Technical Report – Noise and Vibration

Eagle Mine to Humboldt Mill Ore Haul Route

Prepared for:

Eagle Mine, LLC
4547 County Road 601
Champion, MI 49814

Revised Draft: February 17, 2016
Date: October 5, 2015
TriMedia Project Number: 2015-126

Table of Contents

APPENDICES

EXECUTIVE SUMMARY

TriMedia Environmental & Engineering Services, LLC (TriMedia) performed a blind noise and vibration study along the Eagle haul truck route from August 10, 2015 through August, 14, 2015. Data was gathered during both day and night time hours during this period utilizing Blind Study methodology. Eagle staff who requested the study were unaware of the dates of the monitoring while Eagle's operations team and VanDamme's management, and driver team were unaware that the study was being performed. TriMedia utilized the help of several Eagle Mine summer students to mobilize equipment, oversee daytime videography, and perform traffic counts under the direction of TriMedia staff.

The locations of the noise study were:

- Alder Creek Bridge
- Koski Corner (M95 & Hwy 41)
- Negaunee Township (M35 & Hwy 41)
- Wright Street & McClellan Intersection
- Wright Street & Sugarloaf Avenue Intersection
- CR 550 & Middle Island Point Rd (Near Phil's 550 Store)
- CR550 & the MCRC Wetland Mitigation Site

The locations of the vibration study were:

- Alder Creek Bridge
- Wright Street & Sugarloaf Avenue Intersection
- Koski Corner (M95 & Hwy 41)

Traffic content was characterized by both manually counting passing vehicles and by reviewing daytime videography data of specific noise events. Vehicles were categorized into classes established by the Federal Transit Administration (FTA) and counted in sufficient numbers to assume a 95% confidence level with a margin of error of ±10%. Noise signatures were developed and correlated with key vehicle types so that specific noise events could be isolated from the rest of the data pool. TriMedia further used the data to develop a site-specific

background, average noise, and estimated noise disturbance level by analyzing the statistical noise distribution of each monitoring site.

This effort allowed TriMedia to evaluate Eagle trucks in comparison with the ambient noise spectrum and other heavy multi-axle trucks. There are no federal, state, or local standards that apply to community noise or vibration levels from commercial traffic, but there are guidelines of universally accepted recommendations that could be used to evaluate the results. TriMedia evaluated the noise data in reference to the noise level recommendations set by the U.S. Department of Transportation Federal Highway Administration (FHWA) for residential land categories. The vibration data was compared to recommendations set by the FTA relating to potential structural damage on masonry or timber buildings from effects of vibration during construction.

MAJOR FINDINGS RELATED TO NOISE:

- The calculated average noise and estimated disruptive noise levels measured at each monitoring location were below recommended criteria set by the U.S. Department of Transportation (FHWA).
- The measured average noise levels at each site were between 16.82% and 97.0% less than the recommended FHWA criteria, while the estimated noise disturbance levels were between 35.4% and 96.7% less than the recommended FHWA criteria.
- Eagle Haul Trucks are not associated with a majority of the elevated noise events along the route. It was determined that Eagle Haul Trucks were the suspected cause for a majority elevated noise events only at the CR 550 Alder Creek Bridge location.
- The audio fingerprint of an empty Eagle Haul Truck was found to produce increased noise levels at higher frequencies. These levels were different from the background noise levels at most sites and may be noticeable to nearby receivers.
- The audio finger print of the logging type truck generated unique low frequency noise patterns. This increase in low frequency noise levels was unique only to the logging type truck and was not seen in the site specific background audio fingerprint and may be noticeable to nearby receivers.
- The addition of Eagle Haul Trucks does have an effect on the overall noise levels. However, this concept is not unique to Eagle Haul Trucks; the same could be said for

any vehicle type moving along the haul route (i.e. more vehicle traffic generally results in increased noise levels).

- The current volume of Eagle Haul Trucks along the haul route is not involved in a majority of noise events that would be considered disruptive.

MAJOR FINDINGS RELATED TO VIBRATION:

- There were no vibration events that occurred above the recommended vibration level for non-engineered timber and masonry buildings as recommended by U.S. Office of Planning and Environment of the Federal Transit Administration (PPVs greater than 0.2 in/s).
- Eagle Haul Trucks along the haul route do not result in excess ground vibration movement.
- Based on the traffic characterization analysis, Eagle Haul Trucks were only responsible for 2 to 23% of the vibration events recorded above the equipment sensitivity limit across the monitoring sites.
- Only 15.5% of the recorded vibration events exceeded the lower range of human vibration detection.

1.0 INTRODUCTION

1.1 PURPOSE

TriMedia has prepared this *Technical Report – Noise and Vibration* to document noise monitoring results, vibration monitoring results, and to provide a summary of our opinions and recommendations regarding the impact of haul truck traffic from the Eagle Mine. The objective of this assessment was to gather data regarding noise and vibration along the length of the Eagle Mine haul route. The evaluated areas include selected sites along the length of the haul route which is approximately 62 miles. During this project noise levels over a four day period were measured at seven locations and vibration levels measured at three locations along the ore haul route between the Mine and the Mill. See Appendix A for a map of the haul route and the deployed equipment locations. The overall goals of this effort are as follows:

1. Assess noise levels at up to seven locations along the Mine to Mill ore haul route;
2. Develop a noise signature for logging trucks, Eagle Haul trucks, and large commercial trucks;
3. Provide opinion on seasonal effects on noise propagation/dampening/perception;
4. Provide opinion on day verses night on noise propagation/dampening/perception; and
5. Assess vibration levels at up to three locations along the Mine to Mill ore haul route.

1.2 BACKGROUND

In order to best appreciate the results of the noise monitoring in this report, it may be helpful to understand a few basic facts about noise and our perception of relative noise levels. There are many metrics for which sound pressure levels (noise) are measured and quantified. The most common metric uses the decibel (dB) scale. The logarithmic decibel scale accommodates the wide range of sound intensities found in the environment, but it is not altogether intuitive, as sound does not follow a linear relationship. For example, the addition of two equivalent sounds does not equate to a doubling in actual sound pressure level. So if a sound of 50 dB is added to another sound of 50 dB, the increase in sound pressure is only 3-decibels, resulting in a level of 53 dB (not 100 dB). Therefore, as a rule of thumb, every 3 dB change in sound level represents a doubling or halving of sound energy. This fact is important to remember as sound changes less than 3-decibels are imperceptible to the human ear. The information listed in Table 1: Noise Source References can help further demonstrate how different sound levels relate to one another and provide average noise levels of typical daily activity.

Table 1: Noise Source Reference		
Typical Outdoor Activities	**Approximate dBA**	**Typical Indoor Activities**
Jet Fly Over (1,000 ft)	100	Rock Concert
Gas Lawnmower (3 ft)	95	
	90	Food Blender (3 ft)
	85	
Diesel Truck (50 ft & 50 mph)	80	Garbage Disposal (3 ft)
Rail Transit At-grade (50 ft & 50 mph)	75	
Gas Lawnmower (30 ft)	70	Television, Moderate Volume
Heavy Traffic	65	
	60	Normal Speech
Typical Residential Area, Daytime	55	
	50	
	45	Theater
Quite Residential Area, Nighttime	40	
	35	Library
	30	Bedroom at Night

While it is important to understand the scale of how sound is measured it is equally important to understand how changes in sound level are interpreted. The loudness of sound and how it is perceived is a subjective matter that can vary between individuals. The information presented in Table 2: Noise Level Changes outline how the average human would perceive changes in sound levels presented on the decibel scale.

Table 2: Noise Level Changes	
Change in dBA	**Human Perception of Sound**
2 to 3	Barely Perceptible
5	Readily noticeable
10	A doubling or halving of the loudness of sound
20	A “dramatic change”
40	Difference between a faintly audible sound and a very loud sound

Bolt, Beranek and Newman, Inc., Fundamentals and Abatement of Highway Traffic, Noise, Report No. PB-222-703. Prepared for Federal Highway Administration, June 1973.

1.3 PROCEDURES AND EQUIPMENT

Noise Monitoring Procedures

Data collection activities included the use of industry standard equipment. Equipment included weatherized 3M SoundPro DL Sound Level Meters with data logging and octave band analyses capabilities and Instantel MicroMate vibration monitors. Each SoundPro DL was equipped with a cable-attached microphone, environmental case, wind screen, and data logging device. The meters were calibrated on-site prior to deployment using a Quest QC - 10 sound calibrator. The meters have the capability of performing octave band analysis; the setup parameters can be seen below in Table 3: Sensor Parameters. The equipment was set to log sound pressure levels in one minute intervals using the flat-weighted scale. This scale was selected in order to evaluate for all potential noise sources, providing a complete picture of the total noise at the site. However, this scale does not accurately define how noise is perceived by the human ear. For this purpose the noise measurements were also measured on the A-weighted scale. Reporting the noise data in the dBA scale will allow for direct comparison to established noise regulations.

The noise measuring techniques and procedures used in this study are consistent with those outlined in the American National Standards Institute (ANSI) S12.9-1993/Part 2 and Part 3. At each monitoring location, without endangering data quality, the equipment was placed in such a manner that would limit tampering from personnel or wildlife. Project team members inspected the equipment at each site at least twice per day during the study period. All meters were left to monitor noise levels for a total of four days and nights and were picked up in good working order.

Table 3: Sensor Parameters		
	Sensor 1	**Sensor 2**
Weighting	Flat Scale	A-weighted Scale
Exchange Rate	3 dB	3 dB
Response Time	Slow	Slow
Bandwidth	1/3	n/a
Interval	1 min	1 min

Vibration Monitoring

The Instantel® Micromate® monitors used for the vibration analysis complied with the "Performance Specifications for Blasting Seismographs" document published by the International Society of Explosives Engineers (ISEE). Both the operation and use of this equipment was consistent with the procedures outlined in the ISEE's "ISEE Field Practice Guidelines for Blasting Seismographs".

Each Micromate was equipped with a tri-axial transducer and data logging capabilities. Each transducer measures velocities on three mutually perpendicular axes (Vx, Vy, Vz) corresponding to radial, transverse, and vertical component. The data acquisition equipment simultaneously records each geophone, in digital format, time-domain data for each of the three mutually perpendicular axes at each of the four radial distances. The blasting analysis software provided features graphical output of the wave forms in each of the three axes and comparison of the measured peak particle velocities (PPVs) and frequency content with various accepted standards developed by the U.S. Office of Planning and Environment of the Federal Transit Administration (FTA).

Traffic Content Characterization

To further ensure data quality, onsite monitoring personnel and daytime videography equipment were utilized at each monitoring location. During the daylight hours of the monitoring period, onsite personnel rotated between each of the seven locations. Typical personnel activities included; equipment maintenance, equipment calibration, and traffic content characterization. The traffic content at each monitoring site was evaluated by onsite personnel in 15-minute blocks. During this time, passing vehicles were counted and placed into categories based on vehicles types established by the FTA, with the addition of categories for Eagle Haul Trucks and logging trucks. In addition to the rotating onsite personnel, multi weather video cameras were placed at each site during daylight hours to record traffic. The video cameras were installed each morning at the monitoring locations and retrieved each night for data download, providing time stamped video from approximately 9:00 am to 4:30 pm. This video data was utilized to investigate potential causes of high noise and vibration levels during times when onsite personnel were not present.

Traffic Noise Modeling

All traffic noise modeling was performed utilizing Federal Highway Administration (FHWA) Highway Traffic Noise Prediction Model v2.5. The software package is provided by the FHWA for use in predicting noise impact levels for all Federal and Federal-aided highway projects as required by 23 CFR, Part 772.17. Along with the traffic characterization data provide by the video equipment and onsite staff, noise contours were developed for assessing noise propagation patterns along the haul route near each monitoring location.

Octave Band Analysis

Noise data collected from the 3M SoundPro DL Sound Level Meters was analyzed utilizing 3M's Detection Management Software v1.8 and basic statistical analysis software. Data collected from site specific video and onsite staff was evaluated in conjunction with the measured noise levels across 31 octave bands on a flat decibel scale. This information was utilized to generate and evaluate the noise spectrum of ambient background noise, Eagle Haul Trucks, and generic logging trucks.

2.0 STANDARDS AND GUIDELINES

2.1 NOISE

Currently there are no federal, state, or local standards that apply to the results of this study. In this case it is common to utilize related guidelines and recommendations set forth by other governing bodies. The use of universally accepted values can help to evaluate the noise conditions at the selected sites.

U.S. Department of Transportation Federal Highway Administration (FHWA)

The FHWA has established Noise Abatement Criteria for both Federal and Federal-aided highway projects in the form of objective absolute noise levels for varying land use categories. These category limits are used to determine if and where traffic noise impacts occur during these specific types of highway projects. These noise limits apply to the types of projects and land uses defined in 23 CFR 772.5. Depending on the Activity Category associated with the land type, the recommended hourly Leq can range from 52 dBA to 72 dBA. Depending on local zoning ordinances, certain locations can be placed into an FHWA Land Category where no recommended level has been established. The FHWA also recommends a statistical L_{10} limit based on land use, which can range from 55 dBA to 75 dBA. For the purposes of this study, TriMedia will assume that all of the impacted land would be classified as Activity Level B: Residential. Land in this category have a recommend Leq of 67 dBA and L10 of 70 dBA.

2.2 VIBRATION

The State of Michigan and local governments do not currently maintain vibration standards. For the purpose of this baseline assessment, vibration data was compared to the standards set by the U.S. Office of Planning and Environment of the FTA.

Federal Transit Administration

The FTA has established recommended vibration criteria for evaluating potential annoyance or interference with vibration-sensitive activities due to construction related vibration. While specifically designed for evaluating vibration limits during transit construction projects, the criteria can be applied in most cases when the primary concern relates to potential damage effects of vibration. Vibration damage criteria have been established by the FTA for various structural categories. These limits are used as criteria during the environmental impact assessment phase of a project to identify problem locations that must be addressed during final project design. As outlined in document number FTA-VA-90-1003-06 “Transit Noise and Vibration Impact Assessment”, the recommended vibration level for non-engineered timber and masonry buildings should not exceed Peak Particle Velocities (PPVs) greater than 0.2 in/s. For reference purposes it should be noted that PPVs that exceeded 0.05 inches/sec are considered to be in the lower range of human vibration detection.

3.0 NOISE DATA AND RESULTS

3.1 MONITORING LOCATIONS

TriMedia mobilized to the seven location sites on 8/11/2015 to deploy a total seven 3M SoundPro DL Sound Level Meters as described previously in this report. The monitoring equipment was deployed in the right of way along the haul route in study specific locations. Maps of the noise monitoring locations and points of interest can be seen in Appendix A - Location Maps.

3.2 AVERAGE NOISE LEVELS

Sound level is typically measured by a sound level meter or noise dosimeter. Both are standardized instruments that can measure in several different weighting scales. These scales adjust the frequency response of the instrument to approximate that of the human ear under various environmental conditions. The scale commonly used for community noise monitoring is the A-weighted scale. The A-weighted scale approximates how the human ear perceives sound at various frequencies by emphasizing those heard between 1000-2000 hertz (hz), or the middle-ranged frequency. Sounds detected on a sound level meter or dosimeter on the A-weighted scale are reported in decibels and denoted as "dBA". Further, the average sound level measured over a defined period of time is referred to the L_{eq}. It is important to recall that sound is measured on the logarithmic scale of decibels, so simply adding the levels and dividing by the number of samples measured over time will not yield a true average. The purpose of the L_{eq} is to avoid skewing from instantaneous (or short duration) high and low levels of sound. L_{eq} is defined as the equivalent noise level that accounts for noise level variations over a period of time. The formula used to calculate L_{eq} is provided below:

$$L_{eq} = 10\log\left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\frac{p_A^2}{p_0^2}dt\right]$$

L_{eq} = equivalent continuous sound pressure level

p_0 = reference pressure level = 20µPa

p_A= acquired sound pressure in Pa

t_1 = start time for measurement

t_2 = end time for measurement

The overall L_{eq} for each monitoring location can be seen in Appendix C: Table C-1 Noise Level Summary, while a summary the daily noise levels for each monitoring site can be seen in Appendix D: Daily Noise Levels.

3.3 L10 AND L90

In order to help evaluate and interpret the noise data, statistical analyses were performed for each monitoring site to determine key community noise statistical indicators. These indicators are used to report what level of noise is exceeded for a certain measurement of the monitoring time. During community noise studies the two most common statistical indicators that are determined are the L10 and L90. The L90 refers to the specific noise level that is exceeded over 90 percent of the time. This level is often used to establish an estimated background noise level. In comparison the L10 refers to what noise level is exceeded 10% of the time. The L10 has been found to be a useful descriptor of road traffic noise as it correlates well with the disturbance people note when close to busy roads.

To help account for the difference associated with each of the monitoring sites both the L10 and L90 were determined. These values are determined from the daily measured noise levels over the four day monitoring period. Any noise levels occurring above the calculated L10 for each site were used in later analysis of disruptive noise events. A complete summary of both the L10 and L90 for each monitoring location can be seen in Appendix C: Table C-1 Noise Level Summary.

3.4 NOISE CONTOURS

Noise propagation contours were developed for each site using the methods previously described. The contours provide a rough estimate of the noise propagation characteristics, based on traffic volume, atmospheric conditions, ground cover, and structural interactions. To verify the noise contours, the calculated L_{eq} for each monitoring location was determined utilizing the software package and compared with the field measured values. A complete summary of these noise level comparisons can be found in Appendix C: Table C-1 Noise Level Summary.

For each monitoring site, two sets of noise contours were developed based on traffic pattern and composition data collected in the field. The first set of noise contours estimates how noise levels propagate while including Eagle Haul Route trucks in an approximate 1,000 ft. radius from each monitoring site. The second set of noise contours provides an estimated noise propagation pattern in that same region assuming that no Eagle Haul Trucks were present during the day. The noise contour figures for each monitoring site are located in Appendix E: Noise Contour Figures.

3.5 AUDIO EVENT TRAFFIC CHARACTERIZATION

The L10 noise level was determined for each monitoring location; this value represents what would typically be considered the maximum noise limit to prevent noise related disturbances. The site specific L10 was used to identify potential disruptive noise events at each site based on the surrounding noise levels. The disruptive noise events at each monitoring location were analyzed to establish a profile of the disruptive events. Identified disruptive day time noise events were randomly selected and cross referenced with the site specific video data to identify potential causes of the noise events. Events were selected in a sufficient quantity to ensure the traffic characterizations results maintained a 95% confidence level with a margin of error of ±10%. Vehicles present during the noise events were placed into one of the following categories outlined in the table below. A complete summary of noise events exceeding the site L10 for each monitoring location can be seen in Appendix C: Table C-2 Noise Events Exceeding Site L10.

Table 4: Traffic Characterization Categories		
Category Name	**Gross Vehicle Weight Rating**	**Examples**
Passenger Vehicles	< 10,300 lbs	Passenger cars, light duty trucks, SUVs, vans
Medium Duty Trucks	14,000 to 26,00 lbs	Garbage trucks, snow plows, box trucks
Heavy Duty Trucks	> 26,000 lbs	Semi-Trucks and Tractor Trailers
Eagle Haul Trucks	> 26,000 lbs	Truck used by Eagle along the haul route
Logging Truck	> 26,000 lbs	Miscellaneous logging trucks
Non-Eagle Mine Trucks	> 26,000 lbs	Mining related vehicles not owned by Eagle
Other	Varies	Lawn mowers, construction equipment, road painting, motor homes, sprinklers, ATVs, etc.
Motorcycles	Varies	All two axle motorcycles
Unknown	none	The source of the noise events was not picked up by the video equipment or was out of view

3.6 OCTAVE BAND ANALYSIS

The human ear is more sensitive to noise levels in the higher frequency range of 2,000 to 8,000 Hz while sounds occurring in the lower frequency range are not as easily perceived by an observer. This type of response is best described when measuring sound levels on the dBA scale. The dBA scale was developed to represent how an overall noise level would be perceived by the human ear. The opposite is true for noise levels recorded on a flat scale also known as the dBZ. The use of the dBZ scale represents the total amount of noise present and does not take into account how the levels are perceived by a human observer. This concept can be illustrated in the information provided in the figure below (Figure 1).

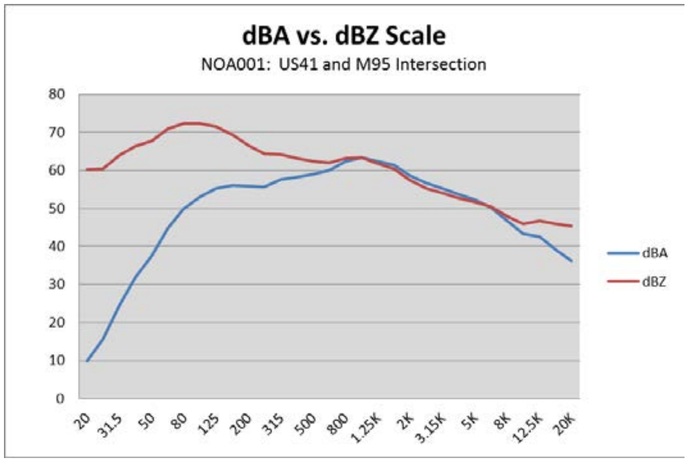


Figure 1: Ear's response to noise (dBA) vs. Total noise (dBZ).

Using data collected at the US41 and M95 Intersection (NOA001) monitoring location, the difference in the total noise level (dBZ scale) at the site and the perceived noise level (dBA scale) can be illustrated. Figure 1 shows that sound pressure levels measured in the dBZ scale indicate an overall increase in noise levels. However when the sound levels are adjusted to represent how noise is perceived by the human ear using the dBA scale, a decrease is seen, predominantly in the lower frequency levels. The majority of the noise levels generated at this site are in the low undetectable frequencies. This shows that while there are increased levels of noise, it cannot be detected by the human ear.

Understanding how and what frequencies contribute to the overall noise level is an important concept in noise control. The use of octave band analysis investigates the specific frequency range involved in the observed total noise of a site or source. Filters on the monitoring equipment record sound pressure levels within a predetermined and standardized frequency band. This information allows for the development of an audio fingerprint that can be used to help assess a noise source's contribution to the overall noise level. An audio fingerprint can also then be developed for background noise levels at particular site of interest. A direct comparison of the two audio fingerprints can help show which noise sources stand out or contribute to the background levels. Noise sources that have an audio fingerprint that is significantly different then the background level will potentially be perceived by a receiver as disruptive, due to the uniqueness of the sound, even though the sound may not technically be considered disruptive. Noise sources that have a similar or lower audio fingerprint to that of the background noise level are generally not noticed by nearby receivers, although they still contribute to the overall noise level.

The background audio fingerprint for each monitoring site was determined and compared to the audio fingerprints of both an Eagle Haul Route Tuck and a logging type truck of similar size and vehicle class. A specific fingerprint was determined for both loaded and unloaded versions of each vehicle type. The results of audio fingerprint comparison can be seen in the graphs provided in Appendix F: Audio Fingerprints.

4.0 VIBRATION MEASUREMENTS AND RESULTS

4.1 MONITORING LOCATIONS

TriMedia deployed vibration monitoring equipment at three locations as described previously in this report. The ground at each monitoring site was firm, with monitors placed along the right of way. During each equipment placement the vibration monitors had a sensor check performed to ensure data accuracy and were manually triggered by the field crew to ensure proper operation. Each unit had the trigger limit set at 0.03 inches/sec (in/s), which is below the lower range of human vibration detection of 0.05 in/s. Vibration monitoring generally occurred between the hours of 9:00 am to 5:00 pm each day.

4.2 VIBRATION EVENTS

The vibration equipment only records an event if the ground vibration levels exceed the preset trigger limits in the x, y, or z axis. Each event records for only two seconds as it is assumed that these events are short duration. During the monitoring period there were a total of 187 vibration events at all three sites. Of the recorded vibration events only 15.5% occurred above the lower range of human vibration detection (0.05 in/sec). None of the recorded events exceeded the recommended vibration level for non-engineered timber and masonry buildings as recommended by U.S. Office of Planning and Environment of the FTA (PPVs greater than 0.2 in/s). A complete summary of vibration events exceeding the trigger limit for each monitoring location can be seen in Appendix G: Ground Vibration Events.

4.3 VIBRATION EVENT TRAFFIC CHARACTERIZATION

Recorded day time vibration events were randomly selected and cross referenced with the site specific video data to identify potential causes of the vibration events. Events were selected in a sufficient quantity to ensure the traffic characterizations results maintained a 95% confidence level with a margin of error of in ±10%. Vehicles present or in the view of the camera during the vibration events were placed into one of the following categories outlined in Table 4: Traffic Characterization Categories. A complete summary of the traffic content for the recorded vibration events exceeding the trigger limit for each monitoring location can be seen in Appendix G: Ground Vibration Events.

5.0 OPINIONS

5.1 OBSERVED NOISE LEVELS

When modeling propagation of noise levels in the surrounding environment due to traffic along the haul route, it was found that the addition of Eagle haul trucks does have an effect on the overall noise levels. However this finding is not unique to Eagle haul trucks. The same could be said for any vehicle type moving along the haul route (i.e. more vehicles generally result in increased noise levels). Any change in the traffic amount, regardless of vehicle type, would cause a change in the nearby noise levels. However, this change would only be noticeable in areas immediately adjacent to the haul route as illustrated in the noise contour figures.

The results of L10 and Traffic Content analysis performed on each monitoring site indicate that Eagle haul trucks are not associated with a majority of the elevated noise events along the route. The field collected L10 data is a statistical community noise indicator which is typically considered the maximum noise limit to prevent noise related disturbances. The site specific L10 was used to help identify when a potential disruptive noise event occurred at each site based on the measured noise levels. When analyzing the traffic content of each noise event that occurred above the site specific L10, it was found that Eagle haul trucks (both empty and full) were not the suspected source for all but one of the sites (NOA007). A majority of the time, the suspected source of the elevated noise event would occur in one of the other vehicles classifications (i.e. non-Eagle trucks) as summarized in Table C-2: Noise Events Exceeding Site L10.

While Eagle haul trucks do not place an excess noise burden along the current haul route, individual receptors may perceive and identity noise events associated with Eagle haul trucks. When comparing the audio fingerprint of an empty and full Eagle haul truck it was found that the empty truck produced noise levels at frequencies above 1,000 Hertz (Hz) resulting in a slight increase in total noise level emission. It was found that an empty Eagle haul truck produces a noise level that is 0.66 dBA more than a full Eagle haul truck, which is below what is generally considered the minimum decibel difference that a human ear can perceive. This increase in higher noise frequency may be directly related to the lack of ore weighting down the trailer. Unloaded, the trailer may be subject to increased vibration during travel. In addition, the lack of cargo weight may also allow the engine to operate at higher Revolutions Per Minute (RPMs), thus resulting in greater occurrence of higher frequency noise level. While the increased noise level emission from an empty Eagle haul truck will largely not be detected by the human ear or discernable from a full Eagle haul truck. The increase in the high frequency noise range generally does not match the background noise level for most sites and may be perceived as unique to nearby receptors.

Both the full and empty Eagle haul truck audio fingerprints were also compared to the fingerprints of both full and empty logging type trucks. It was found that the audio fingerprint of both the full and empty logging type trucks generated increased noise levels in the low frequency range (50 to 100 Hz). This increase in low frequency noise levels was unique only to the logging type trucks and was generally was not seen in most of the site specific background audio fingerprints. Due to the uniqueness of this low frequency noise generated by the logging type trucks, it is possible that receptors at certain sites along the haul route would be able to perceive and identify associated noise events caused by these vehicles, as the noise generated by the logging type truck is distinctive from the background. The audio fingerprints of the logging type trucks were also found to produce similar total noise levels to that of full Eagle haul trucks. Allowing receivers along the haul route to potentially misinterpret the sound of this vehicle or any similar vehicle and wrongfully associate it with mine truck traffic.

The average noise (leq) and L10 levels of each monitoring location were below the recommended criteria set by the U.S. Department of Transportation Federal Highway Administration. It is the professional opinion of TriMedia that current amounts of Eagle haul truck traffic along the current haul route does not place significant noise burden levels on the surrounding environment.

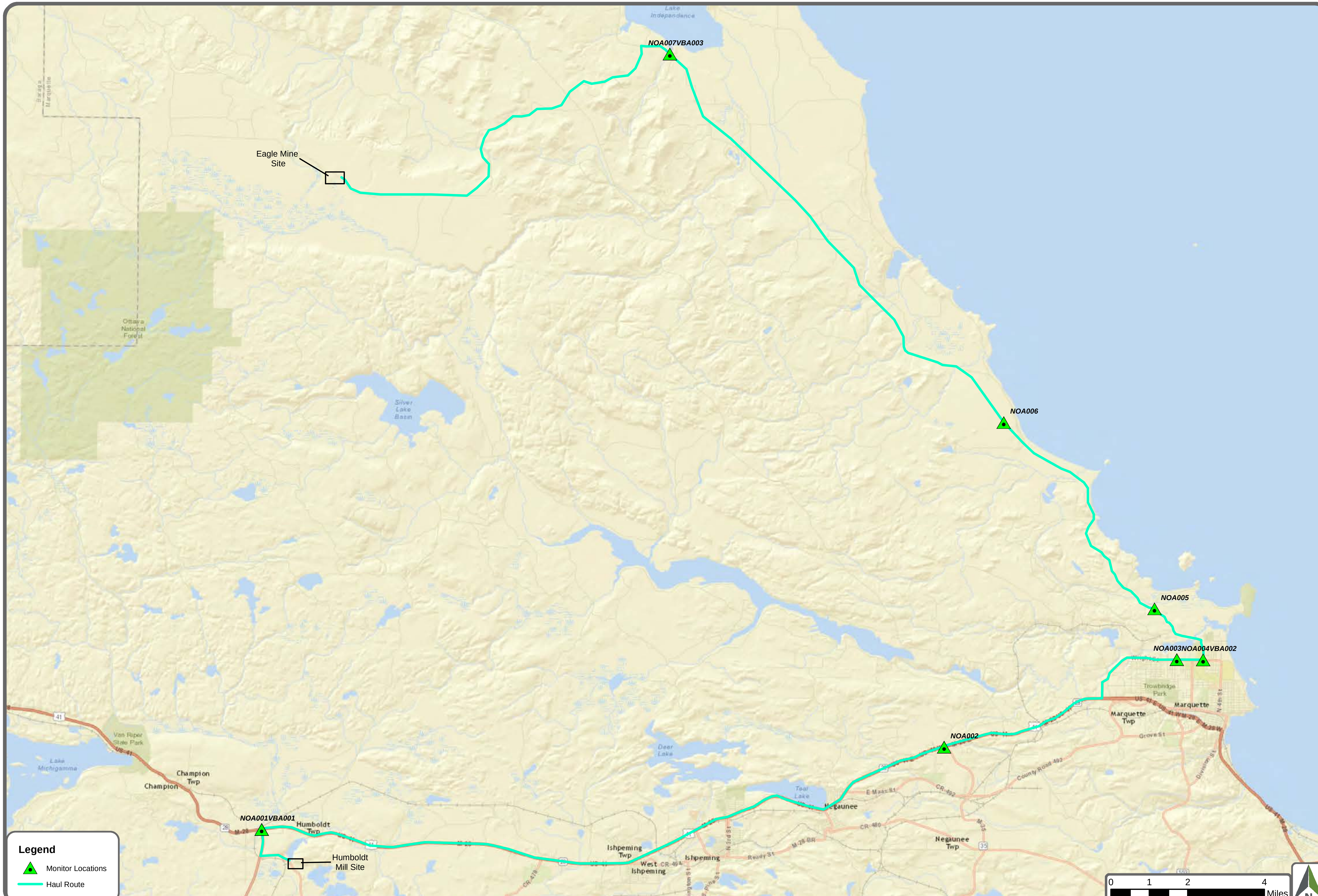
The current volume of Eagle haul trucks along the haul route is not involved in a majority of disruptive noise events. In addition, it was determined that they do not place an excess noise burden on the surrounding community. However due to unique characteristics in the audio fingerprint of both an empty Eagle haul truck and logging type trucks (full and empty); it may be possible for nearby receivers to perceive the movement of these vehicles due to differences in noise frequency. Further study would be required to determine how the audio fingerprint of Eagle haul trucks would compare to other heavy duty vehicles on the haul route in effort to determine which vehicles would be most likely perceived by a nearby receiver. It is also suspected that noise level propagation related to traffic along the haul route would increase during the winter months due to atmospheric, foliage, and ground cover changes. Further field monitoring and noise modeling would be required to fully evaluate how noise level propagation would change with the seasons.

5.2 GROUND VIBRATION

Based on results of the ground vibration monitoring, there were no vibration events that occurred above the recommended vibration level for non-engineered timber and masonry buildings as recommended by U.S. Office of Planning and Environment of the Federal Transit Administration (PPVs greater than 0.2 in/s). It is the professional opinion of TriMedia that the current volume of Eagle Haul Trucks along the haul route does not result in excess ground vibration movement. Results of the Traffic Content analysis for ground vibration performed on each monitoring site indicates that Eagle Haul Trucks are not associated with a majority of the vibration events along the route. It is important to note that very few of the recorded vibration events exceeded the lower range of human vibration detection. Further monitoring of haul route ground vibration at current mine production levels is not recommended.

APPENDICES

Appendix A
Location Maps



TRIMEDIA ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
Marquette County, Michigan

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA JOB NUMBER 2015-126

FIGURE TITLE:

Haul Route & Monitoring Locations

FIGURE NUMBER:

A

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Overall.mxd

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
US 41 & M 95 Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Monitoring Locations
Site NOA001 &
Site VBA001

FIGURE NUMBER:

A-1

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_A1.mxd

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
US 41 & M 35 Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Monitoring Locations
Site NOA002

FIGURE NUMBER:

A-2

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Haul Route Study\GIS\MXD\Fig_A2.mxd

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
Wright St & McClellan Ave Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:
Monitoring Locations
Site NOA003

FIGURE NUMBER:
A-3

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_A3.mxd

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
Wright St & Sugarloaf Ave Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Monitoring Locations
Site NOA004 &
Site VBA002

FIGURE NUMBER:

A-4

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_A4.mxd

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 & Middle Island Point Rd Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Monitoring Locations
Site NOA005

FIGURE NUMBER:

A-5

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_A5.mxd

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 & MCRC Wetland Mitigation Site

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Monitoring Locations
Site NOA006

FIGURE NUMBER:

A-6

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_A6.mxd

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 Alder Creek Bridge

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Monitoring Locations
Site NOA007 &
Site VBA003

FIGURE NUMBER:

A-7

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_A7.mxd

Appendix B
Photographic Documentation

Eagle Mine
Eagle Mine Haul Route

Photo Number: Site 001
Taken By: JPG
Date Taken: 8/13/2015
Description: Noise Monitoring and Vibration Equipment Setup

Photo Number: Site 002
Taken By: JPG
Date Taken: 8/14/2015
Description: Noise Monitoring Equipment Setup

Photo Number: Site 003
Taken By: JPG
Date Taken: 8/14/2015
Description: Noise Monitoring Equipment Setup

Eagle Mine
Eagle Mine Haul Route

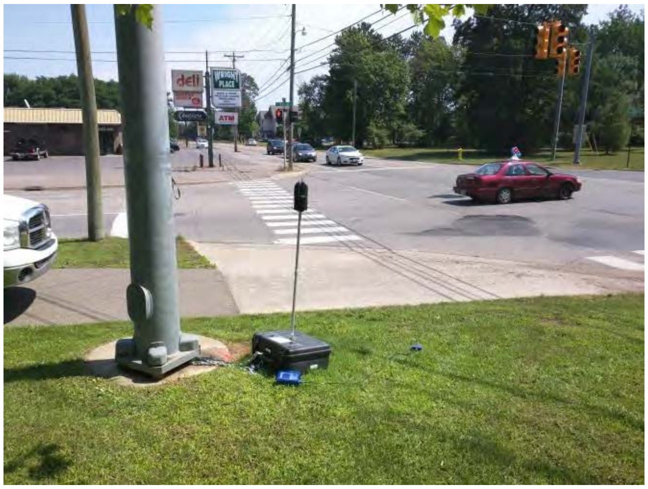


Photo Number: Site 004
Taken By: JPG
Date Taken: 8/14/2015
Description: Noise Monitoring and Vibration Equipment Setup

Photo Number: Site 005
Taken By: JPG
Date Taken: 8/14/2015
Description: Noise Monitoring Equipment Setup

Photo Number: Site 006
Taken By: JPG
Date Taken: 8/14/2015
Description: Noise Monitoring Equipment Setup

Photo Number: Site 007
Taken By: JPG
Date Taken: 8/14/2015
Description: Noise Monitoring and Vibration Equipment Setup

Appendix C
Noise Tables

Table C - 1: Noise Level Summary
Eagle Mine Haul Route

Monitoring Location	**NOA001**	**NOA002**	**NOA003**	**NOA004**	**NOA005**	**NOA006**	**NOA007**
Haul Route Location	US41 and M95 Intersection	US 41 and M 35 Intersection	Wright St. and McClellan Intersection	Wright St. and Sugarloaf Intersection	Phil's 550 Store Location	County Road 550	County Road 550
Description	Humboldt Township	Negaunee Township	Marquette	Marquette	Marquette	MCRC Wetland Mitigation Site	Alder Creek Bridge
Latitude	46.497145	46.530579	46.564137	46.564168	46.583302	46.653278	46.791387
Longitude	-87.919866	-87.547362	-87.420288	-87.405951	-87.432727	-87.515831	-87.700614
Start Date	8/11/2015	8/11/2015	8/11/2015	8/11/2015	8/11/2015	8/11/2015	8/11/2015
Noise Levels (dBA)							
L_{eq}	56.6	66.2	54.9	53.2	51.7	51.7	53.3
L90	44.5	62.0	47.1	46.3	46.3	45.9	45.9
L10	59.6	68.1	58.2	56.3	55.1	55.9	57.7
FHWA PL_{eq}[1]	59.7	66.2	56.5	54.9	53.8	52.9	54.6
FHWA L10[2]	70.0	70.0	70.0	70.0	70.0	70.0	70.0
FHWA L_{eq}[2]	67.0	67.0	67.0	67.0	67.0	67.0	67.0

Notes:
[1] U.S. Department of Transportation Federal Highway Administration (FHWA) Traffic Noise Model predictied average noise level.
[2] U.S. Department of Transportation Federal Highway Administration (FHWA) recommended noise limit for Type 2 land categories.
L_{eq} = Equivalent Continuous Sound Level
L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.
L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.
Bold indicates levels that exceed the recommendations per FHWA .
All results are presented in dBA.

TRIMEDIA ENVIRONMENTAL & ENGINEERING

Table C-2: Noise Events Exceeding Site L10

Eagle Mine Haul Route

Monitoring Location	**NOA001**	**NOA002**	**NOA003**	**NOA004**	**NOA005**	**NOA006**	**NOA007**
Haul Route Location	US41 and M95 Intersection	US 41 and M 35 Intersection	Wright St. and McClellan Intersection	Wright St. and Sugarloaf Intersection	Phil's 550 Store Location	County Road 550	County Road 550
Description	Humboldt Township	Negaunee Township	Marquette	Marquette	Marquette	MCRC Wetland Mitigation Site	Alder Creek Bridge
Site Specific L10 (dBA)	59.6	68.1	58.2	56.3	55.1	55.9	57.7
Day Time Noise Events	194	213	221	249	121	167	147
Noise Event Composition (%)[1]							
Passenger Vehicles	20.3	68.1	11.5	24.7	25.3	7.5	7.3
Medium Duty Trucks	6.5	3.3	24.5	11.0	10.7	1.1	14.6
Heavy Duty Trucks	22.5	11.3	24.0	18.3	25.3	15.1	22.0
Eagle Haul Trucks	9.5	0.5	7.8	5.0	13.3	22.6	39.0
Logging Truck	8.2	4.7	5.2	5.0	9.3	6.5	13.4
Non-Eagle Mine Trucks	0.0	8.9	0.0	0.0	0.0	0.0	0.0
Motorcycles	32.5	3.3	19.3	21.5	16.0	47.3	2.4
Other	0.4	0.0	7.8	14.6	0.0	0.0	1.2
Unknown	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

[1] 95% Confidance Level, ±10% of Day Time Noise Events

Leq = Equivalent Continuous Sound Level

L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.

L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.

All results are presented in dBA.

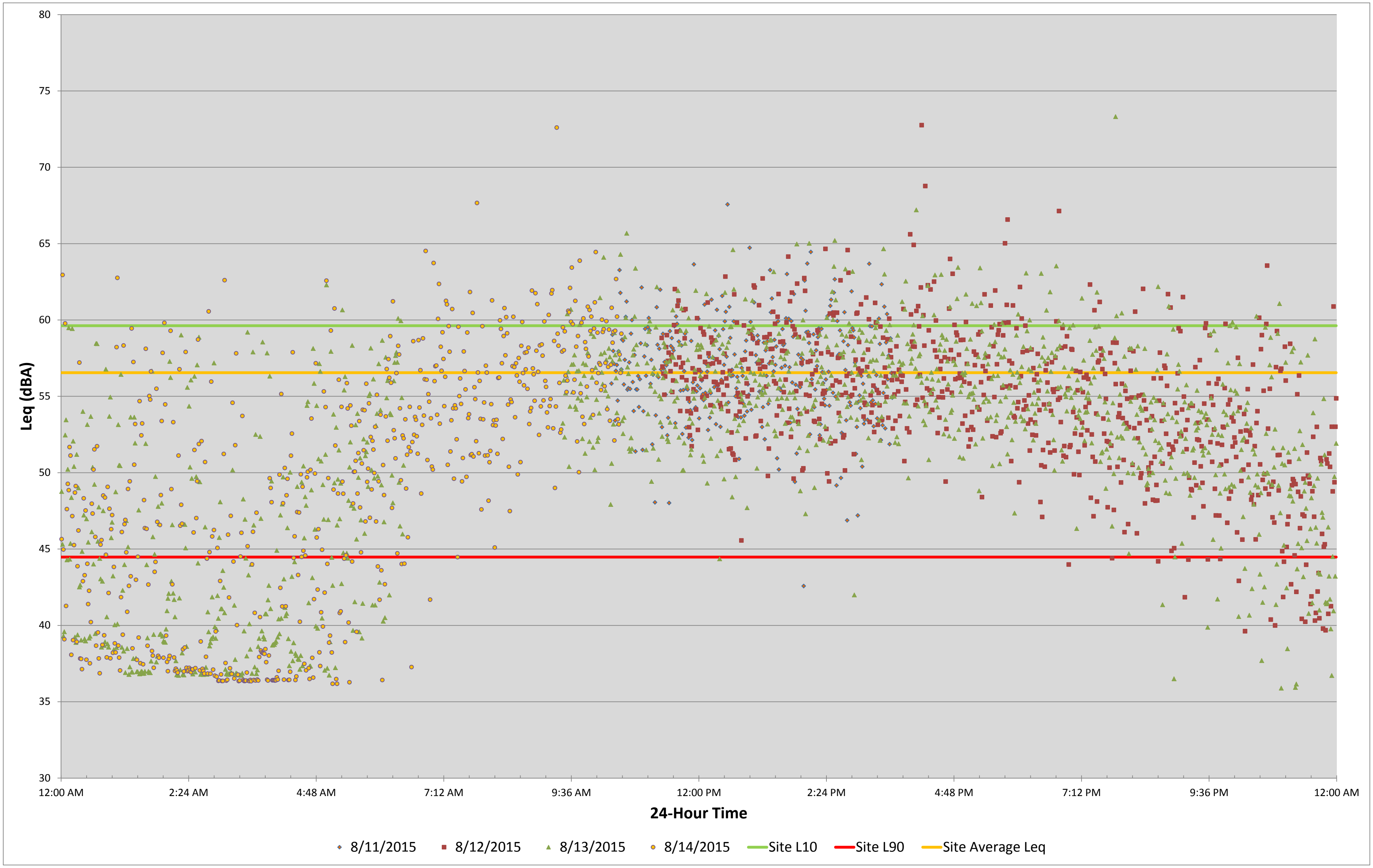
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Appendix D
Daily Noise Levels

Figure D-1

Daily Noise Level: NOA001

US41 and M95 Intersection - Humboldt Township



L_{eq} = Equivalent Continuous Sound Level
Site Average L_{eq} = Site specific equivalent continuous sound level as measure during the monitoring period.
L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.
L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.
dBA = Sound pressure level units, measured on an A-weighted scale.

TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Date: 08/11/15 to 08/14/15

Figure D-2

Daily Noise Level: NOA002

US 41 and M 35 Intersection - Negaunee Township

L_{eq} = Equivalent Continuous Sound Level

Site Average L_{eq} = Site specific equivalent continuous sound level as measure during the monitoring period.

L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.

L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.

dBA = Sound pressure level units, measured on an A-weighted scale.

Note: Power issues related to the monitoring equipment resulted in a data loss from 10:05 am to 11:54 am, resulting in a data gap for this timer period.

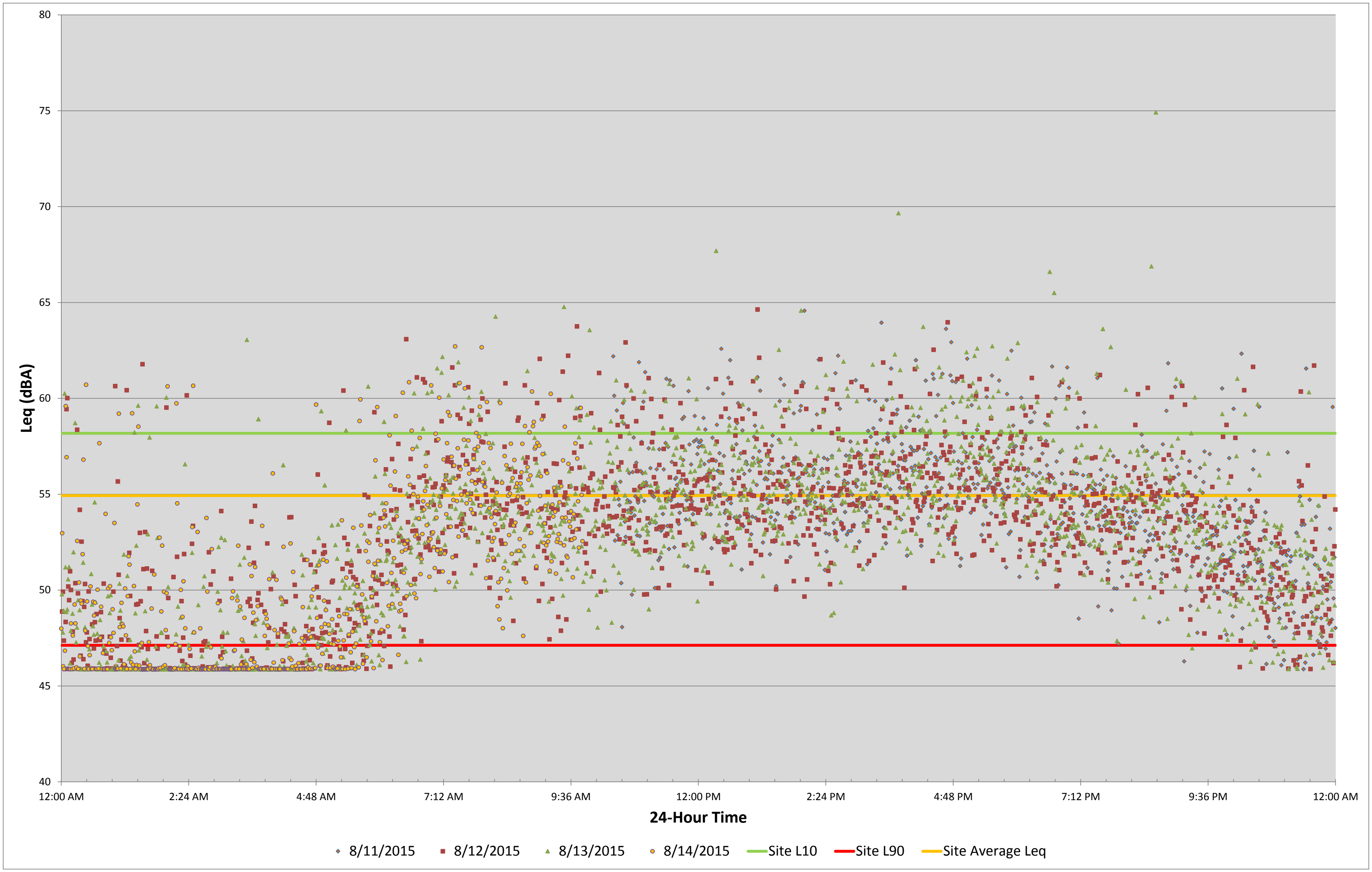
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Date: 08/12/15 to 08/14/15

Figure D-3

Daily Noise Level: NOA003

Wright St. and McClellan Intersection - Marquette



L_{eq} = Equivalent Continuous Sound Level
Site Average L_{eq} = Site specific equivalent continuous sound level as measure during the monitoring period.
L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.
L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.
dBA = Sound pressure level units, measured on an A-weighted scale.

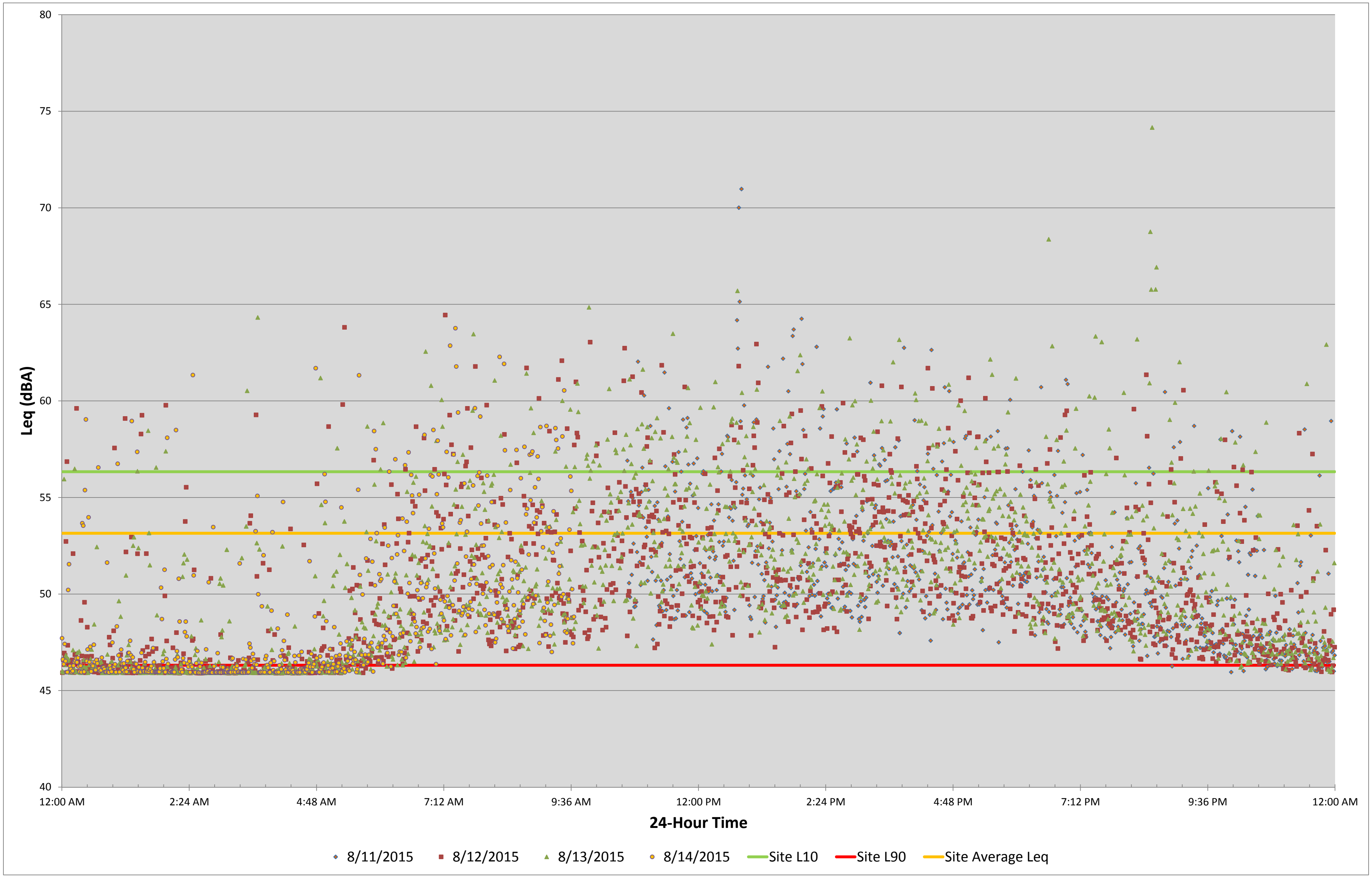
TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Monitioring Date: 08/11/15 to 08/14/15

Figure D-4

Daily Noise Level: NOA004

Wright St. and Sugarloaf Intersection - Marquette



L_{eq} = Equivalent Continuous Sound Level
Site Average L_{eq} = Site specific equivalent continuous sound level as measure during the monitoring period.
L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.
L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.
dBA = Sound pressure level units, measured on an A-weighted scale.

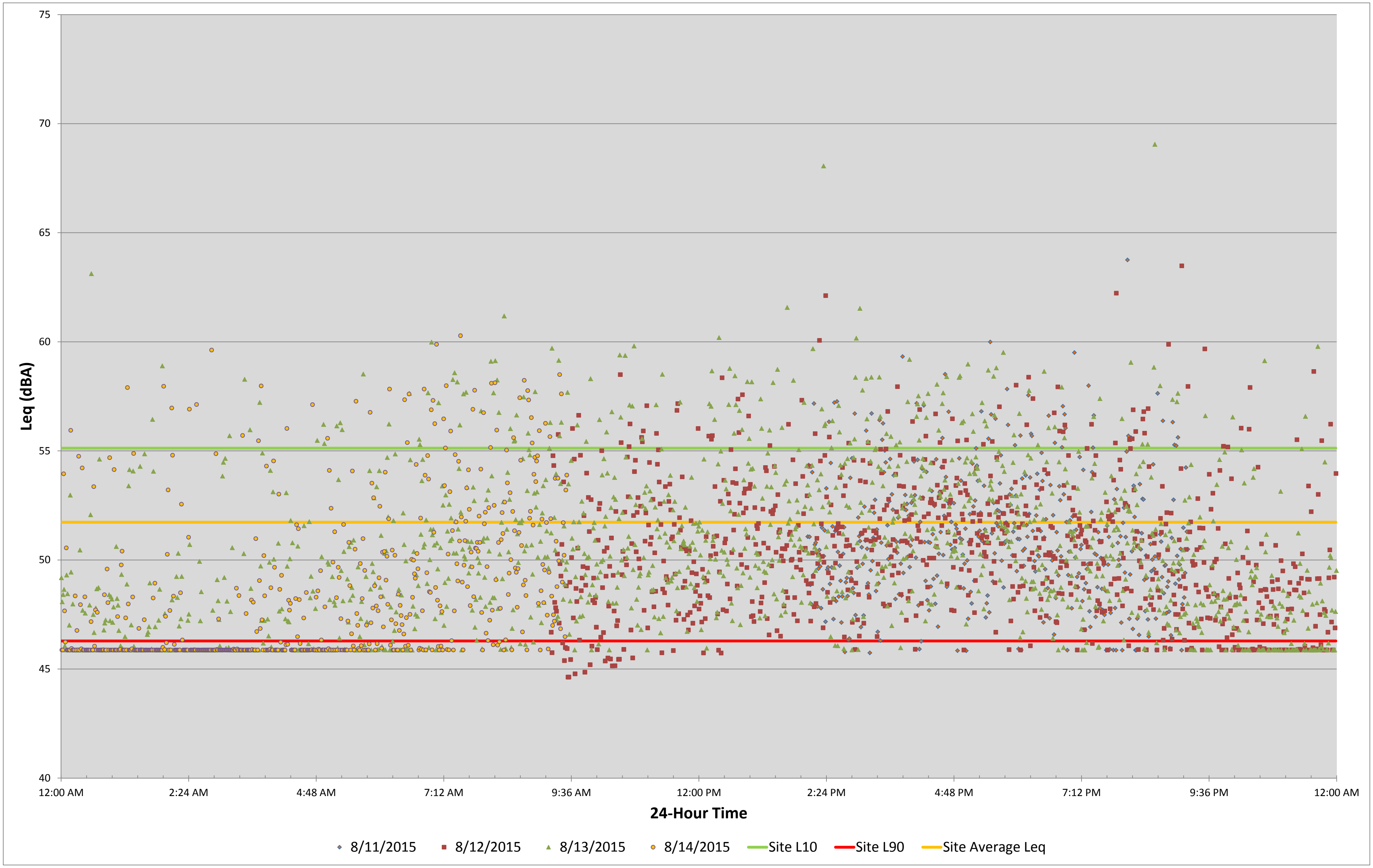
TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Monitioring Date: 08/11/15 to 08/14/15

Figure D-5

Daily Noise Level: NOA005

Phil's 550 Store Location - Marquette



L_{eq} = Equivalent Continuous Sound Level
Site Average L_{eq} = Site specific equivalent continuous sound level as measure during the monitoring period.
L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.
L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.
dBA = Sound pressure level units, measured on an A-weighted scale.

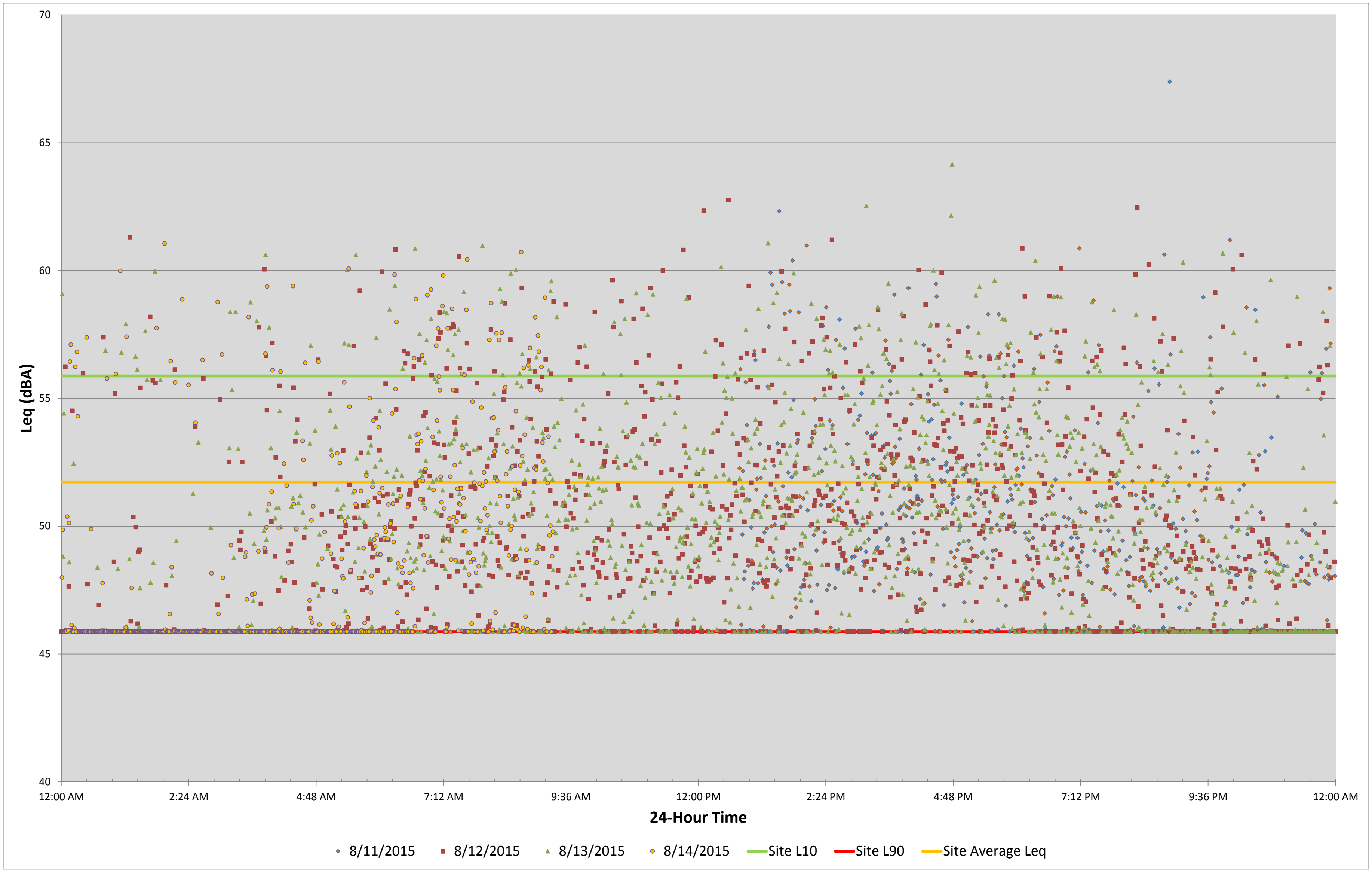
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Date: 08/11/15 to 08/14/15

Figure D-6

Daily Noise Level: NOA006

County Road 550 - MCRC Wetland Mitigation Site



L_{eq} = Equivalent Continuous Sound Level
Site Average L_{eq} = Site specific equivalent continuous sound level as measure during the monitoring period.
L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.
L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.
dBA = Sound pressure level units, measured on an A-weighted scale.

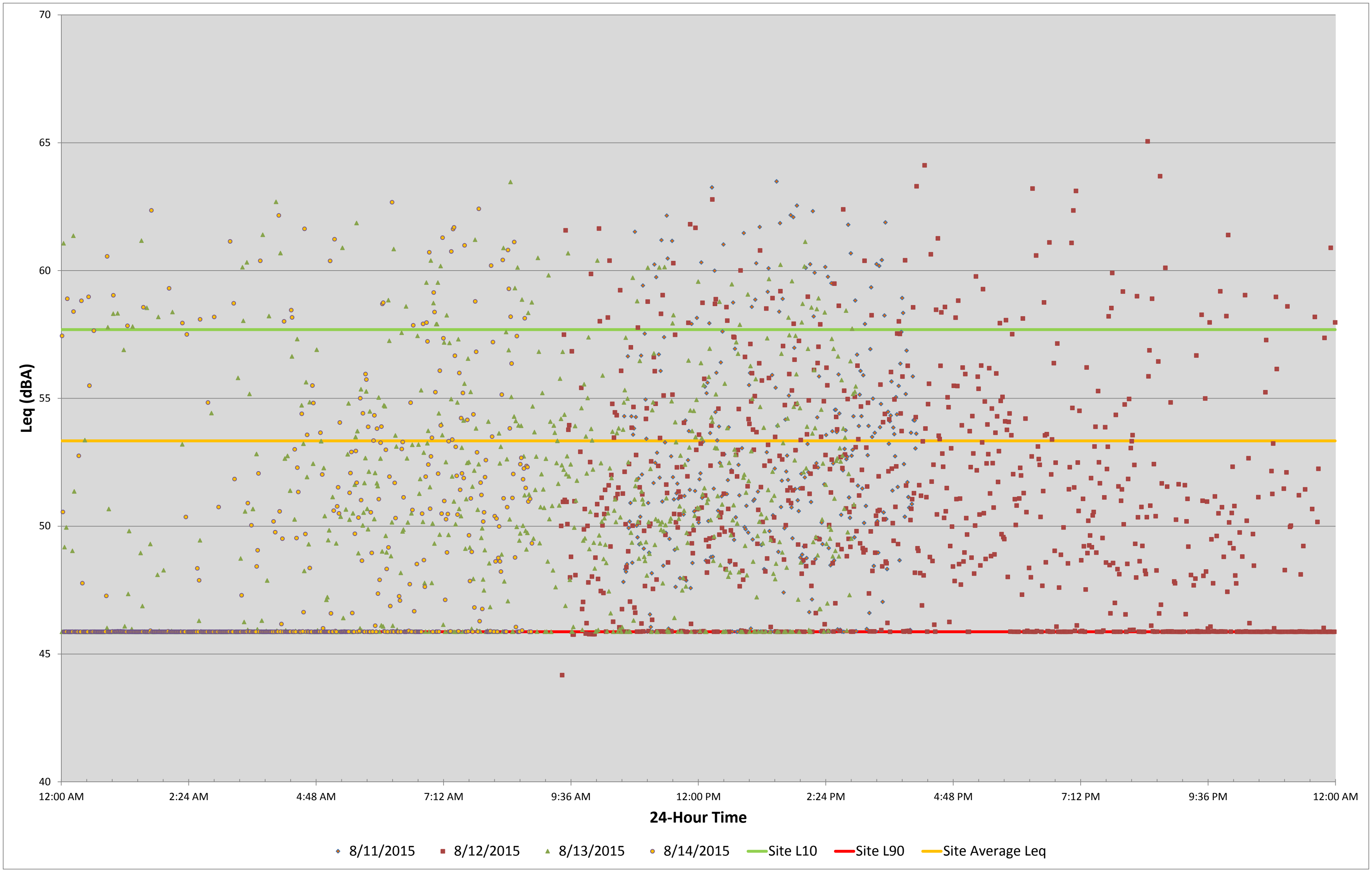
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Date: 08/11/15 to 08/14/15

Figure D-7

Daily Noise Level: NOA007

County Road 550 - Alder Creek Bridge



L_{eq} = Equivalent Continuous Sound Level
Site Average L_{eq} = Site specific equivalent continuous sound level as measure during the monitoring period.
L90 = Sound pressure level exceeded over 90% of the time, ambient background noise.
L10 = Sound pressure level exceeded 10% of the time, disruptive noise limit.
dBA = Sound pressure level units, measured on an A-weighted scale.

TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Date: 08/11/15 to 08/14/15

Appendix E
Noise Contour Figures

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
US 41 & M 95 Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:
Noise Propogation Contours with Eagle Haul Truck Traffic Site NOA001

FIGURE NUMBER:
E-1a

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
US 41 & M 95 Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Noise Propogation Contours without Eagle Haul Truck Traffic
Site NOA001

FIGURE NUMBER:

E-1b

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-1b.mxd

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
US 41 & M 35 Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Noise Propogation Contours with Eagle Haul Truck Traffic Site NOA002

FIGURE NUMBER:

E-2a

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-2a.mxd

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
US 41 & M 35 Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

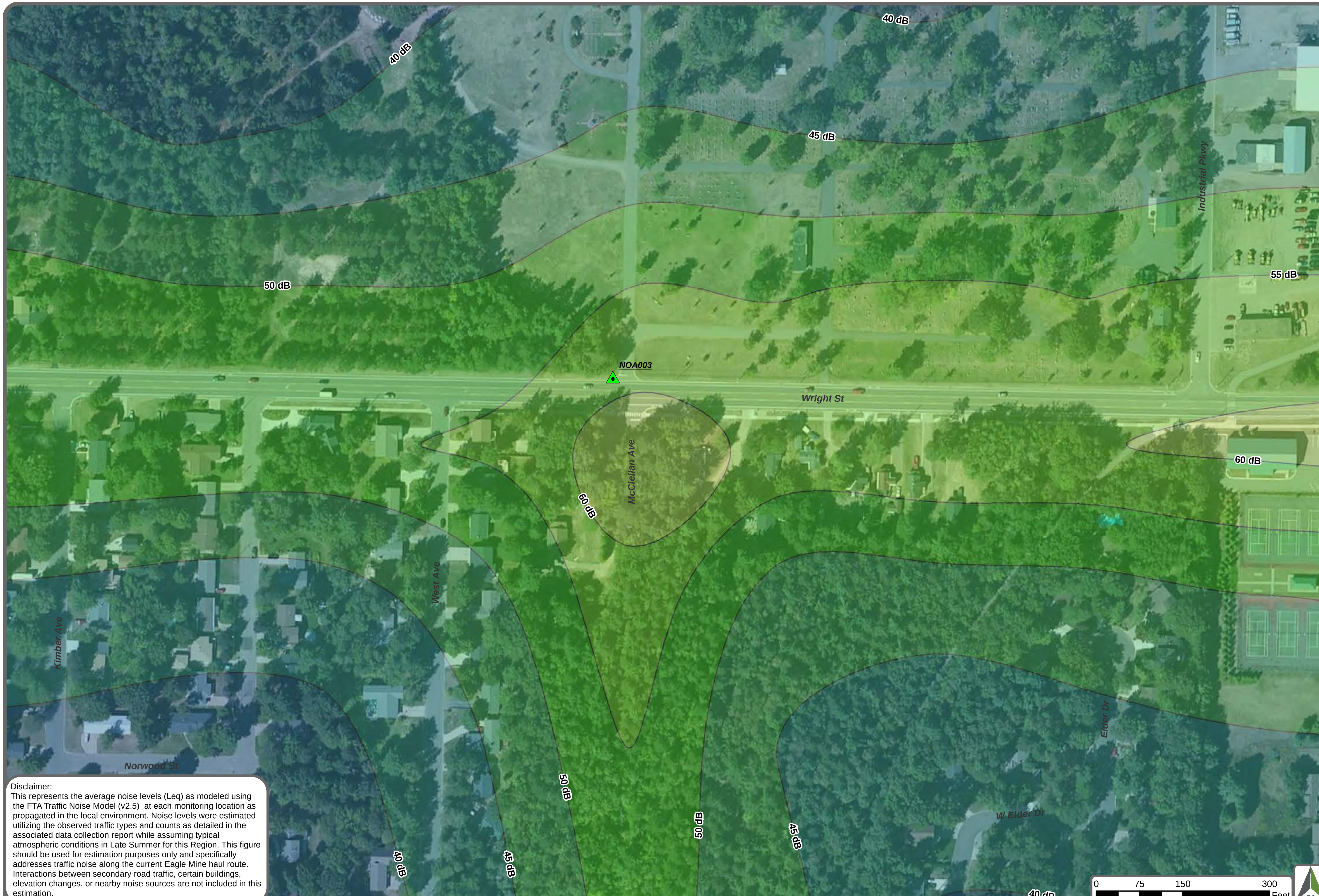
FIGURE TITLE:

Noise Propogation Contours without Eagle Haul Truck Traffic Site NOA002

FIGURE NUMBER:

E-2b

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-2b.mxd



Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
Wright St & McClellan Ave Intersection

DATE	DESCRIPTION:

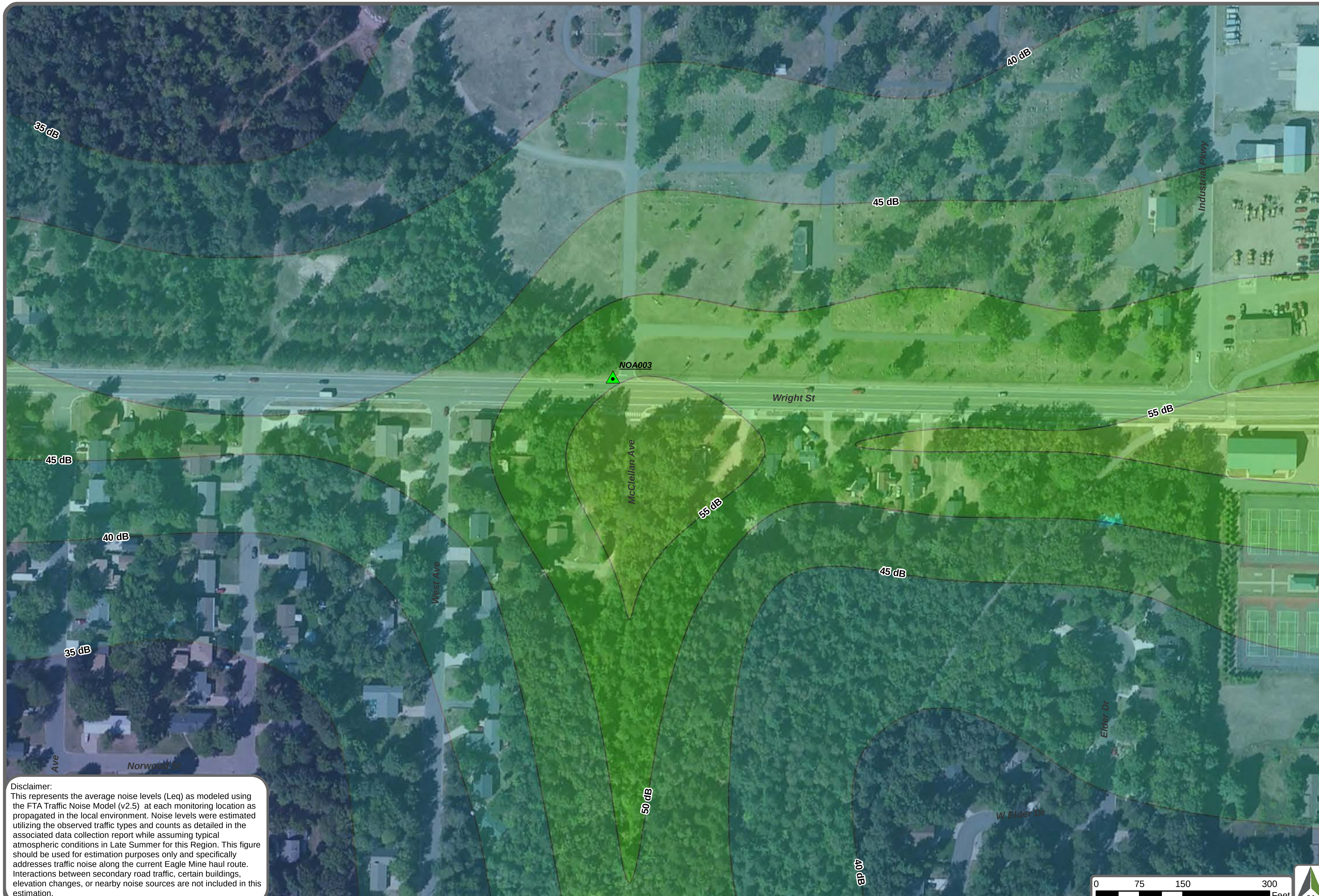
DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:
Noise Propogation Contours with Eagle Haul Truck Traffic Site NOA003

FIGURE NUMBER:
E-3a

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-3a.mxd



Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
Wright St & McClellan Ave Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

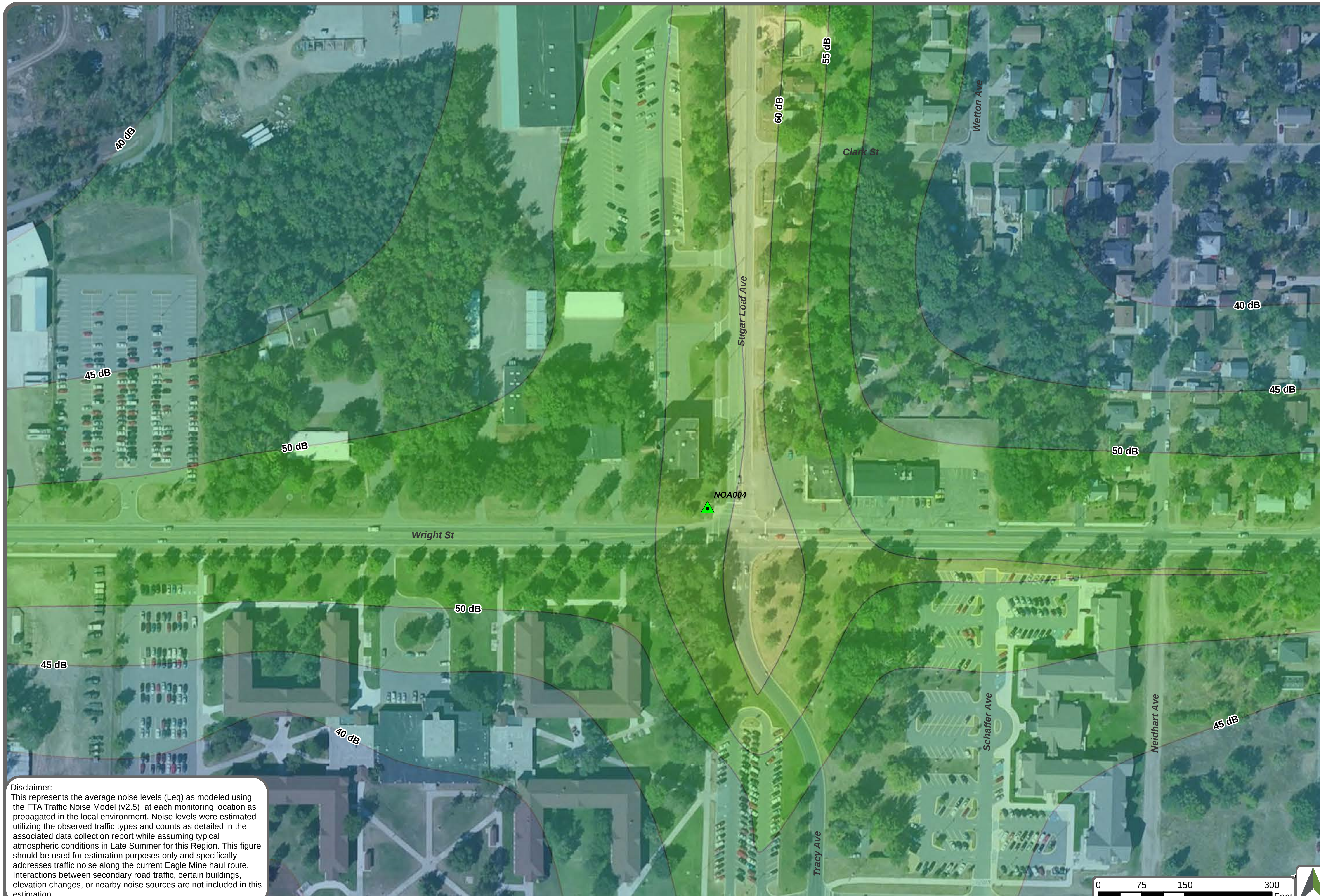
FIGURE TITLE:

Noise Propogation Contours without Eagle Haul Truck Traffic Site NOA003

FIGURE NUMBER:

E-3b

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-3b.mxd



Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
Wright St & Sugarloaf Ave Intersection

DATE	DESCRIPTION:

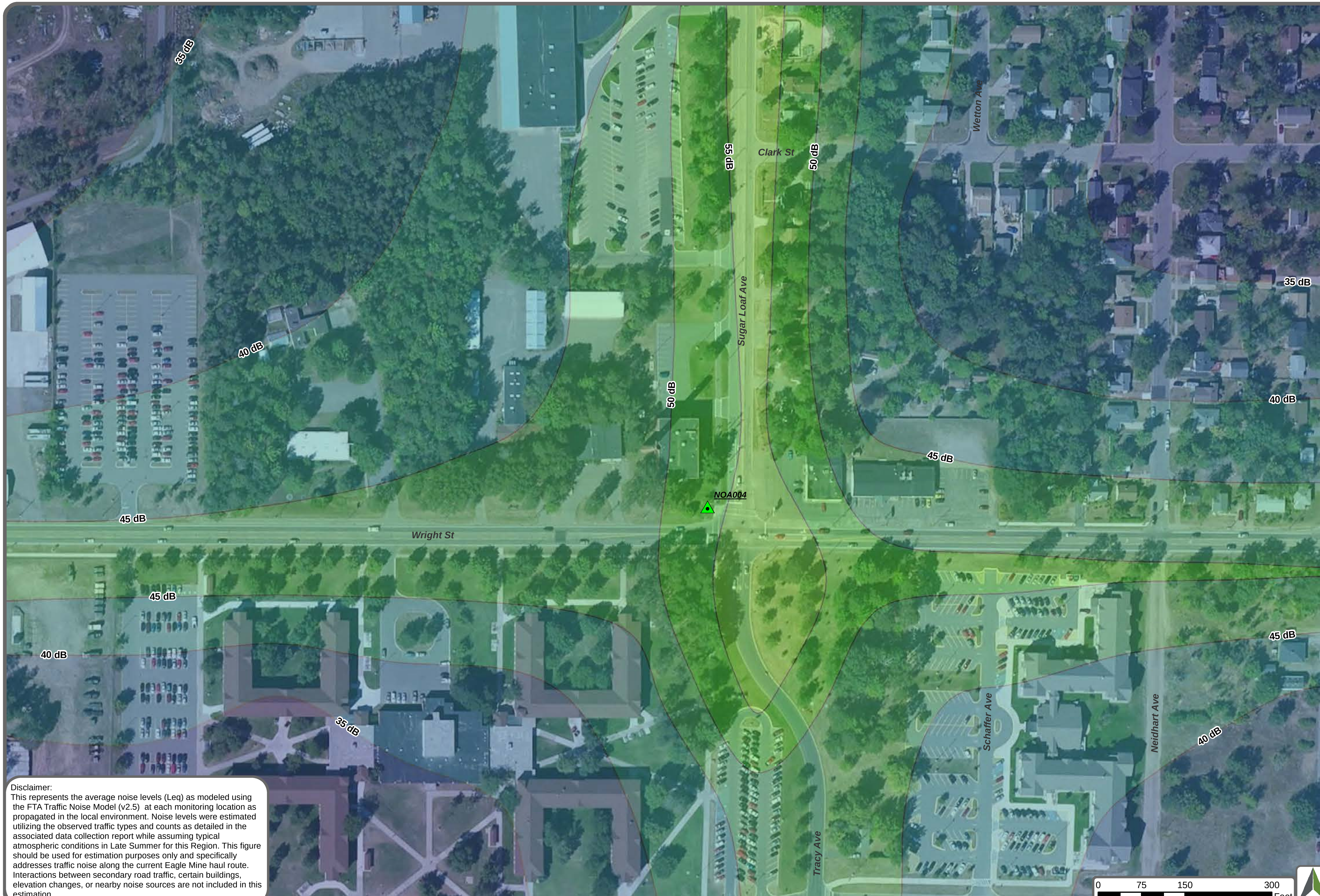
DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:
Noise Propogation Contours with Eagle Haul Truck Traffic Site NOA004

FIGURE NUMBER:
E-4a

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-4a.mxd



Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
Wright St & Sugarloaf Ave Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

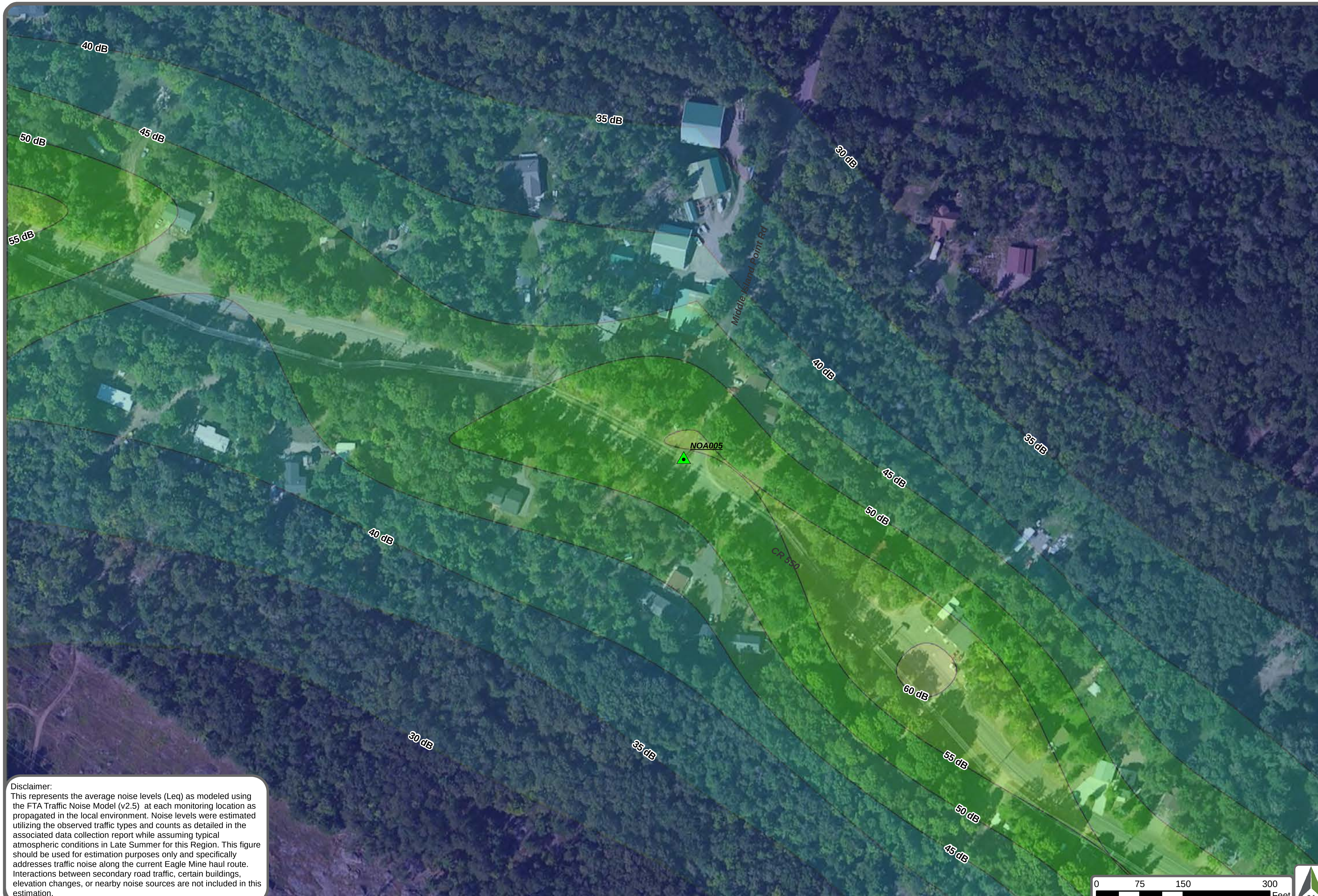
FIGURE TITLE:

Noise Propogation Contours without Eagle Haul Truck Traffic Site NOA004

FIGURE NUMBER:

E-4b

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-4b.mxd



Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 & Middle Island Point Rd Intersection

DATE	DESCRIPTION

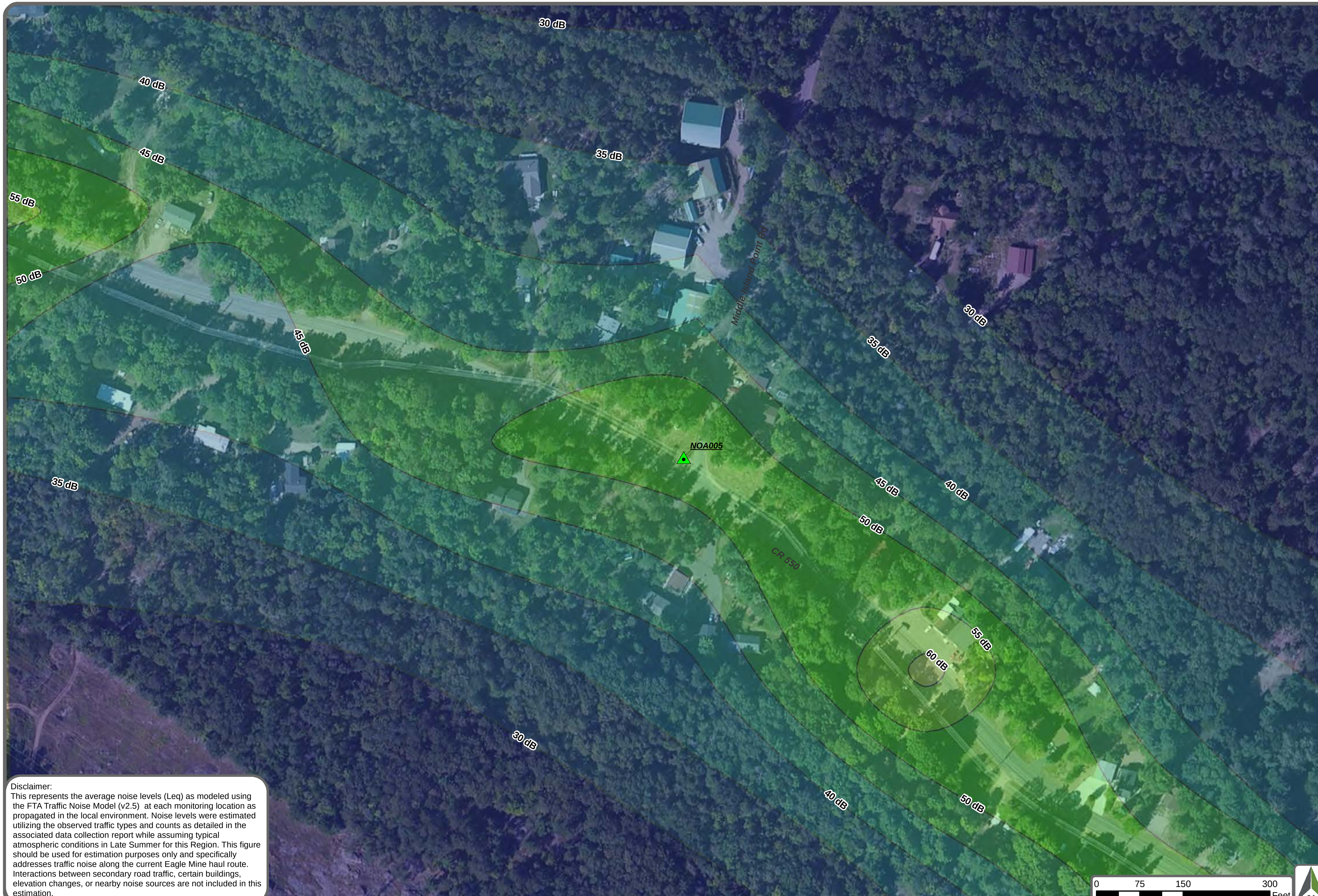
DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA JOB NUMBER 2015-126

FIGURE TITLE:
Noise Propogation Contours with Eagle Haul Truck Traffic Site NOA005

FIGURE NUMBER:
E-5a

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-5a.mxd



Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 & Middle Island Point Rd Intersection

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Noise Propogation Contours without Eagle Haul Truck Traffic Site NOA005

FIGURE NUMBER:

E-5b

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-5b.mxd

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 & MCRC Wetland Mitigation Site

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Noise Propogation Contours with Eagle Haul Truck Traffic Site NOA006

FIGURE NUMBER:

E-6a

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-6a.mxd

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 & MCRC Wetland Mitigation Site

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Noise Propogation Contours without Eagle Haul Truck Traffic Site NOA006

FIGURE NUMBER:

E-6b

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-6b.mxd

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 Alder Creek Bridge

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Noise Propogation Contours with Eagle Haul Truck Traffic Site NOA007

FIGURE NUMBER:

E-7a

Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-7a.mxd

Disclaimer:
This represents the average noise levels (Leq) as modeled using the FTA Traffic Noise Model (v2.5) at each monitoring location as propagated in the local environment. Noise levels were estimated utilizing the observed traffic types and counts as detailed in the associated data collection report while assuming typical atmospheric conditions in Late Summer for this Region. This figure should be used for estimation purposes only and specifically addresses traffic noise along the current Eagle Mine haul route. Interactions between secondary road traffic, certain buildings, elevation changes, or nearby noise sources are not included in this estimation.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Lundin Mining
Eagle Mine
Noise & Vibration Haul Route Study
CR 550 Alder Creek Bridge

DATE	DESCRIPTION:

DESIGNED: KGK
DRAWN: KGK
CHECKED: JPG
APPROVED: TLA

TRIMEDIA
JOB NUMBER
2015-126

FIGURE TITLE:

Noise Propogation Contours without Eagle Haul Truck Traffic Site NOA007

FIGURE NUMBER:

E-7b

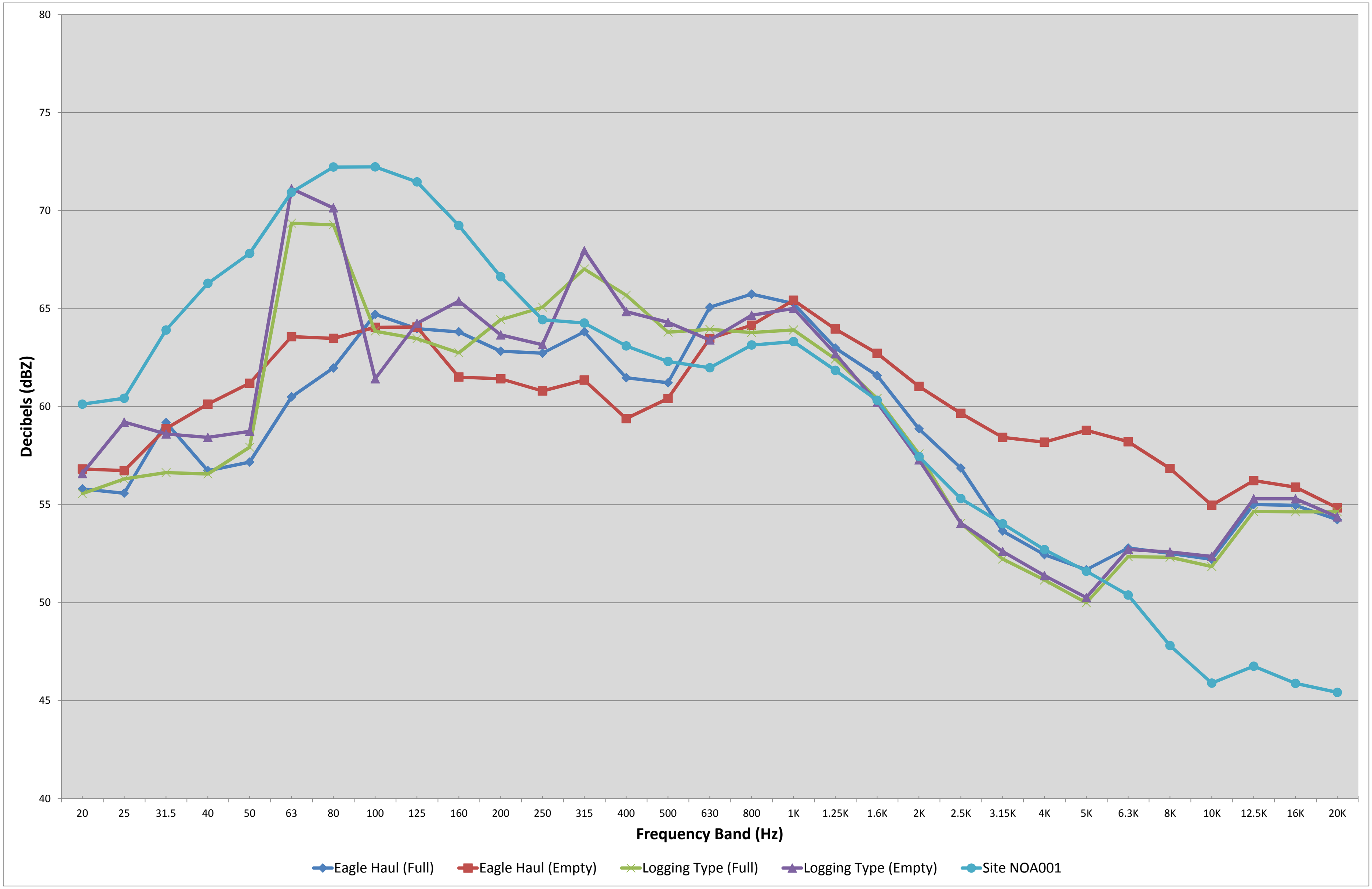
Path: G:\Projects\2015\2015-126 Lundin Mining - Eagle Mine Noise & Vibration Study\GIS\MXD\Fig_E-7b.mxd

Appendix F
Audio Fingerprints

Figure F-1

Audio Fingerprint Analysis: NOA001

US41 and M95 Intersection - Humboldt Township



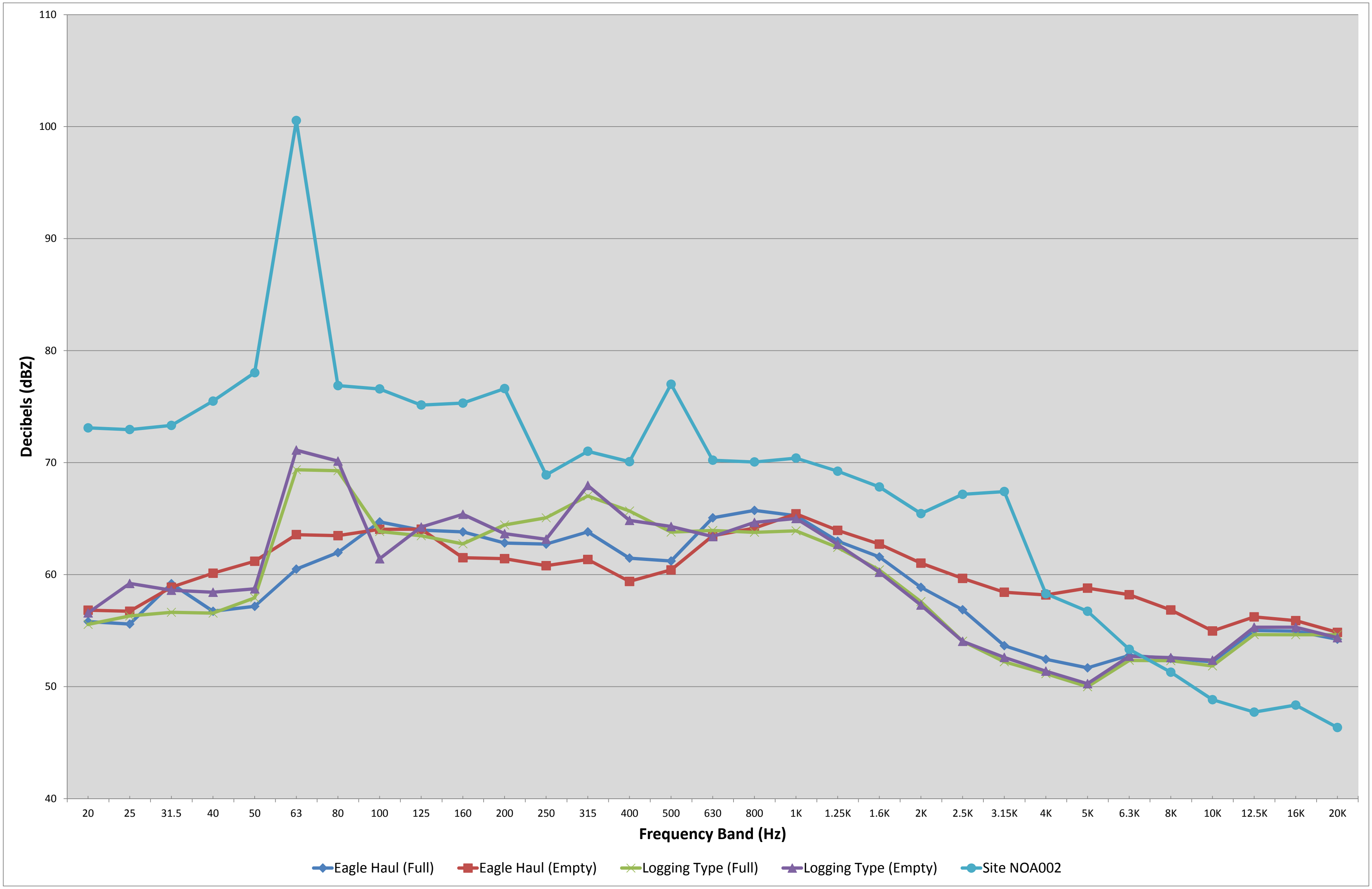
dBZ = Sound pressure level units, measured on an Flat weighted scale.
Hz = the SI unit of frequency, equal to one cycle per second.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Figure F-2

Audio Fingerprint Analysis: NOA002

US 41 and M 35 Intersection - Negaunee Township



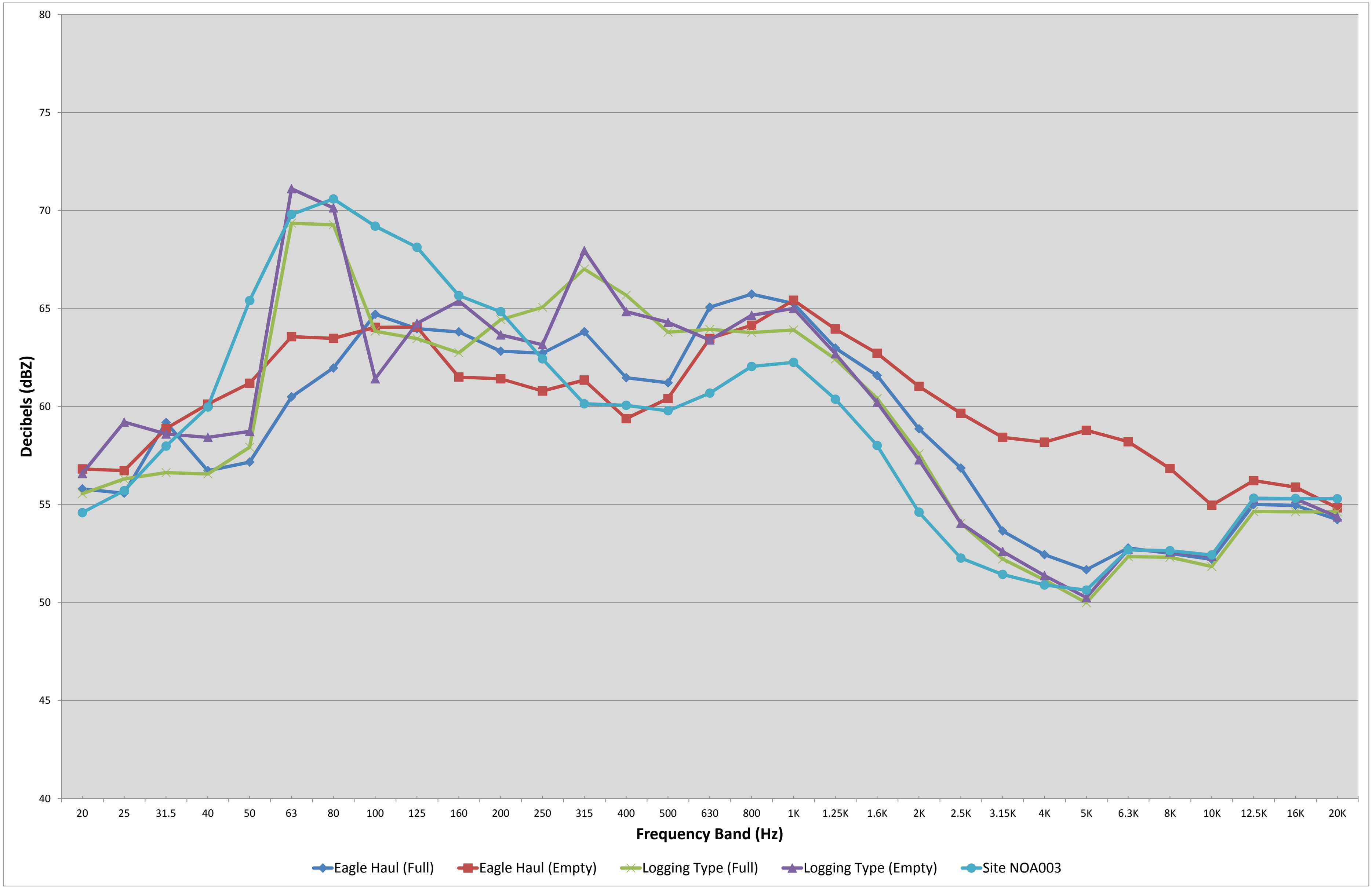
dBZ = Sound pressure level units, measured on an Flat weighted scale.
Hz = the SI unit of frequency, equal to one cycle per second.

TRIMEDIA ENVIRONMENTAL & ENGINEERING

Figure F-3

Audio Fingerprint Analysis: NOA003

Wright St. and McClellan Intersection - Marquette



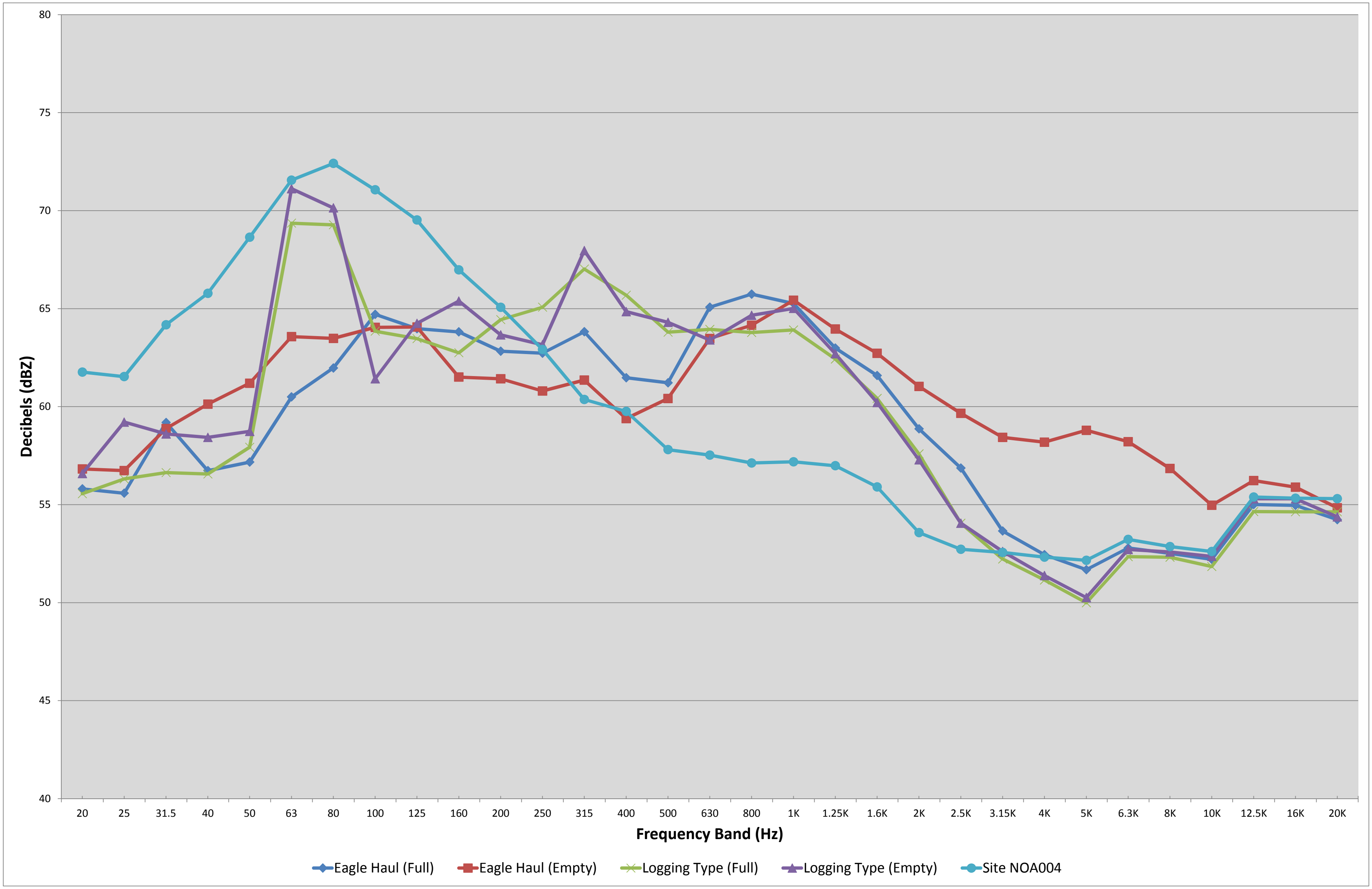
dBZ = Sound pressure level units, measured on an Flat weighted scale.
Hz = the SI unit of frequency, equal to one cycle per second.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Figure F-4

Audio Fingerprint Analysis: NOA004

Wright St. and Sugarloaf Intersection - Marquette



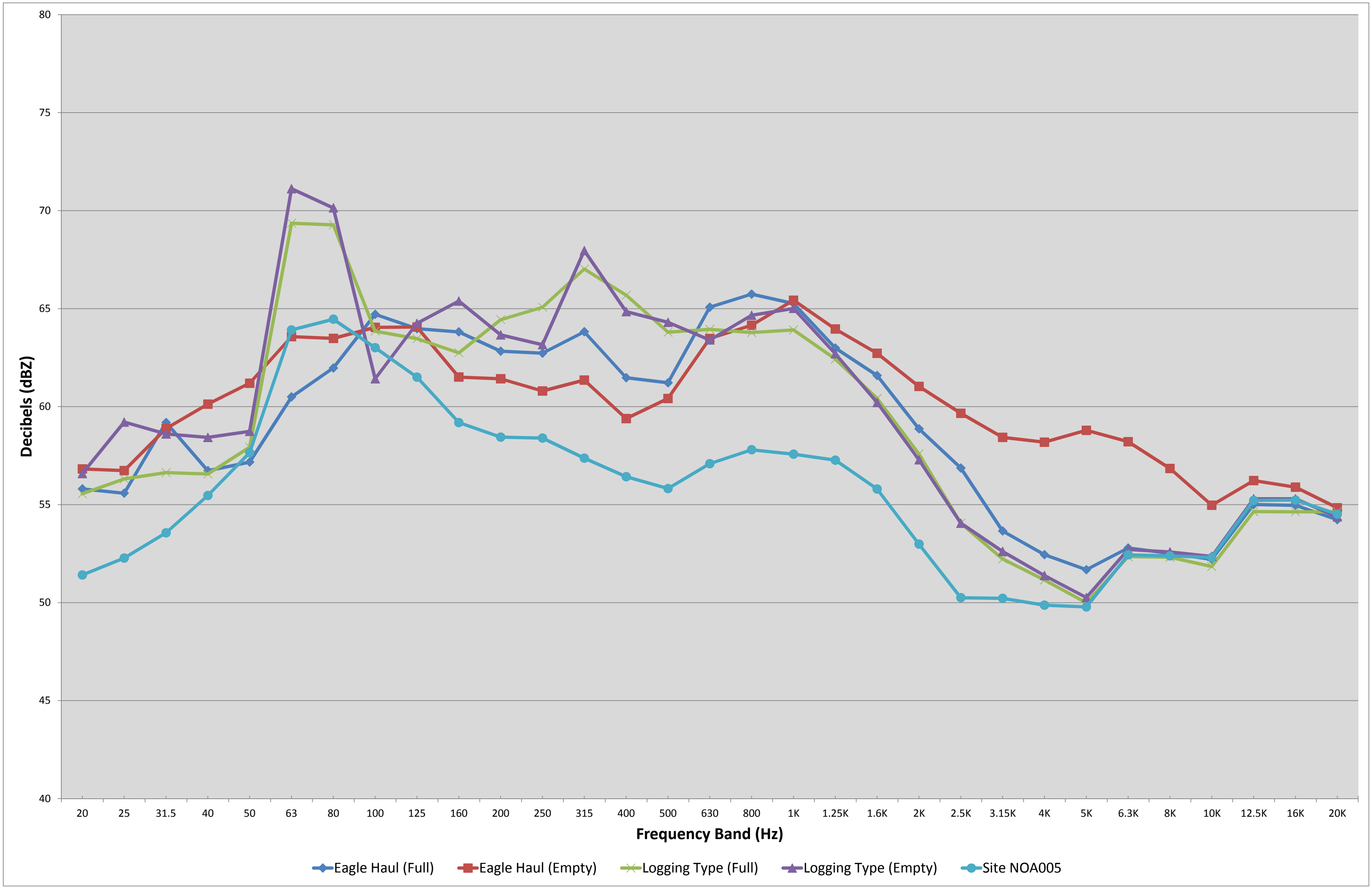
dBZ = Sound pressure level units, measured on an Flat weighted scale.
Hz = the SI unit of frequency, equal to one cycle per second.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

Figure F-5

Audio Fingerprint Analysis: NOA005

Phil's 550 Store Location - Marquette

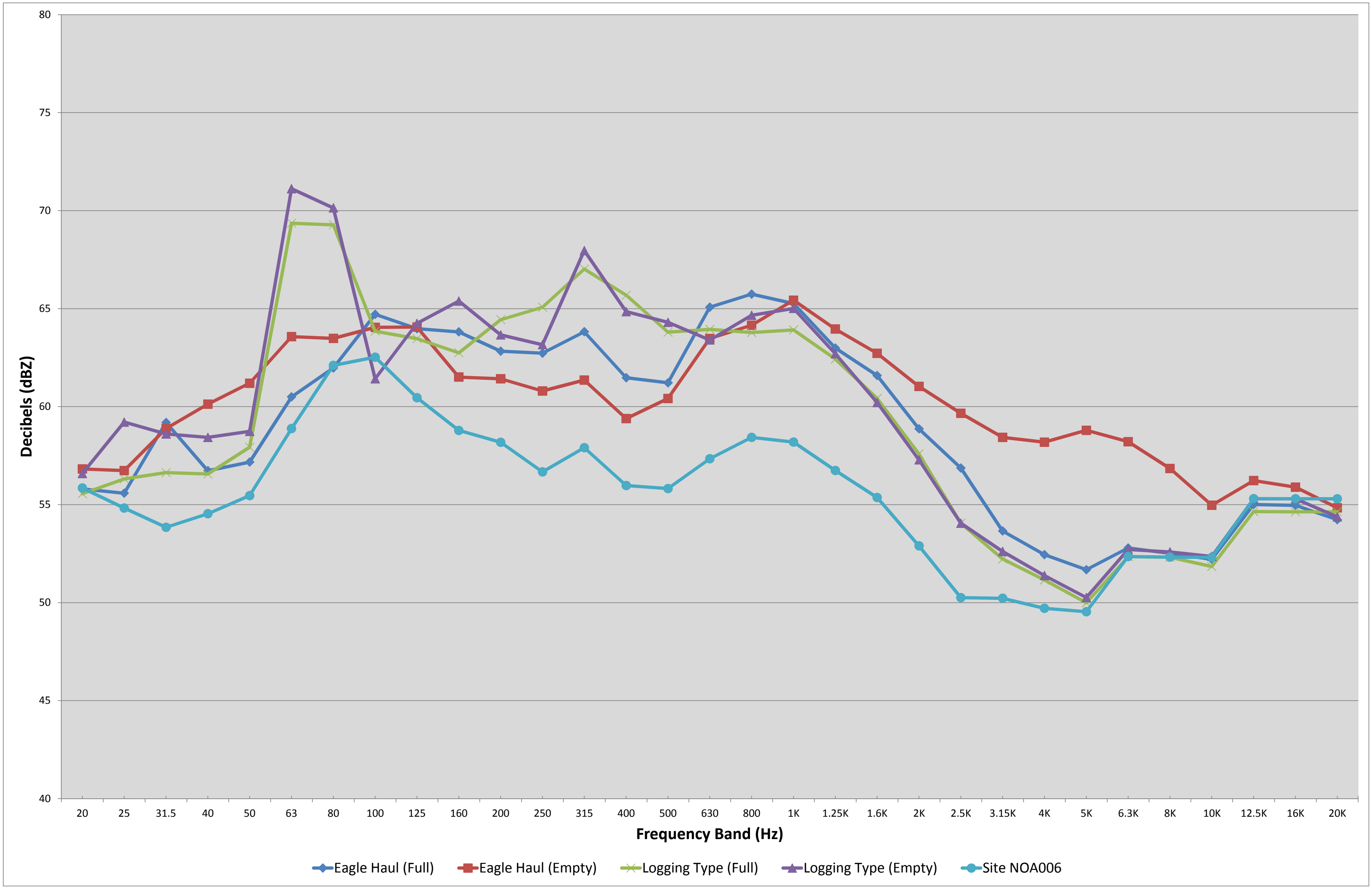


dBZ = Sound pressure level units, measured on an Flat weighted scale.
Hz = the SI unit of frequency, equal to one cycle per second.

Figure F-6

Audio Fingerprint Analysis: NOA006

County Road 550 - MCRC Wetland Mitigation Site



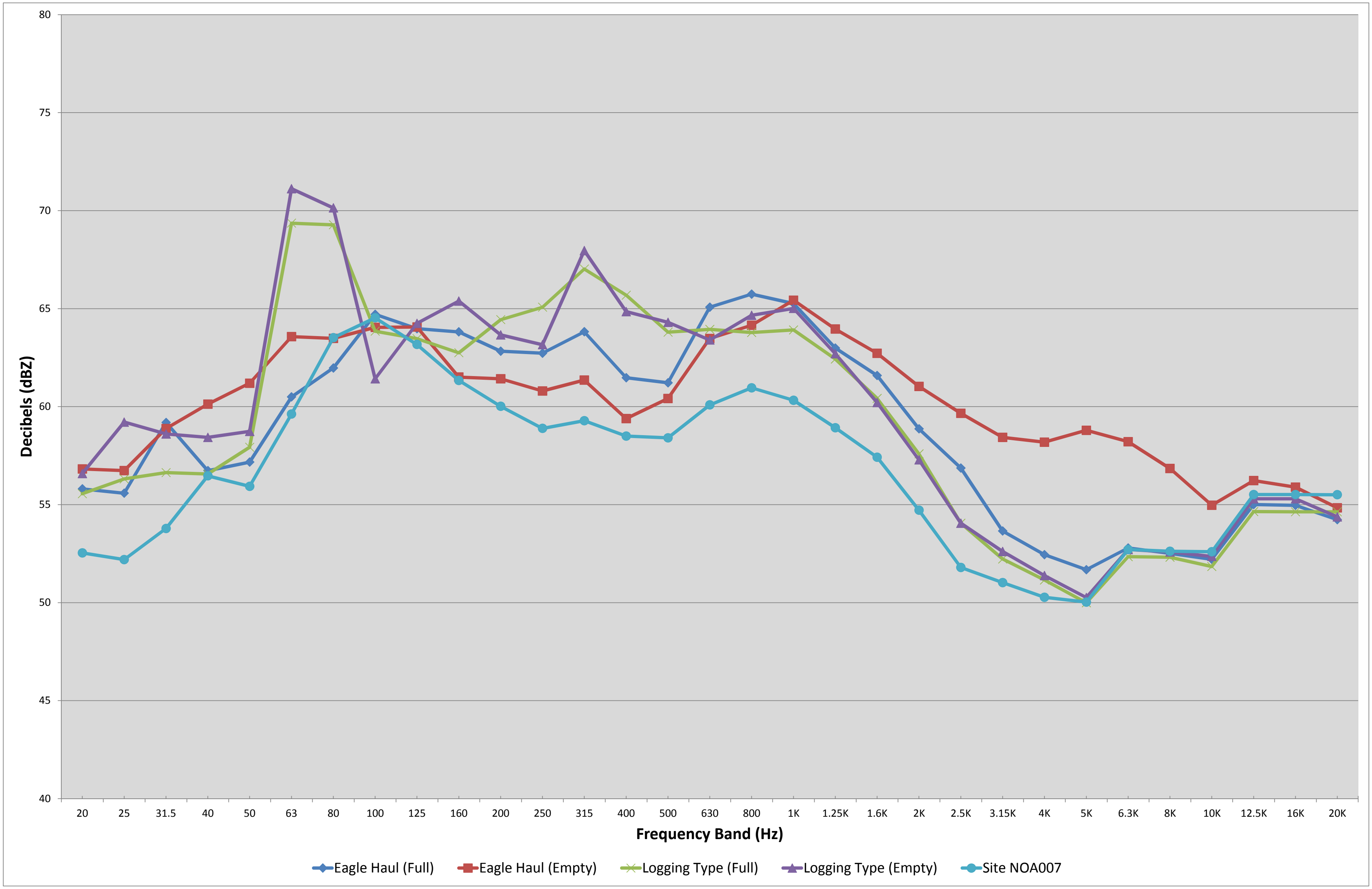
dBZ = Sound pressure level units, measured on an Flat weighted scale.
Hz = the SI unit of frequency, equal to one cycle per second.

TRIMEDIA ENVIRONMENTAL & ENGINEERING

Figure F-7

Audio Fingerprint Analysis: NOA007

County Road 550 - Alder Creek Bridge



dBZ = Sound pressure level units, measured on an Flat weighted scale.
Hz = the SI unit of frequency, equal to one cycle per second.

TRIMEDIA
ENVIRONMENTAL & ENGINEERING

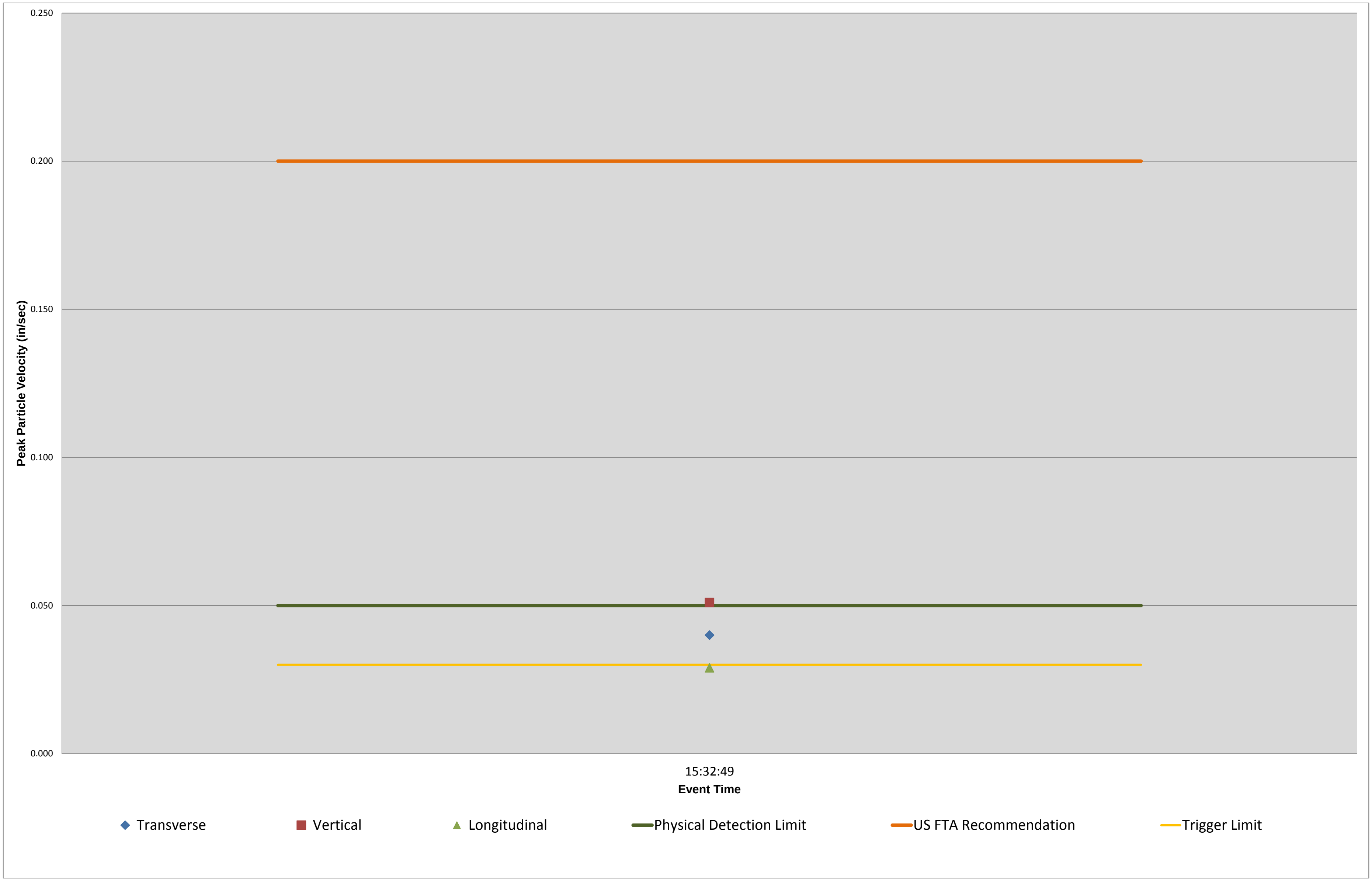
Appendix G

Ground Vibration Events

Figure G-1

Ground Vibration Events: VBA001 on 8/12/15

US41 and M95 Intersection - Humboldt Township



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

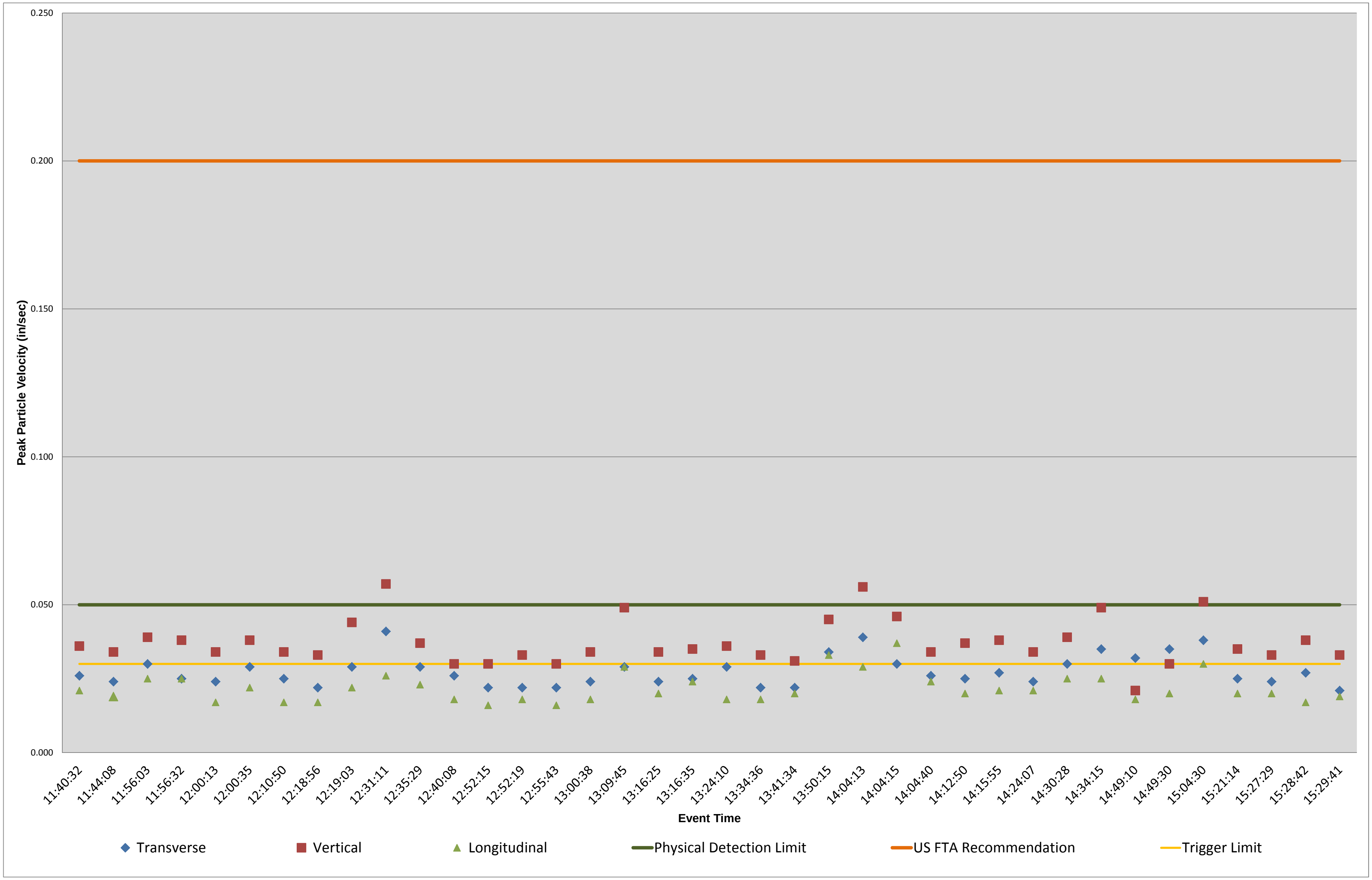
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 11:25:24 to 15:55:01

Figure G-2

Ground Vibration Events: VBA001 on 8/13/15

US41 and M95 Intersection - Humboldt Township



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

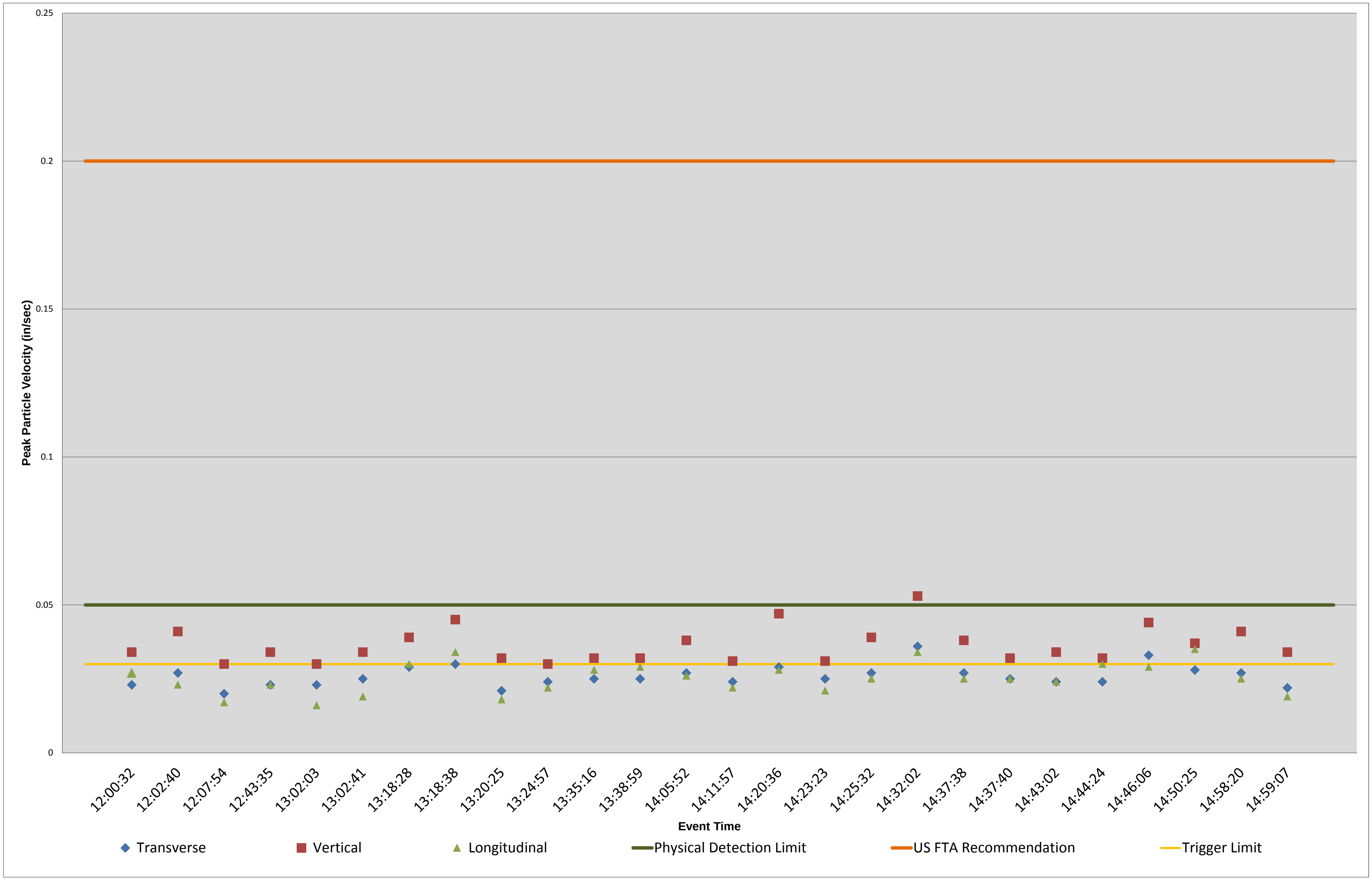
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 10:58:13 to 15:40:39

Figure G-3

Ground Vibration Events: VBA001 on 8/14/15

US41 and M95 Intersection - Humboldt Township



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

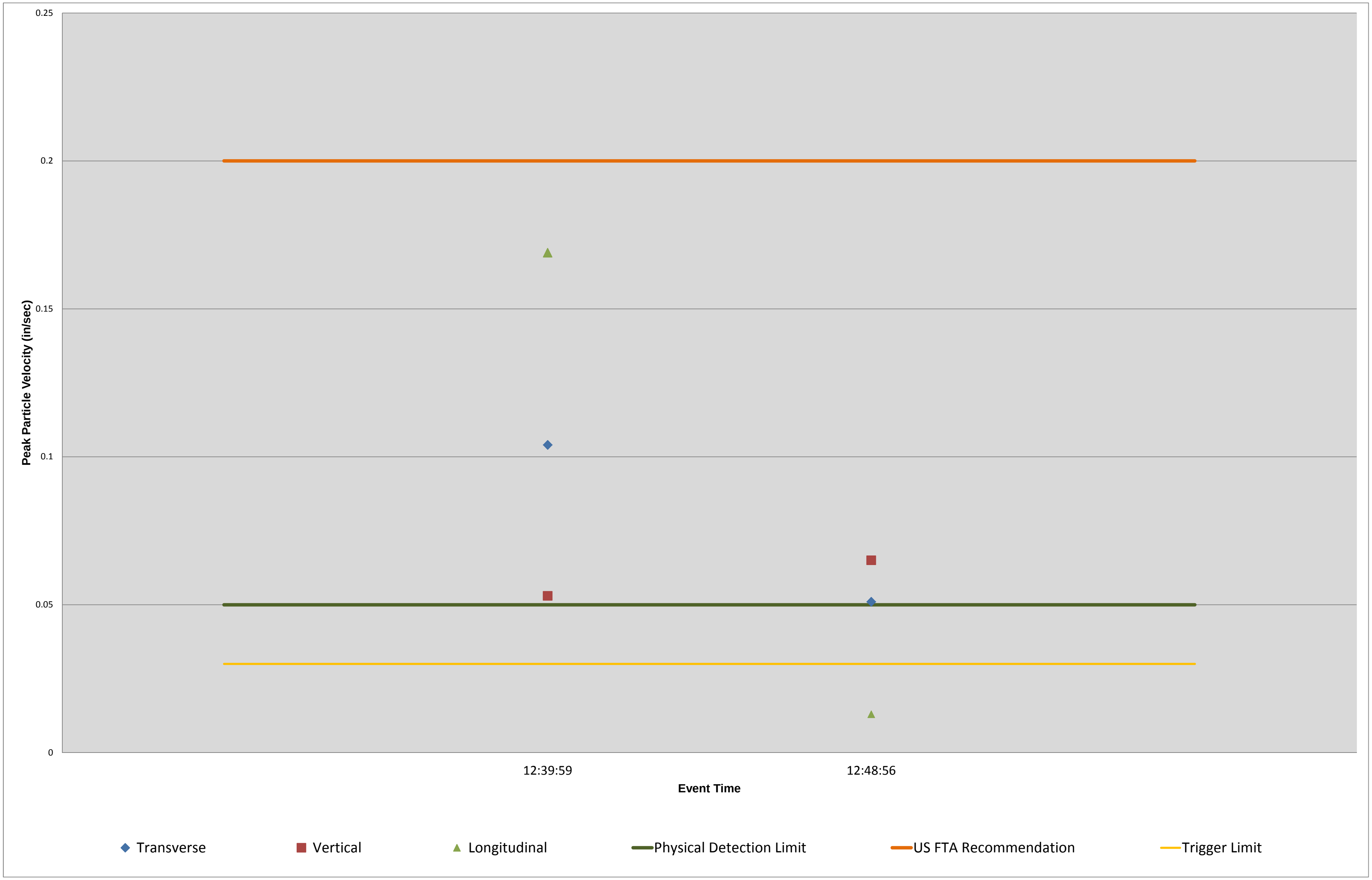
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 10:36:33 to 15:06:23

Figure G-4

Ground Vibration Events: VBA002 on 8/11/15

Wright St. and Sugarloaf Intersection - Marquette



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

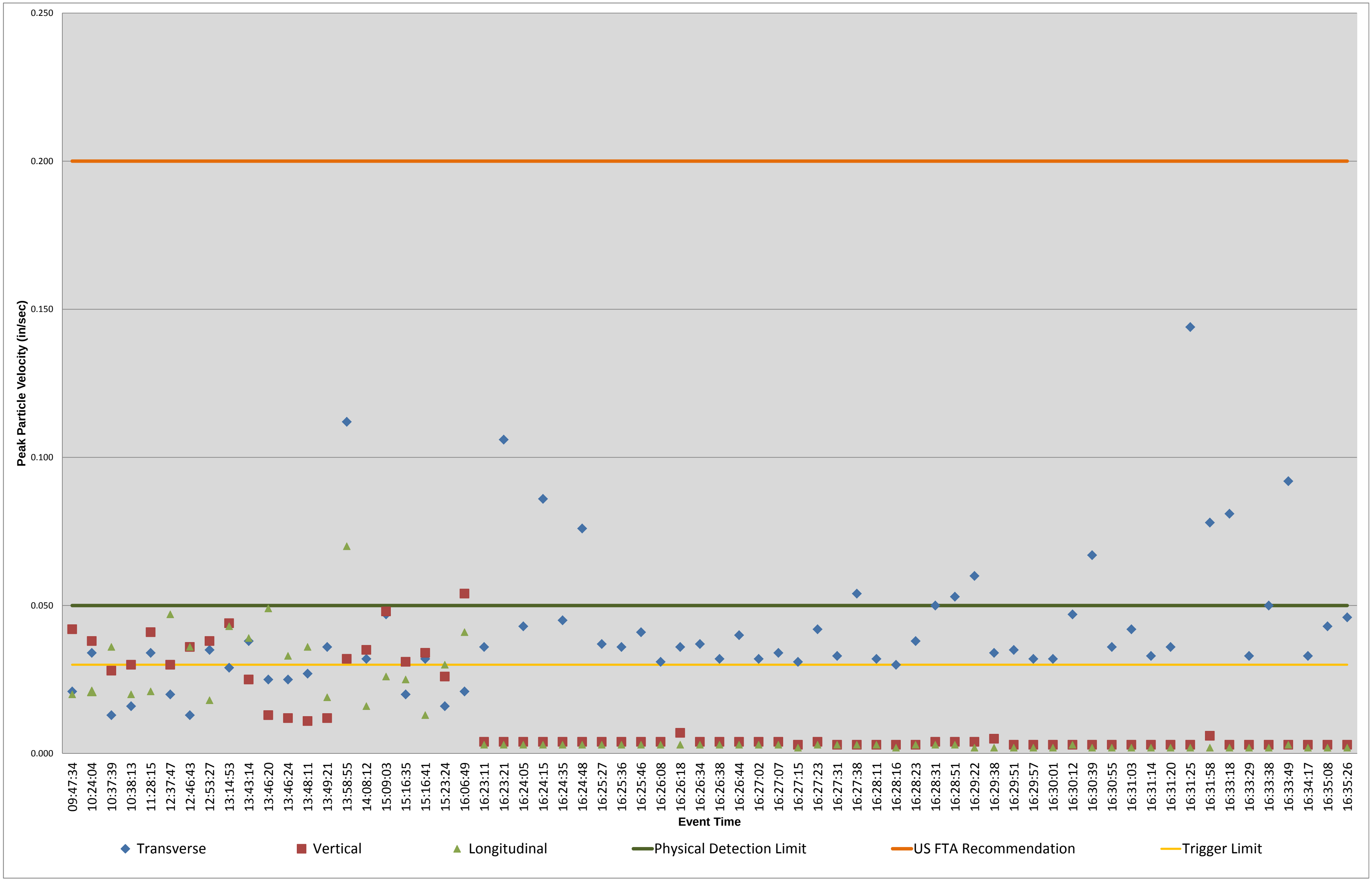
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 10:45:59 to 16:18:00

Figure G-5

Ground Vibration Events: VBA002 on 8/13/15

Wright St. and Sugarloaf Intersection - Marquette



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

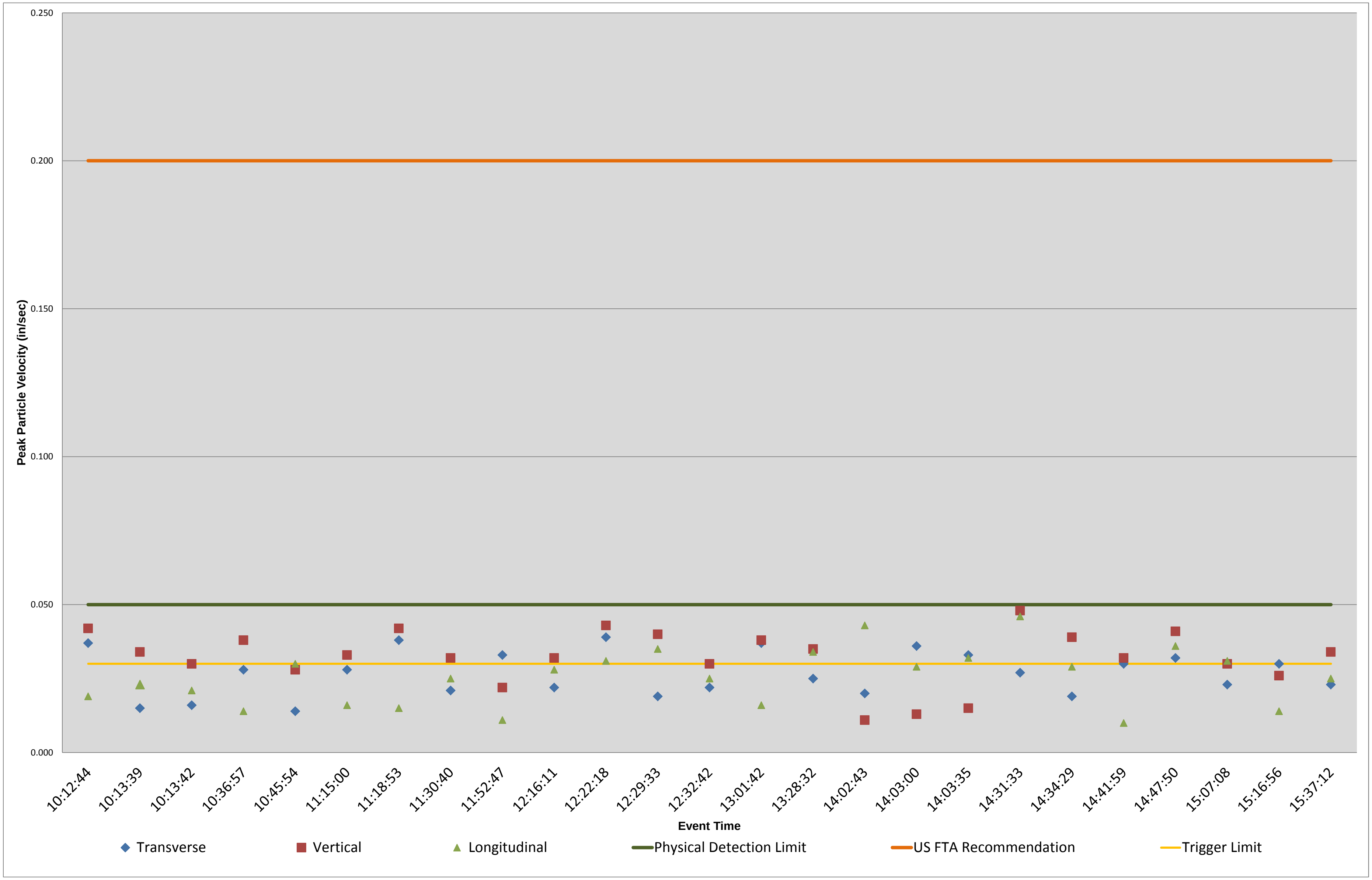
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 09:03:23 to 16:44:58

Figure G-6

Ground Vibration Events: VBA002 on 8/14/15

Wright St. and Sugarloaf Intersection - Marquette



Peak Particle Velocity (PPV) = Inches Per Second

Event Time: (hh:mm:ss)

US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

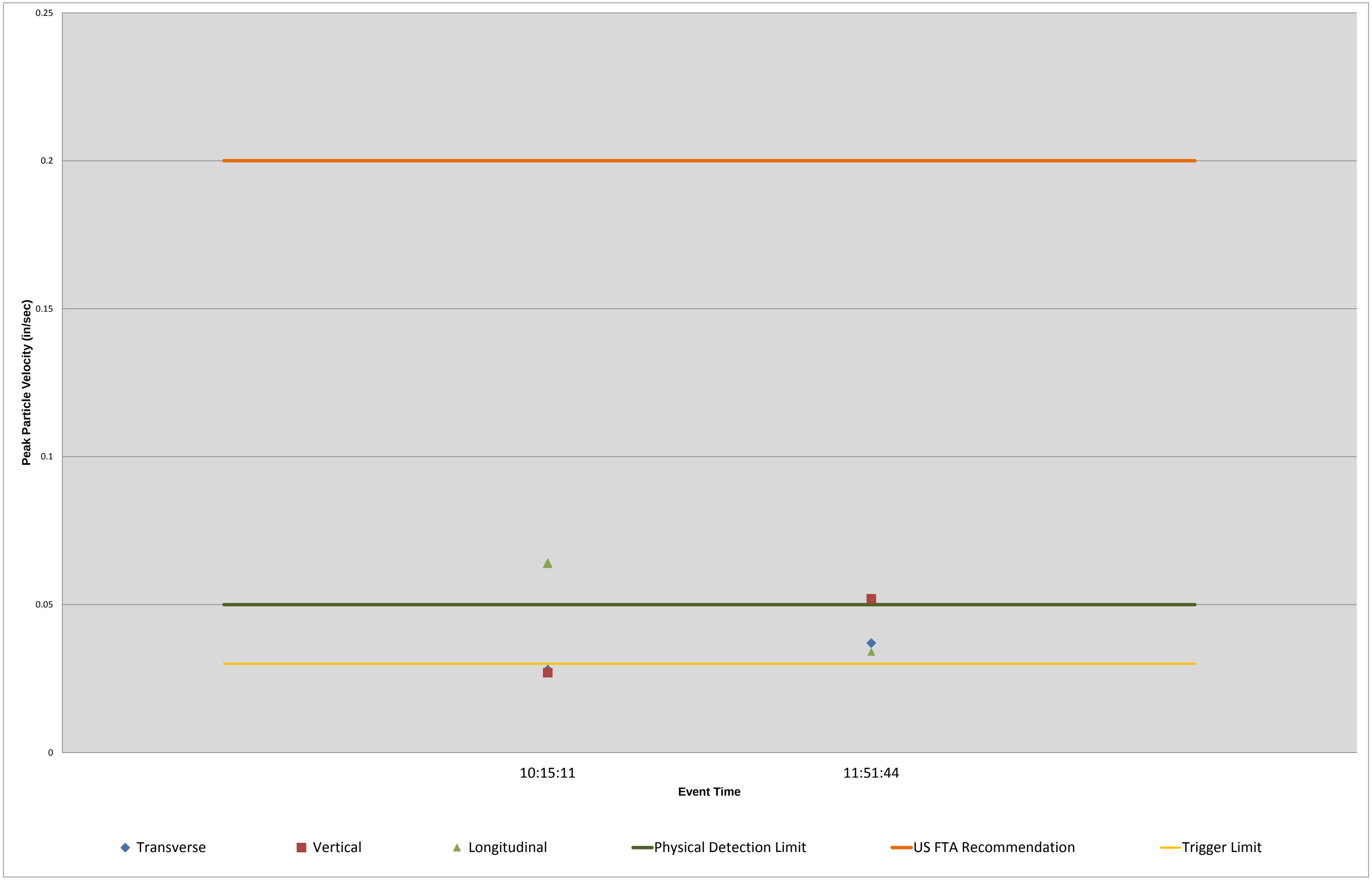
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 09:37:07 to 15:46:57

Figure G-7

Ground Vibration Events: VBA003 on 8/12/15

County Road 550 - Alder Creek Bridge



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

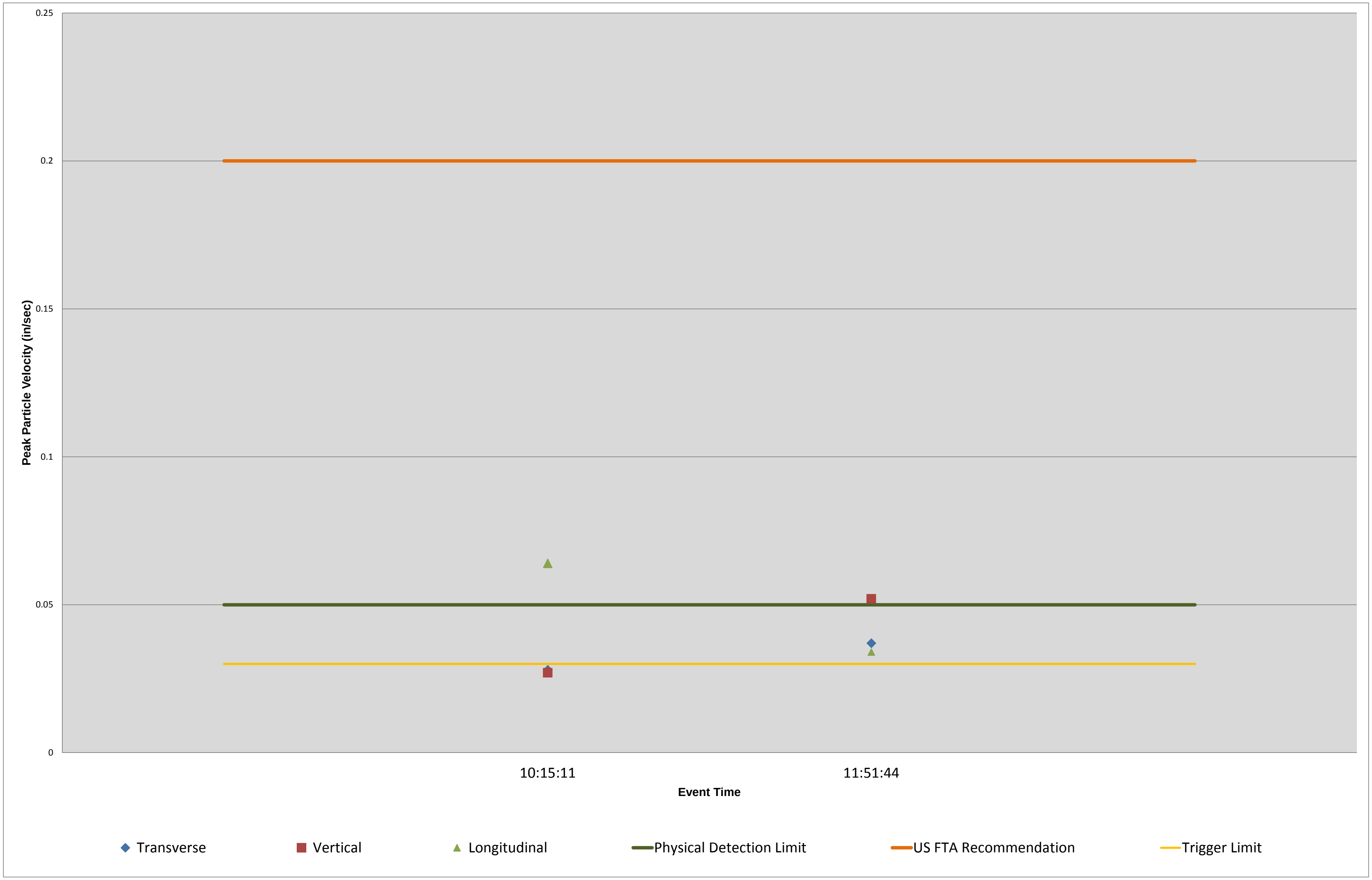
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 09:43:55 to 15:25:09

Figure G-8

Ground Vibration Events: VBA003 on 8/12/15

County Road 550 - Alder Creek Bridge



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

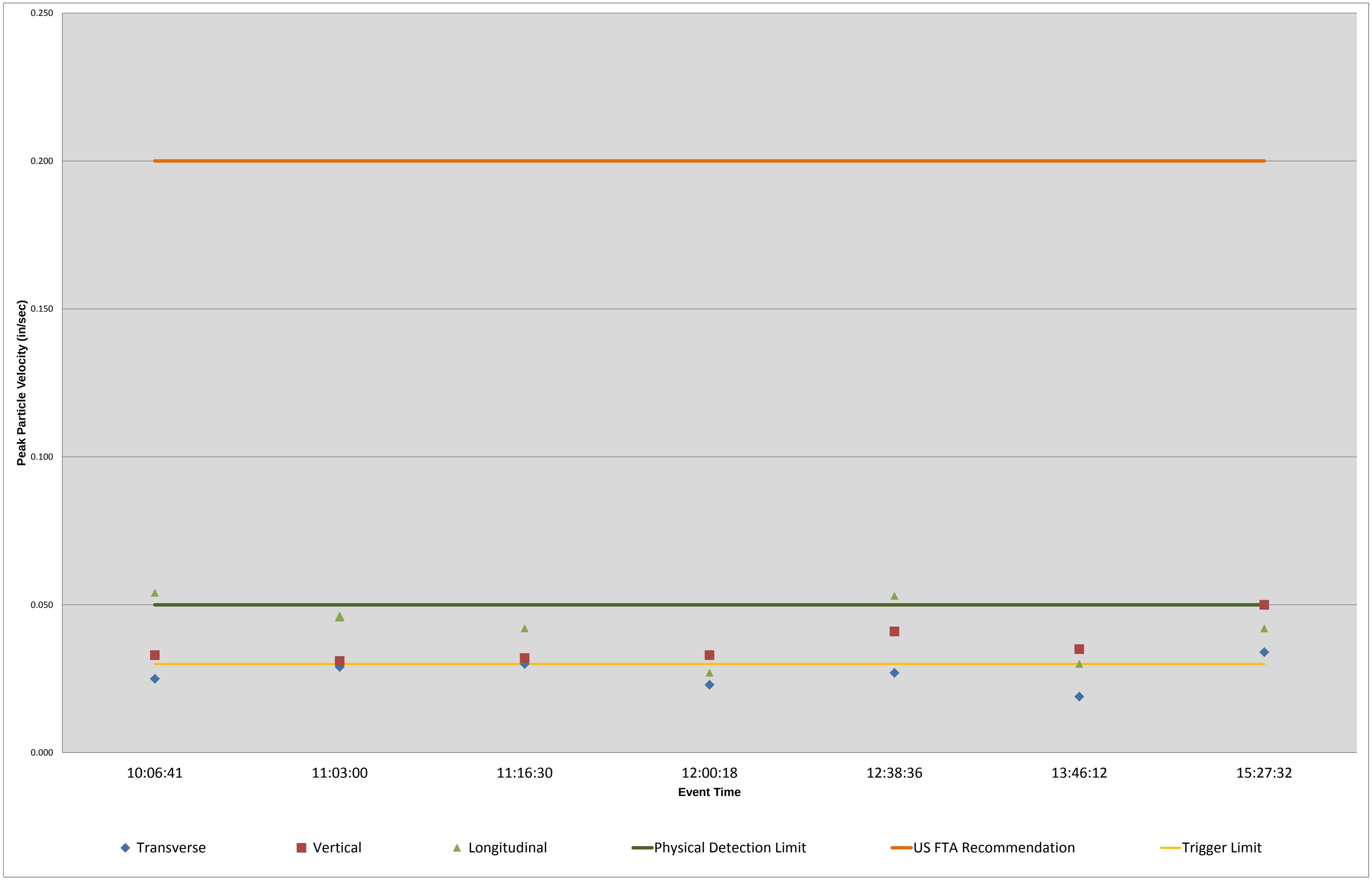
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 09:43:55 to 15:25:09

Figure G-9

Ground Vibration Events: VBA003 on 8/13/15

County Road 550 - Alder Creek Bridge



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

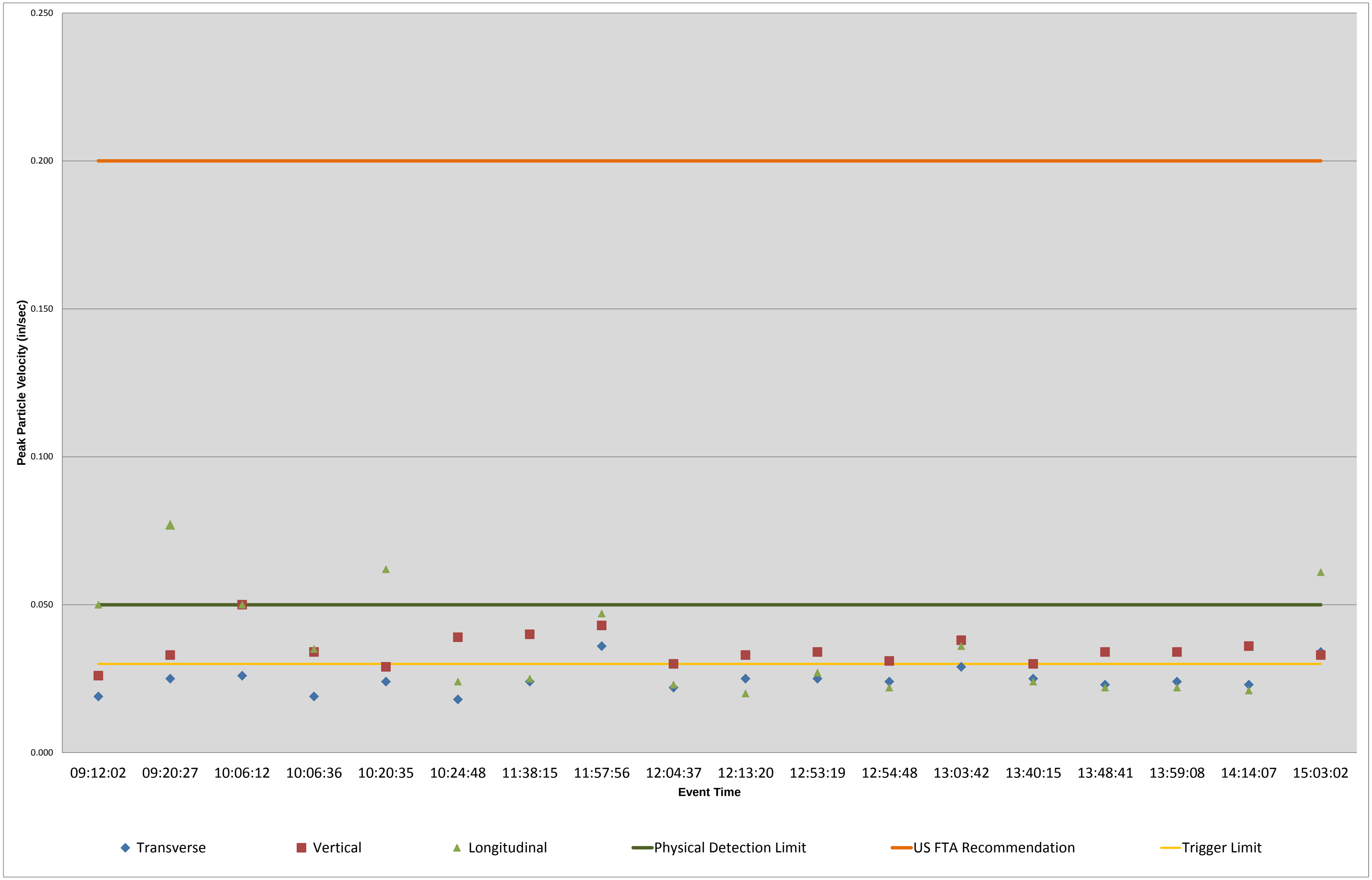
TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 09:50:26 to 15:41:28

Figure G-10

Ground Vibration Events: VBA003 on 8/14/15

County Road 550 - Alder Creek Bridge



Peak Particle Velocity (PPV) = Inches Per Second
Event Time: (hh:mm:ss)
US Federal Transit Authority (USFTA): Recommended PPV limits within construction areas for Non-engineered timber and masonry buildings structures (Type III).

TRIMEDIA ENVIRONMENTAL & ENGINEERING

Monitioring Period: 08:57:10 to 15:43:36

Table G-11: Vibration Events Exceeding Trigger Limit
Eagle Mine Haul Route

Monitoring Location	**NOA001**	**NOA004**	**NOA007**
Haul Route Location	US41 and M95 Intersection	Wright St. and Sugarloaf Intersection	County Road 550
Description	Humboldt Township	Marquette	Alder Creek Bridge
Trigger Limit (in/s)	0.003	0.003	0.003
Total Day Time Vibration Events	65	97	37
Vibration Event Composition (%)[1]			
Passenger Vehicles	18.6	5.7	15.4
Medium Duty Trucks	0.0	17.1	2.6
Heavy Duty Trucks	55.8	5.7	5.1
Eagle Haul Trucks	2.3	0.0	23.1
Logging Truck	23.3	0.0	10.3
Non-Eagle Mine Trucks	0.0	0.0	0.0
Motorcycles	0.0	0.0	0.0
Other	0.0	0.0	12.8
Unknown	0.0	71.4	30.8

Notes:
[1] 95% Confidance Level, ±10% of Day Time Vibration Events
[2] This category includes Cars, SUVs, Light Duty Trucks, and Vans

TRIMEDIA
ENVIRONMENTAL & ENGINEERING