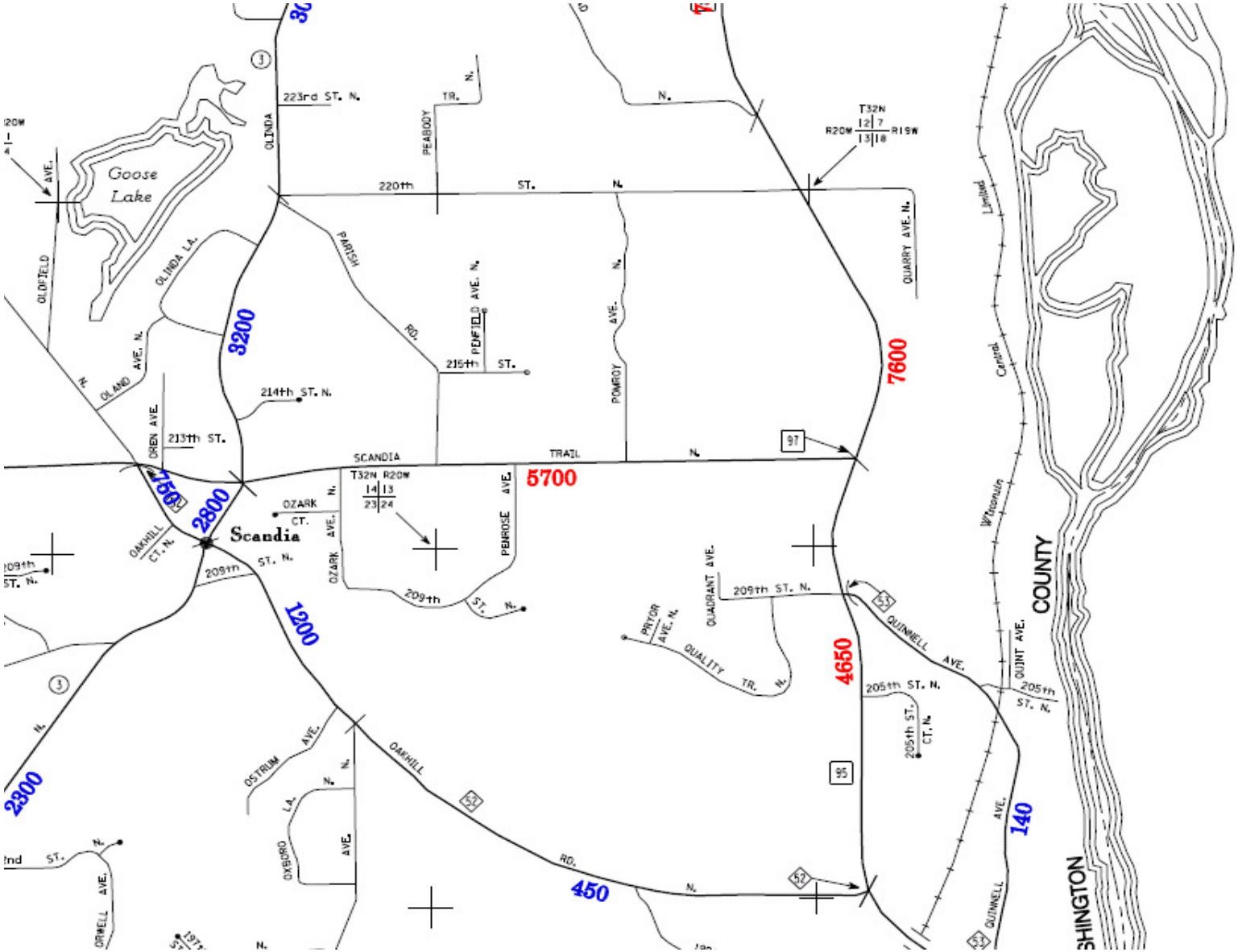
Monitoring Period

ATTACHMENT 2

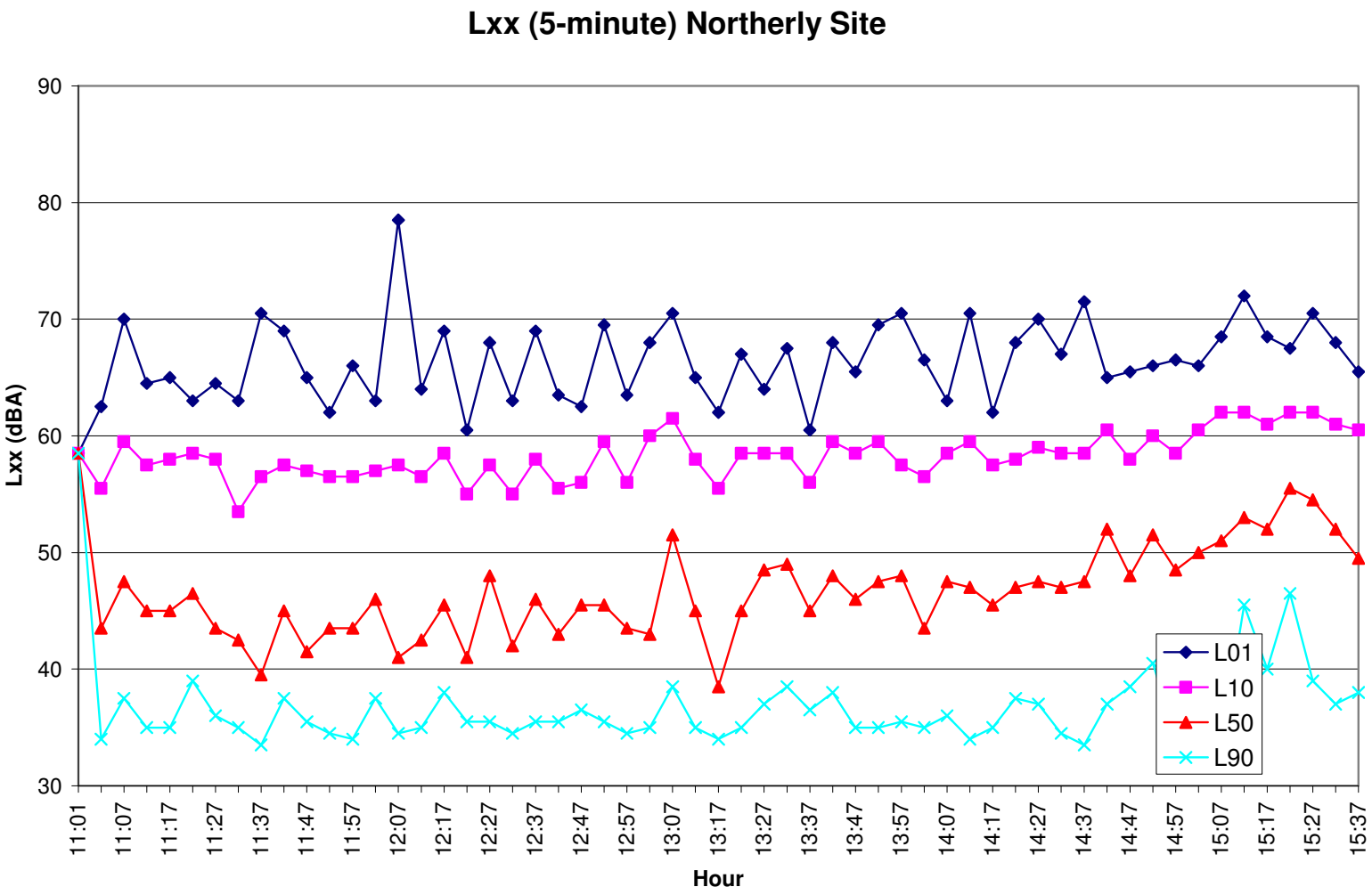


ATTACHMENT 3

Mike Caron on Zavoral Ambient Noise Monitoring
21 December 2009



ATTACHMENT 4



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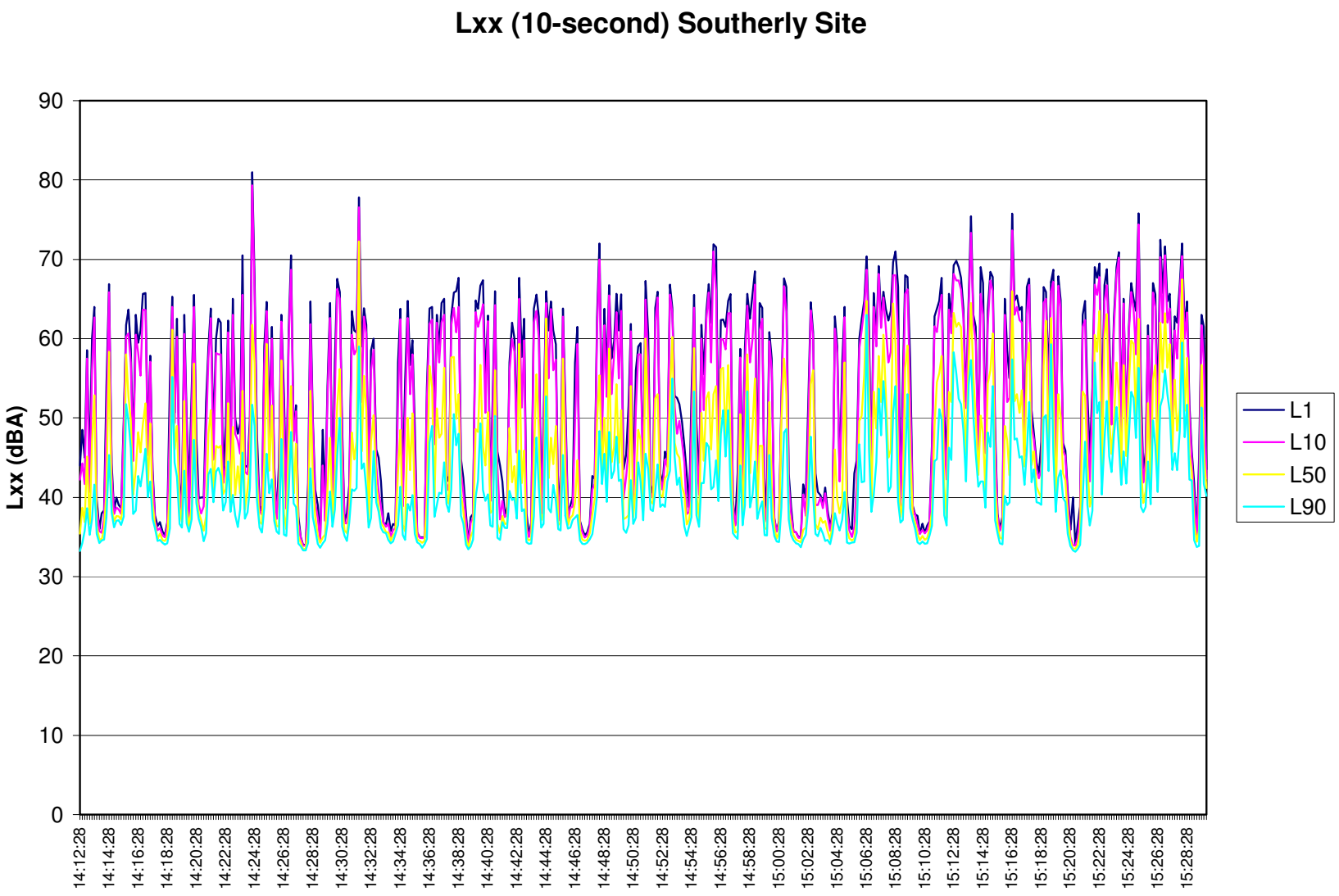

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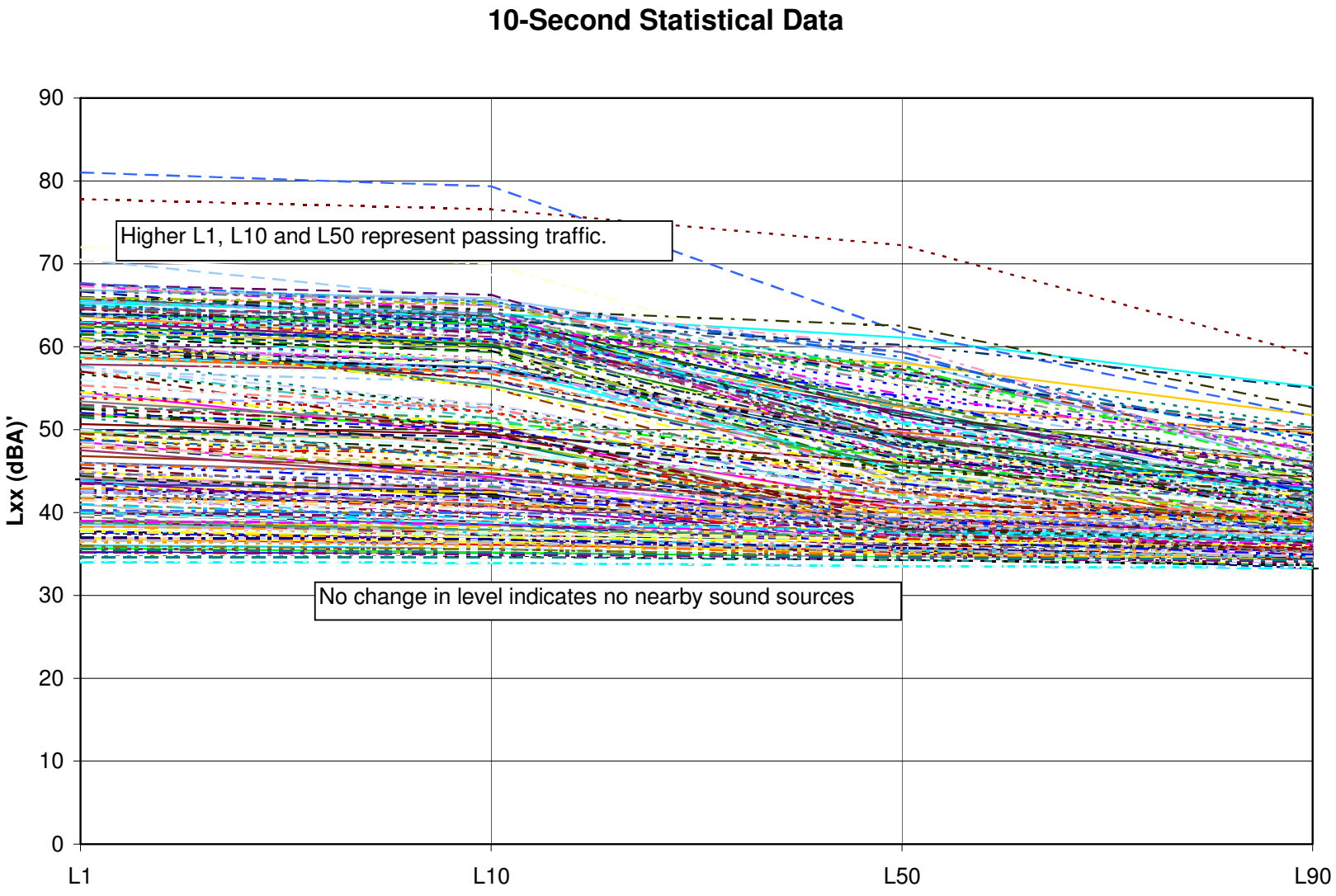
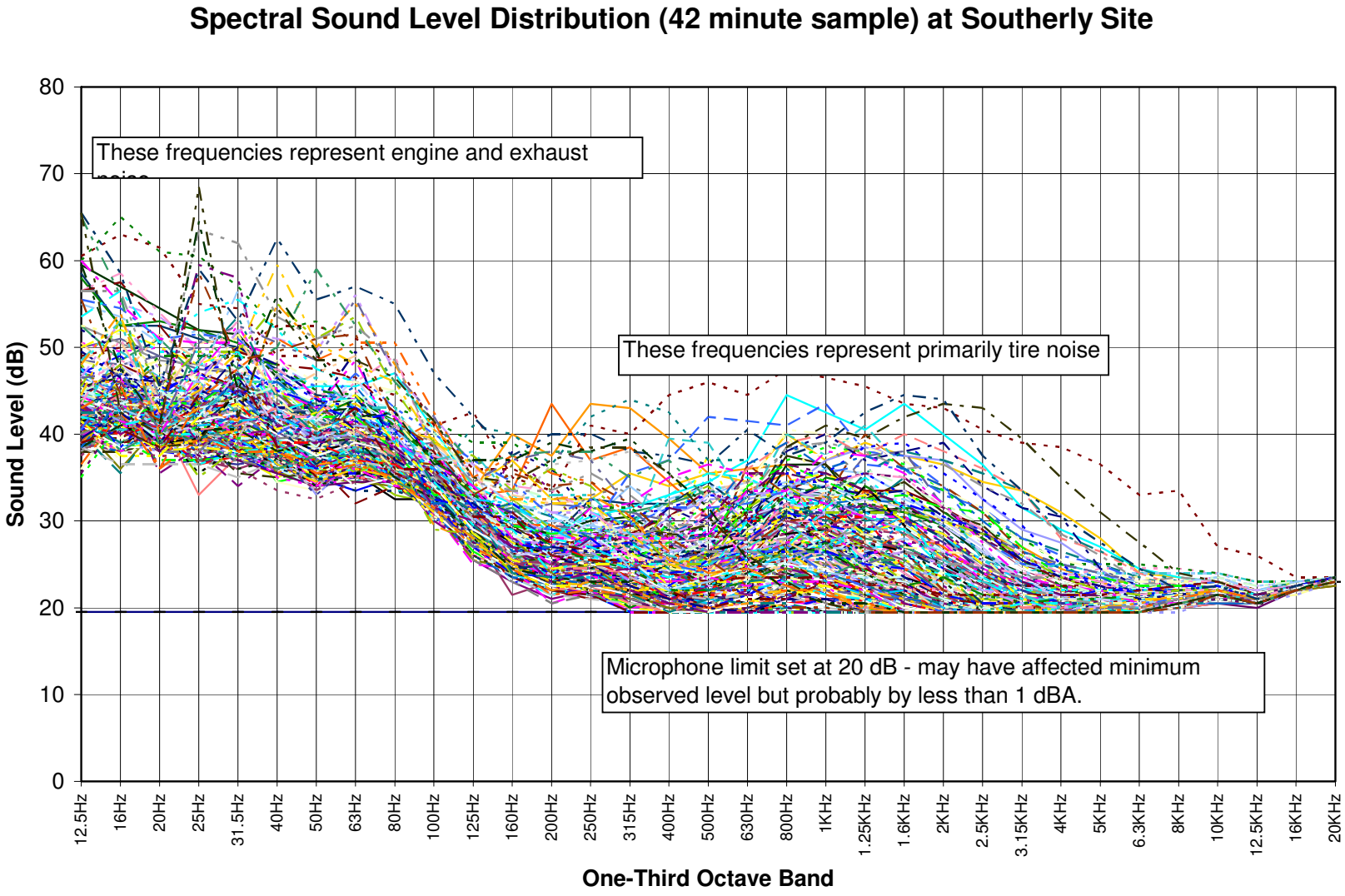
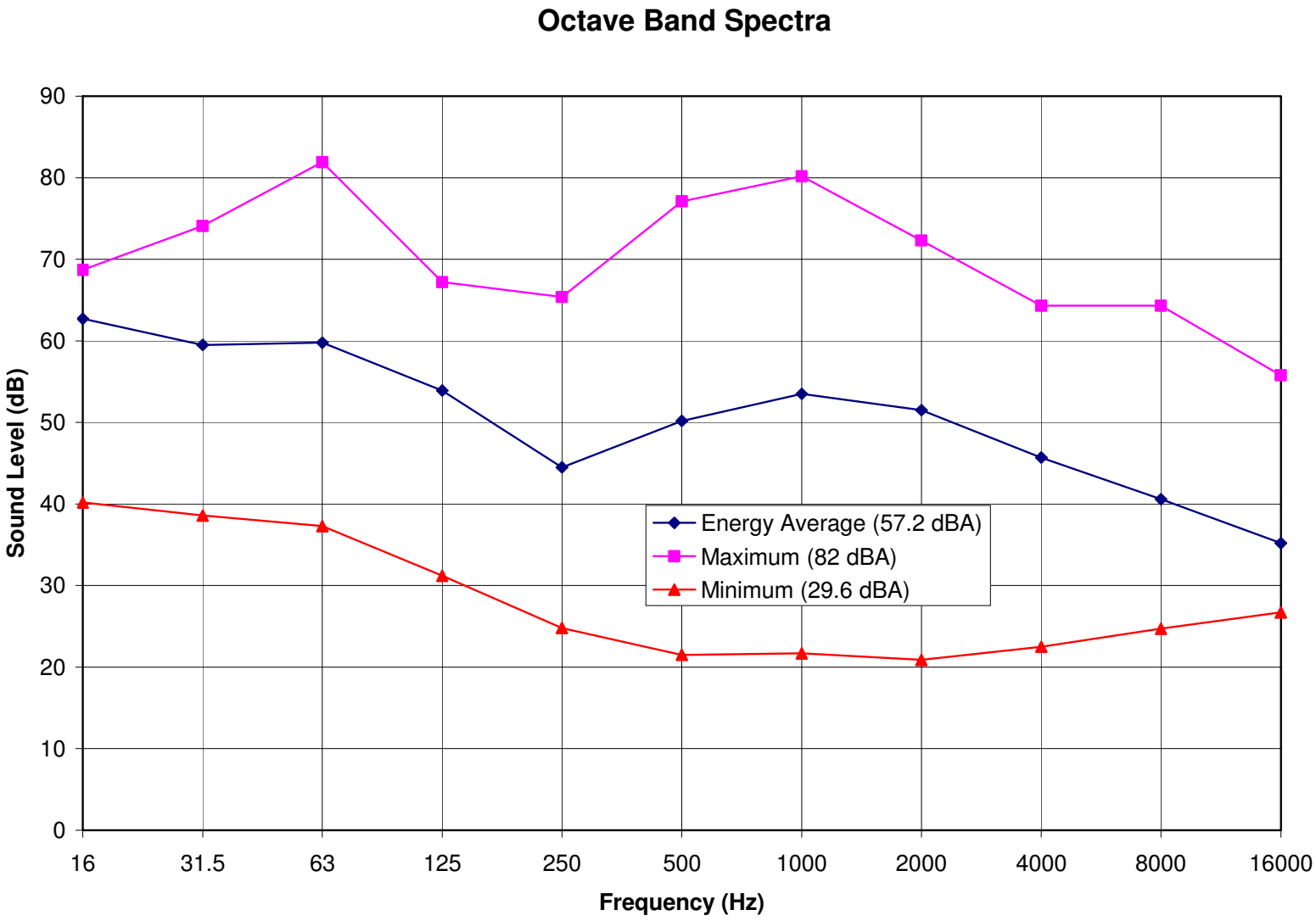


ATTACHMENT 7



ATTACHMENT 8



ATTACHMENT 9