Construction Noise and Vibration Mitigation and Monitoring Plan
Evergreen Point Floating Bridge and Landings Project

Prepared for
Washington State Department of Transportation

Prepared by
ATSConsulting
acoustics, transportation + strategy

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Table of Contents

Table of Contents................................................................................................................................... ii
List of Figures ........................................................................................................................................ iii
List of Tables ........................................................................................................................................ iv
Acronyms............................................................................................................................................... v
Glossary................................................................................................................................................ vi
1 Introduction ................................................................................................................................... 1
2 Construction Activities ................................................................................................................... 2
  2.1 West Approach Construction Activities ................................................................................... 2
  PIER 36 – DRILLED SHAFTS (4 TOTAL) ..................................................................................... 2
  PONTOONS A AND B SHAFT ANCHORS (3 TOTAL)................................................................. 2
  EXISTING BRIDGE DEMOLITION – WEST APPROACH AND TRANSITION SPAN ............... 2
  2.2 Floating Bridge Construction Activities .................................................................................... 3
  EXISTING FLOATING BRIDGE DEMOLITION – REMOVAL ...................................................... 3
  2.3 East Approach Construction Activities: ................................................................................... 3
  INSTALLATION OF PIER 1 AND 2 COFFERDAMS .................................................................... 3
  PONTOON W SHAFT ANCHORS (2 TOTAL)................................................................................ 3
  CONSTRUCTION OF TEMPORARY MOORING DOLPHINS ....................................................... 3
  CONSTRUCTION OF TEMPORARY WORK BRIDGE ................................................................. 3
  CONSTRUCTION OF SITE ACCESS AND BRIDGE MAINTENANCE FACILITY ....................... 4
  EXISTING BRIDGE DEMOLITION – EAST APPROACH AND TRANSITION SPAN ............... 4
3 Receivers Affected by Construction Noise and Vibration ............................................................... 5
4 Construction Noise Limits .............................................................................................................. 7
  4.1 City of Seattle Noise Ordinance .............................................................................................. 7
  4.2 City of Medina Noise Ordinance ............................................................................................. 8
  NOISE VARIANCE........................................................................................................................ 9
5 Construction Vibration Thresholds ............................................................................................... 11
  5.1 Human Response ................................................................................................................. 11
  5.2 Building Damage Risk Criteria .............................................................................................. 12
6 Construction Noise Predictions .................................................................................................... 14
  METHODOLOGY ........................................................................................................................ 14
  6.1 Impact Assessment ................................................................................................................. 29
Figure 7-7: East Approach Construction Activities: Temporary Work Bridge ........................................37
Figure 7-8: East Approach Construction Activities: Site Access and Bridge Maintenance Facility ..........38
Figure 7-9: East Approach Construction Activities: Existing Bridge Demolition .................................39

List of Tables

Table 3-1: Noise and Vibration Sensitive Receivers ........................... 6
Table 4-1: Seattle Noise Ordinance Maximum Permissible Sound Levels ................................. 7
Table 5-1: Human Response to Different Levels of Ground-Borne Vibration ........................................ 11
Table 5-2: Human Response to Steady State Vibration .................................................. 12
Table 5-3: Human Response to Transient Vibration ................................................. 12
Table 5-4: FTA Construction Vibration Damage Criteria .................................................. 13
Table 5-5: AASHTO Maximum Vibration Levels for Preventing Damage ................................. 13
Table 6-1: Construction Noise Levels ................................................................. 15
Table 6-2: Modeled Construction Noise Levels at Historic Properties, Lmax (dBA) ......................... 16
Table 6-3: Modeled Construction Noise Levels at Residential Non-Historic Properties, Lmax (dBA) ................................................................. 17
Table 7-1: Equipment Vibration Emission Levels .................................................. 40
Table 7-2: Construction Vibration Predictions for Historic Properties ................................. 42
Table 7-3: Construction Vibration Levels at Non-Historic Properties ........................................ 43
Table 7-4: Distance to Construction Vibration Impact Threshold: ........................................ 44
Acronyms

ANSI  American National Standards Institute
APE  Area of potential effect
dBA  decibel measured on the A-weighted scale
CCMP  Community Construction Management Plan
Caltrans  California Department of Transportation
FTA  Federal Transit Administration
in/sec  inches per second
ISO  International Standards Organization
Lmax  maximum noise level
Lv  vibration velocity level
PPV  peak particle velocity
SDEIS  Supplemental Draft Environmental Impact Statement
SR  State Route
VdB  RMS vibration velocity
WSDOT  Washington State Department of Transportation
Glossary

**Crest factor:** The ratio of peak particle velocity to maximum RMS amplitude in an oscillating signal.

**Decibel:** The standard unit of measurement for sound pressure level and vibration level. Technically, a decibel is the unit of level which denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm of this ratio. Also written as dB or dBA when measured on the A-weighted scale.

**One-third octave band:** A standardized division of a frequency spectrum in which the octave bands are divided into thirds for more detailed information. The interval between center frequencies is a ratio of 1.25.

**Peak Particle Velocity (PPV):** The peak signal value of an oscillating vibration velocity waveform expressed in inches/second.

**Receiver:** A stationary far-field position at which noise or vibration levels are specified.

**Root Mean Square (rms):** The square root of the mean-square value of an oscillating waveform, where the mean-square value is obtained by squaring the value of amplitudes at each instant of time and then averaging these values over the sample time.

**RMS Velocity Level (Lv):** See “Vibration Velocity Level.”

**VdB:** see Vibration Velocity Level.

**Vibration Velocity Level (Lv):** Ten times the common logarithm of the ratio of the square of the amplitude of the RMS vibration velocity to the square of the amplitude of the reference RMS vibration velocity. The reference velocity in the United States is one micro-inch per second also written as VdB.

**Vibration:** An oscillation wherein the quantity is a parameter that defines the motion of a mechanical system.
1 Introduction

This Construction Noise and Vibration Mitigation and Monitoring Plan (the Plan) supplements the SR 520, I-5 to Medina: Bridge Replacement and HOV Project's 2009 Noise Discipline Report and its 2011 Addenda and discloses the noise and vibration effects of the proposed construction for the Evergreen Point Floating Bridge and Landings Project (FB&L) on the historic and non-historic properties that would be affected during the construction.

The Plan was prepared to meet the requirements of the Section 106 Programmatic Agreement which requires WSDOT to evaluate and to identify areas where impacts to historic properties within the area of potential effects (APE) may occur as a result of construction vibration. This report describes the results of this evaluation for the Floating Bridge and Landings (FB&L) Project for both historic and non-historic properties.

The Plan is also intended to provide guidance and additional information to the Design Build Contractor on the noise and vibration limits of their planned means and methods of construction and location for vibration monitoring during construction. The Plan will also become part of the Community Construction Mitigation Plan (CCMP) for this project.

The Plan includes the following elements:

- Construction activities and schedule
- Sensitive receivers affected by construction noise and vibration
- Construction noise criteria
- Vibration damage risk criteria
- Predicted construction noise level
- Predicted construction vibration levels
- Mitigation measures
- Noise and vibration monitoring during construction

At the end of this report, Appendix A is an explanation and examples of the fundamentals of noise and vibration.
2 Construction Activities

The following sections contain a brief description of the major construction activities required for the project. Figure 2-1 shows the general locations of those activities.

Figure 2-1: General Locations of Construction Activities

2.1 West Approach Construction Activities

Pier 36 – Drilled Shafts (4 total)
The Design-Builder will install drilled shaft foundations at Pier 36. This work will involve installation of permanent steel casing using a vibratory hammer. The shafts are 12 foot in diameter and the casing will be installed to a depth of up to 30 feet below the mudline. The Pier 36 drilled shafts are approximately 700 feet from the shoreline and 740 feet from the nearest residences. This work is scheduled to occur in August of 2012.

Pontoon A and B Shaft Anchors (3 total)
The Design-Builder will install three drilled shaft anchors for Pontoon A and B using a vibratory hammer. Shafts are 10 feet in diameters and temporary steel casing will be driven to depth of up to 30 feet. The shaft anchors are approximately 410 feet from the shoreline and 490 feet to the nearest residences. This work is scheduled to occur in July and August of 2012.

Existing Bridge Demolition – West Approach and Transition Span
The Design-Builder will remove portions of the existing west approach and transition spans. Mounted hammer hoe rams will be used to break concrete. The majority of the existing bridge
superstructure and columns will likely be sawed into smaller sections and removed intact to limit impacts to Lake Washington (the Lake). The distance from the bridge to the shoreline is approximately 225 feet and the distance from the bridge to the nearest residence is 250 feet. This work is scheduled to occur in January to April of 2015.

2.2 Floating Bridge Construction Activities

The Design-Builder will assemble the new floating bridge on the Lake both in its future alignment as well as an Eastside Staging area. These activities are not expected to result in construction noise that will impact any nearby residences. This work will occur from 2012 to 2014.

Existing Floating Bridge Demolition – Removal

The Design-Builder will disassemble the existing floating bridge into component pontoons on Lake Washington and float the components through the Ballard Locks for disposal (this could involve demolition at an existing facility such as Concrete Technology in Tacoma or sale of the pontoons intact). Distance to nearby residences is over 1000 feet. This work will occur from January to July 2013.

2.3 East Approach Construction Activities:

Installation of Pier 1 and 2 Cofferdams

The Design-Builder will install two cofferdam systems, constructed out of metal sheets, to allow for construction of the foundation systems for Piers 1 and 2. The foundation system will consist of spread footings. The metal sheet piling will be vibrated into position with a vibratory hammer. It may also be necessary to use an impact hammer to complete the sheet piling installation. Pier 1 is approximately 180 feet from the shoreline and 240 feet to the nearest residence. Pier 2 is located on shore and is approximately 70 feet to the nearest residence. Pier 1 will be constructed between April and May 2012. Pier 2 will be constructed between July and August 2012.

Pontoon W Shaft Anchors (2 total)

The Design-Builder will install two drilled shaft anchors for Pontoon W. This work will include installation of temporary steel casings using a vibratory hammer. The shaft diameters are 10 feet and the steel casing will be installed to a depth of up to 30 feet. The Pontoon W shaft anchors are approximately 330 feet from the shoreline and 390 feet from the nearest residence. This work is scheduled to occur in April and May of 2012.

Construction of Temporary Mooring Dolphins

The Design-Builder will build a temporary Eastside staging area where pontoons will be assembled (joined together) on Lake Washington. This staging area is located to the North of the new alignment. The temporary mooring dolphins will be installed with a vibratory hammer. There will be between three and six 48 inch diameter piles installed to a depth of 50 to 100 feet. The temporary mooring dolphins are approximately 710 feet from the shoreline and 770 feet to the nearest residence. This work is scheduled to occur in the June to July 2012 timeframe.

Construction of Temporary Work Bridge

The Design-Builder will build a temporary work bridge from the East shores of Lake Washington (Medina) out to the assembly area on Lake Washington. The temporary work bridge will consist
of a temporary pile supported structure. The piling will be installed with a vibratory hammer. There will be 36 piles 24 to 30 inch diameter piles driven to a depth of 50 to 100 feet. The distance from the piling to the nearest residence is approximately 100 feet. This work is scheduled to occur in July and August of 2012.

**Construction of Site Access and Bridge Maintenance Facility**

The Design-Builder will construct a temporary construction road to the waterfront along with the construction of a new Bridge Maintenance Facility, walls (temporary and permanent) and Bridge abutments. Construction equipment that will be utilized will include excavators, end loaders, bulldozers, trucks, vibratory rollers, cranes. This access road will be used for delivery of materials (primarily concrete) for a significant portion of the project. Distance to the nearest residence is approximately 50 feet. This work is scheduled to occur between April 2012 and October 2014.

**Existing Bridge Demolition – East Approach and Transition Span**

The Design-Builder will remove the existing east approach and transition spans. Mounted hammer hoe rams will be used to break concrete. Portions of the existing bridge superstructure and columns will likely be sawed into smaller sections and removed intact to limit impacts to the Lake. In addition, there are columns on land that will be removed. Distance to the nearest residences is approximately 60 to 75 feet. This work is scheduled to occur in April to July 2015.
3 Receivers Affected by Construction Noise and Vibration

Noise and vibration sensitive receivers that may be affected during construction were identified in the Final Environmental Impact Statement SR 520 Bridge Replacement and HOV Program, SR 520, I-5 to Medina: Bridge Replacement and HOV Project and the Section 106 Programmatic Agreement between FHWA/WSDOT and the Washington State Historic Preservation Officer. The receivers are both historic and residential properties and are often within 200 to 300 feet of the construction activities closest to the east approach and landings of the SR 520 Bridge in Medina and in Seattle in the Madison Park area closest to the west approach of the bridge.

The historic and non-historic properties that were determined to be affected during construction and are assessed as part of this study are presented in Table 3-1 and their locations are shown on Figure 6-1 through Figure 6-10.
### Table 3-1: Noise and Vibration Sensitive Receivers

<table>
<thead>
<tr>
<th>Historic Residential Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>2411 42nd Avenue E -- Edgewater Condominiums</td>
</tr>
<tr>
<td>3267 Evergreen Point Road-- Dixon House</td>
</tr>
<tr>
<td>2851 Evergreen Point Road-- James Arnston House</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Historic Residential Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>43rd Avenue E &amp; E McGilvra St</td>
</tr>
<tr>
<td>2389 43rd Avenue E</td>
</tr>
<tr>
<td>2325 43rd Avenue E (West Building)</td>
</tr>
<tr>
<td>2325 43rd Avenue E (East Building)</td>
</tr>
<tr>
<td>3201 Evergreen Point Road</td>
</tr>
<tr>
<td>3217 Evergreen Point Road</td>
</tr>
<tr>
<td>3211 Evergreen Point Road</td>
</tr>
<tr>
<td>3215 Evergreen Point Road</td>
</tr>
<tr>
<td>3207 Evergreen Point Road</td>
</tr>
<tr>
<td>3205 Evergreen Point Road</td>
</tr>
<tr>
<td>2895 Evergreen Point Road</td>
</tr>
<tr>
<td>2891 Evergreen Point Road</td>
</tr>
<tr>
<td>3100 Evergreen Point Road</td>
</tr>
<tr>
<td>2879 Evergreen Point Road</td>
</tr>
<tr>
<td>2857 76th Avenue NE</td>
</tr>
<tr>
<td>2853 76th Avenue NE</td>
</tr>
<tr>
<td>3261 Evergreen Point Road</td>
</tr>
<tr>
<td>3249 Evergreen Point Road</td>
</tr>
<tr>
<td>3241 Evergreen Point Road</td>
</tr>
<tr>
<td>3257 Evergreen Point Road</td>
</tr>
<tr>
<td>3235 Evergreen Point Road</td>
</tr>
<tr>
<td>3227 Evergreen Point Road</td>
</tr>
<tr>
<td>3225 Evergreen Point Road</td>
</tr>
<tr>
<td>3223 Evergreen Point Road</td>
</tr>
</tbody>
</table>
4 Construction Noise Limits

The State of Washington has a noise control ordinance (WAC 173-60) that applies (together with local noise regulations) to general construction activities. The state provisions have been adopted in some form by both the City of Medina and the City of Seattle. The following are the adopted noise ordinances for each city.

4.1 City of Seattle Noise Ordinance

Daytime Noise

The Administrative Code of the City of Seattle (Ordinance 102228), Chapter 25.08, Noise Control, regulates the noise levels of construction and equipment operations (Section 25.08.425). The ordinance requires that equipment used in commercial construction activities not exceed the maximum permissible sound levels presented in Table 4-1. The levels should be measured from the real property of another person or at a distance of fifty (50) feet from the equipment, whichever is greater.

Table 4-1: Seattle Noise Ordinance Maximum Permissible Sound Levels

<table>
<thead>
<tr>
<th>District of Sound Source</th>
<th>District of Receiving Property Within the City of Seattle</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residential (dBA)</td>
<td>Commercial (dBA)</td>
</tr>
<tr>
<td>Rural</td>
<td>52</td>
<td>55</td>
</tr>
<tr>
<td>Residential</td>
<td>55</td>
<td>57</td>
</tr>
<tr>
<td>Commercial</td>
<td>57</td>
<td>60</td>
</tr>
<tr>
<td>Industrial</td>
<td>60</td>
<td>65</td>
</tr>
</tbody>
</table>

Note: Between the hours of 10 p.m. and 7 a.m. during weekdays and 10 p.m. and 9 a.m. During weekends, the levels in Table 4.1 are reduced by 10 dBA.

Exceptions

Levels may be exceeded between the hours of 7 a.m. and 10 p.m. on weekdays and between the hours of 9 a.m. and 10 p.m. on weekends by no more than the following dBAs for the following types of equipment:

1. 25 dBA for equipment on construction sites, including but not limited to crawlers, tractors, dozers, rotary drills and augers, loaders, power shovels, cranes, derricks, graders, off-highway trucks, ditchers, trenchers, compactors, compressors, and pneumatic-powered equipment;
2. 20 dBA for portable powered equipment used in temporary locations in support of construction activities or used in the maintenance of public facilities, including but not limited to chainsaws, log chippers, lawn and garden maintenance equipment and powered hand tools; or
3. 15 dBA for powered equipment used in temporary or periodic maintenance or repair of the grounds and appurtenances of residential property, including but not limited to lawnmowers, powered hand-tools, snow-removal equipment and composters.
Impact Equipment

Sound created by impact types of construction equipment, including but not limited to pavement breakers, pile drivers, jackhammers, sandblasting tools, or other types of equipment or devices which create impulse noise or impact noise or are used as impact equipment, as measured at the property line or 50 feet from the equipment (whichever is greater), may exceed the maximum permissible sound levels described above in any one-hour period between the hours of 8 a.m. and 5 p.m. on weekdays and 9 a.m. and 5 p.m. on weekends, but in no event is to exceed the following:

- \( \text{Leq} = 90 \text{ dBA} \) continuously;
- \( \text{Leq} = 93 \text{ dBA} \) for 30 minutes;
- \( \text{Leq} = 96 \text{ dBA} \) for 15 minutes;
- \( \text{Leq} = 99 \text{ dBA} \) for 7 minutes;

Sound levels in excess of \( \text{Leq} = 99 \text{ dBA} \) are prohibited unless authorized by variance.

The standard of measurement is a one-hour \( \text{Leq} \) measured for times not less than one minute to project an hourly \( \text{Leq} \).

Nighttime Noise Limits

When construction activities occurring during nighttime hours (weekdays from 10 p.m. to 7 a.m. and weekends from 9 a.m. to 10 p.m.) cannot meet the maximum permissible levels established by Section 25.08.410 of the Noise Ordinance (Table 4-1), a noise variance is required.

4.2 City of Medina Noise Ordinance

Under the Medina Municipal Code, Chapter 8.06 Noise it is a violation to engage in any commercial construction and development activity or to operate any heavy equipment before the hours of 7:00 a.m. and after 7:00 p.m. Monday through Friday and before the hours of 8:00 a.m. and after 5:00 p.m. on Saturday. No construction and development activity or use of heavy equipment may occur on Sundays or holidays that are holidays observed by the city. The city manager or designee may grant a variance to engage in a construction and development activity or to operate heavy equipment after the hours of 7:00 p.m. and before 7:00 a.m. on Monday through Friday and after the hours of 5:00 p.m. and before 8:00 a.m. on Saturday, on Sundays or holidays that are observed by the city if this will not unreasonably interfere with any residential use. (Ord. 800 § 1, 2007; Ord. 509 § 3, 1990).

No variance shall be granted until the City administrator or hearing examiner has considered the relative interests of the applicant, other owners or possessors of property likely to be affected by the noise, and the general public. A technical or economic variance may be granted only after a public hearing on due notice. The administrator or hearing examiner may grant a variance, if he finds that:

1. The noise occurring or proposed to occur does not endanger public health or safety; and
2. The applicant demonstrates the criteria required for temporary, technical or economic variance as follows:
• Technical variance. A technical variance may be granted by the hearing examiner on the grounds that there is no practical means known or available for the adequate prevention, abatement or control of the noise involved. Any technical variance shall be subject to the holder's taking of any alternative measures that the hearing examiner may prescribe. The duration of each technical variance shall be until such practical means for prevention, abatement or control become known or available. The holder of a technical variance as required by the hearing Examiner, shall make reports to the administrator detailing actions taken to develop a means of noise control or to reduce the noise involved and must relate these actions to pertinent current technology.

• Economic variance. An economic variance may be granted by the hearing examiner on the ground that compliance with the particular requirement or requirements from which the variance is sought will require the taking of measures that, because of their extent or cost, must be spread over a period of time. The duration of an economic variance shall be for a period not to exceed such reasonable time as is required in the view of the hearing Examiner for the taking of the necessary measures. An economic variance shall contain a timetable for the taking of action in an expeditious manner and shall be conditioned on adherence to the timetable.

**Noise Variance**

The Design Builder joint venture, Kiewit/General/Manson (KGM) has applied and been granted a Technical Noise Variance (No. PL12-001) by the City of Medina On March 8, 2012. The proposed construction associated with the Variance would occur between April 2012 and approximately late 2015. Proposed construction associated with the Variance would include the following activities, occurring in an area stretching from Evergreen Point Road to Lake Washington:

• Construction of the floating bridge structure, a fixed east approach, and transition structures between the fixed structures and the floating bridge;

• Towing, storage, and outfitting 33 pontoons constructed offsite for incorporation into the new floating bridge;

• Construction, storage, and outfitting of 44 supplemental stability pontoons, 58 anchors, and anchor cables for incorporation into the new floating bridge;

• Construction of a temporary construction work bridge and walkway to provide access to a temporary floating eastside staging area located approximately 100 feet north of the proposed bridge and 450 feet from the Lake Washington east shoreline;

• Construction of the final connection between the new bridge and the new, lidded roadway section at Evergreen Point Road;

• Construction of a new bridge maintenance facility and dock located underneath the new east approach structure;

• Paving, striping, and installation of tolling gantries east of Evergreen Point Road after the new bridge and approach are constructed; and

• Demolition of the existing bridge after the new bridge is open for traffic.

Proposed construction would exceed the daytime and nighttime noise levels set forth within the City of Medina Noise Code. All the conditions of approval of the Technical Noise Variance
are included in the Findings, Conclusions and Decision of the City of Medina Hearing Examiner in Appendix B.
5 Construction Vibration Thresholds

Construction vibration is assessed for different potential effects:

- Human response
- Building damage

5.1 Human Response

One of the major problems in developing suitable criteria for ground-borne vibration is that there has been relatively little research into human response to vibration, in particular, human annoyance with building vibration. The American National Standards Institute (ANSI) developed criteria for evaluating human exposure to vibration in buildings in 19831 and the International Organization for Standardization (ISO) adopted similar criteria in 19892 and revised them in 20033. The 2003 version of ISO 2361-2 acknowledges that “human response to vibration in buildings is very complex.” It further indicates that the degree of annoyance cannot always be explained by the magnitude of the vibration alone. Other phenomena such as noise, rattling, visual effects such as movement of hanging objects, and time of day (e.g., late at night) all play some role in the response of individuals. To understand and evaluate human response, which is often measured by complaints, all of these related effects need to be considered. The available data documenting real world experience with these phenomena is still relatively sparse. Table 5-1 is a summary of the human response to different levels of vibration. In this table both the root mean square (rms) vibration velocity levels used to assess human annoyance and the corresponding peak particle velocity (PPV) levels, used to measure construction vibration, are presented. A crest factor of 4 (representing a PPV-rms difference of 12 VdB) has been used to calculate the approximate PPV from the rms vibration velocity levels. For evaluating potential annoyance or interference with human activities due to construction vibration, the Federal Transit Administration criteria for General Assessment can be applied in most cases, which is 72 VdB for residential uses and 75 VdB for institutional/office uses.

Table 5-1: Human Response to Different Levels of Ground-Borne Vibration

<table>
<thead>
<tr>
<th>PPV Level</th>
<th>RMS Vibration Velocity Level</th>
<th>Human Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.007 in/sec (77 VdB)</td>
<td>65 VdB</td>
<td>Approximate threshold of perception for many humans.</td>
</tr>
<tr>
<td>0.022 in/sec (87 VdB)</td>
<td>75 VdB</td>
<td>Approximate dividing line between barely perceptible and distinctly perceptible.</td>
</tr>
<tr>
<td>0.07 in/sec (97 VdB)</td>
<td>85 VdB</td>
<td>Vibration acceptable only if there are an infrequent number of events per day.</td>
</tr>
</tbody>
</table>


Numerous other studies have been conducted to characterize the human response to vibration. Table 5-2 summarizes the results of an early study on human response to steady-state (continuous) vibration, which could be generated from a continuously operating roadway roller.

### Table 5-2: Human Response to Steady State Vibration

<table>
<thead>
<tr>
<th>PPV (in/sec)</th>
<th>Human Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6 (at 2 Hz)–0.4 (at 20 Hz)</td>
<td>Very disturbing</td>
</tr>
<tr>
<td>0.7 (at 2 Hz)–0.17 (at 20 Hz)</td>
<td>Disturbing</td>
</tr>
<tr>
<td>0.10</td>
<td>Strongly perceptible</td>
</tr>
<tr>
<td>0.035</td>
<td>Distinctly perceptible</td>
</tr>
<tr>
<td>0.012</td>
<td>Slightly perceptible</td>
</tr>
</tbody>
</table>


Table 5-3 summarizes the results of another study that relates human response to transient vibration, which could be generated by any type of impact equipment such as impact pile driving.

### Table 5-3: Human Response to Transient Vibration

<table>
<thead>
<tr>
<th>PPV (in/sec)</th>
<th>Human Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Severe</td>
</tr>
<tr>
<td>0.9</td>
<td>Strongly perceptible</td>
</tr>
<tr>
<td>0.24</td>
<td>Distinctly perceptible</td>
</tr>
<tr>
<td>0.035</td>
<td>Barely perceptible</td>
</tr>
</tbody>
</table>


The results in Table 5-2 and Table 5-3 suggest that the thresholds for perception and annoyance are higher for transient vibration that occurs over a short period of time than for continuous vibration.

### 5.2 Building Damage Risk Criteria

The primary concern regarding construction vibration relates to potential damage effects. Guideline vibration damage criteria are given in Table 5-4 and Table 5-5 for various structural categories. These limits should be viewed as criteria that should be used during the environmental impact assessment phase to identify problem locations that must be addressed during final design and monitored during construction. The upper limit of damage risk is structural damage to building foundations. The U.S. Bureau of Mines structural damage threshold is 2.0 inches/sec.

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Table 5-4: FTA Construction Vibration Damage Criteria

<table>
<thead>
<tr>
<th>Building Category</th>
<th>PPV (in/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Reinforced-concrete, steel or timber (no plaster)</td>
<td>0.5</td>
</tr>
<tr>
<td>II. Engineered concrete and masonry (no plaster)</td>
<td>0.3</td>
</tr>
<tr>
<td>III. Non-engineered timber and masonry buildings</td>
<td>0.2</td>
</tr>
<tr>
<td>IV. Buildings extremely susceptible to vibration damage</td>
<td>0.12</td>
</tr>
</tbody>
</table>


The American Association of State Highway and Transportation Officials (AASHTO) (1990) identify maximum vibration levels for preventing damage to structures from intermittent construction or maintenance activities. Table 5-5 summarizes the AASHTO maximum levels.

Table 5-5: AASHTO Maximum Vibration Levels for Preventing Damage

<table>
<thead>
<tr>
<th>Building Category</th>
<th>PPV (in/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered structures, without plaster</td>
<td>1.0 - 1.5</td>
</tr>
<tr>
<td>Residential buildings, in good repair with gypsum board walls</td>
<td>0.4 – 0.5</td>
</tr>
<tr>
<td>Residential buildings, plastered walls</td>
<td>0.2 – 0.3</td>
</tr>
<tr>
<td>Historical sites or other critical location</td>
<td>0.1</td>
</tr>
</tbody>
</table>


---

6 Construction Noise Predictions

Methodology

The projected daytime and nighttime construction noise levels were modeled using CadnaA version 4.0, a three dimensional graphics oriented program that uses the International Standards Organization (ISO) 9613, a general purpose standard for outdoor noise propagation. CadnaA incorporates the following elements:

- An emission model to determine the noise generated by the equipment at a reference distance.
- A propagation model that shows how the noise level varies with distance.
- A way of summing the noise of each piece of equipment at noise sensitive locations.

6.2 Modeling Assumptions

The construction noise modeling includes the effects of topography, ground cover, and the shielding effects of building structures. All piling activities are assumed to be done with vibratory pile drivers and not impact hammers.

The construction noise levels were estimated at each of the receivers within close proximity to the construction sites using the actual measured noise level data presented in Table 6-1. This data is from the FHWA Roadway Construction Noise Model and compares the specified limits that are typically used for construction equipment with measured data collected for different construction projects. The measured noise level data was used for the noise modeling when it was higher than the noise level limits.

The construction noise estimates are presented in Table 6-2 for the historic properties and Table 6-3 for the non-historic residential properties as maximum levels ($L_{max}$) for each of the construction activities. The $L_{max}$ corresponds to the noise limits of the Seattle Noise Ordinance. The City of Medina Noise Ordinance does not have noise level limits for construction but instead has allowable hours of construction activity. Off-site transport of demolition materials and the on-site transport of construction materials are not included in the modeling.

The modeling is also graphically shown in Figure 6-1 through Figure 6-10 as noise contours of maximum construction noise levels expected during each of the different phases of construction activities described in Section 2.0.
<table>
<thead>
<tr>
<th>Equipment Description</th>
<th>Lmax Noise Limit at 50 ft, dB Slow</th>
<th>Actual Measured Lmax at 50 ft, dB Slow</th>
<th>Is Equipment an Impact Device?</th>
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</thead>
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<tr>
<td>Auger Drill Rig</td>
<td>85 dBA</td>
<td>84 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Backhoe</td>
<td>80 dBA</td>
<td>78 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Boring Jack Power Unit</td>
<td>80 dBA</td>
<td>83 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Chain Saw</td>
<td>85 dBA</td>
<td>84 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Clam Shovel</td>
<td>93 dBA</td>
<td>87 dBA</td>
<td>Yes</td>
</tr>
<tr>
<td>Compactor (ground)</td>
<td>80 dBA</td>
<td>83 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Compressor (air)</td>
<td>80 dBA</td>
<td>78 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Concrete Mixer Truck</td>
<td>85 dBA</td>
<td>79 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Concrete Pump Truck</td>
<td>82 dBA</td>
<td>81 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Concrete Saw</td>
<td>90 dBA</td>
<td>90 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Crane (mobile or stationary)</td>
<td>85 dBA</td>
<td>81 dBA</td>
<td>No</td>
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<tr>
<td>Dozer</td>
<td>85 dBA</td>
<td>82 dBA</td>
<td>No</td>
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<tr>
<td>Dump Truck</td>
<td>84 dBA</td>
<td>76 dBA</td>
<td>No</td>
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<tr>
<td>Excavator</td>
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<td>81 dBA</td>
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</tr>
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<td>Flat Bed Truck</td>
<td>84 dBA</td>
<td>74 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Front End Loader</td>
<td>80 dBA</td>
<td>79 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Generator (25 KVA or less)</td>
<td>70 dBA</td>
<td>81 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Generator (more than 25 KVA)</td>
<td>82 dBA</td>
<td>73 dBA</td>
<td>No</td>
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<tr>
<td>Gradall</td>
<td>85 dBA</td>
<td>83 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Horizontal Boring Hydraulic Jack</td>
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<td>82 dBA</td>
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<tr>
<td>Impact Pile Driver (diesel or drop)</td>
<td>95 dBA</td>
<td>101 dBA</td>
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<td>Jackhammer</td>
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<td>Mounted Impact Hammer (hoe ram)</td>
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<td>90 dBA</td>
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<td>Paver</td>
<td>85 dBA</td>
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<td>Pickup Truck</td>
<td>55 dBA</td>
<td>75 dBA</td>
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<td>Pneumatic Tools</td>
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<td>Pumps</td>
<td>77 dBA</td>
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<td>85 dBA</td>
<td>81 dBA</td>
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</tr>
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<td>85 dBA</td>
<td>84 dBA</td>
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</tr>
<tr>
<td>Slurry Plant</td>
<td>78 dBA</td>
<td>78 dBA</td>
<td>No</td>
</tr>
<tr>
<td>Slurry Trenching Machine</td>
<td>82 dBA</td>
<td>80 dBA</td>
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<tr>
<td>Soil Mix Drill Rig</td>
<td>80 dBA</td>
<td></td>
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</tr>
<tr>
<td>Tractor</td>
<td>84 dBA</td>
<td>82 dBA</td>
<td>No</td>
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<tr>
<td>Vacuum Excavator (Vac-Truck)</td>
<td>85 dBA</td>
<td>85 dBA</td>
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<td>Vacuum Street Sweeper</td>
<td>80 dBA</td>
<td>82 dBA</td>
<td>No</td>
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<tr>
<td>Vibratory Concrete Mixer</td>
<td>80 dBA</td>
<td>80 dBA</td>
<td>No</td>
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<tr>
<td>Vibratory Pile Driver</td>
<td>95 dBA</td>
<td>101 dBA</td>
<td>No</td>
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<tr>
<td>Welder</td>
<td>73 dBA</td>
<td>74 dBA</td>
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</tr>
</tbody>
</table>

Source: FHWA Roadway Construction Noise Model, January 2006
Table 6-2: Modeled Construction Noise Levels at Historic Properties, Lmax (dBA)

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Location</th>
<th>Pier 36</th>
<th>Pontoons A and B Shaft Anchors</th>
<th>Existing Bridge Demolition West</th>
<th>Pier 2 North</th>
<th>Pier 2 South</th>
<th>Pontoons W Shaft Anchors</th>
<th>Construction of Temporary Mooring Dolphins</th>
<th>Construction of Temporary Work Bridge</th>
<th>Construction of Site Access and Bridge Maintenance Facility</th>
<th>Existing Bridge Demolition East</th>
</tr>
</thead>
<tbody>
<tr>
<td>226</td>
<td>2411 42nd Ave E -- Edgewater Condominiums</td>
<td>79</td>
<td>82</td>
<td>77</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>227</td>
<td>3267 Evergreen Point Road-- Dixon House</td>
<td>---</td>
<td>---</td>
<td>---</td>
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<td>61</td>
<td>64</td>
<td>62</td>
<td>60</td>
<td>50</td>
<td>55</td>
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<tr>
<td>234</td>
<td>2851 Evergreen Point Road-- James Arnston House</td>
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<td>64</td>
<td>64</td>
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<tr>
<td>Receiver</td>
<td>Location</td>
<td>Pier 36</td>
<td>Pontoons A and B Shaft Anchors</td>
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<td>Pier 2 North</td>
<td>Pier 2 South</td>
<td>Pontoons W Shaft Anchors</td>
<td>Construction of Temporary Work Bridge</td>
<td>Construction of Temporary Work Bridge</td>
<td>Bridge Maintenance Facility</td>
<td>Existing Bridge Demolition East</td>
</tr>
<tr>
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<td>3W</td>
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</tr>
<tr>
<td>4W</td>
<td>2325 43rd Ave E (East Building)</td>
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<tr>
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<td>8E</td>
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<tr>
<td>Receiver</td>
<td>Location</td>
<td>Pier 36</td>
<td>Pontoons A and B Shaft Anchors</td>
<td>Existing Bridge Demolition West</td>
<td>Pier 2 North</td>
<td>Pier 2 South</td>
<td>Pontoons W Shaft Anchors</td>
<td>Construction of Temporary Work Bridge</td>
<td>Construction of Site Access and Bridge Maintenance Facility</td>
<td>Existing Bridge Demolition East</td>
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</tr>
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<td>75</td>
<td>60</td>
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</tbody>
</table>
Figure 6-1: West Approach Construction Activities: Pier 36
Figure 6-2: West Approach Construction Activities: Pontoons A and B Shaft anchors
Figure 6-3: West Approach Construction Activities: Existing Bridge Demolition
Figure 6-4: East Approach Construction Activities: Temporary Mooring Dolphins
Figure 6-5: East Approach Construction Activities: Pontoon W Shaft Anchors
Figure 6-6: East Approach Construction Activities: Pier 2 South
Figure 6-7: East Approach Construction Activities: Pier 2 North
Figure 6-8: East Approach Construction Activities: Maintenance Facility and Access Road
Figure 6-9: East Approach Construction Activities: Temporary Work Bridge
Figure 6-10: East Approach Construction Activities: Existing Bridge Demolition
6.1 Impact Assessment

The City of Seattle Noise Ordinances limits construction noise to 87 dBA at the nearest property during the hours of 7 a.m. to 10 a.m. on weekdays and between 9 a.m. and 10 p.m. on weekends, for non-impact equipment such as those described in Section 4.1 of this report. For impact equipment such as pile drivers and hoe rams the noise level limit is 90 dBA for continuous operation. The Medina Noise Ordinance exempts construction activities from noise level limits when they occur Monday through Friday from 7:00 a.m. to 7:00 p.m. on Saturday from 8:00 a.m. to 5:00 p.m. The same noise level limits required by the City of Seattle will be assumed for the noise sensitive receivers in Medina.

The predicted construction noise levels from the different phases of construction described in Section 2.0 are not expected to exceed an Lmax of 87 dBA at any of the historic properties either in Seattle near the West Approach to the Bridge or in Medina near the East Approach and Landings to the Bridge.

The pile driving (assuming vibratory pile drivers) for the West Approach Pontoons A and B Shaft Anchors are expected to exceed the 90 dBA noise level limit at the closest non-historic residential property, Site 1W. On the East Approach there is one non-historical property, Site 1E, where the pile driving for the Pier 2 North shafts will exceed the noise level limit of 90 dBA. At another non-historical property, Site 11E, the Existing Bridge Demolition activities are expected to exceed the noise level limit of 87 dBA. At all other non-historical residential locations for both the West Approach and East Approach, the noise level limits are not expected to be exceeded.
7 Construction Vibration Predictions

7.1 Methodology

For this study, the FTA analytical/empirical vibration prediction model was used to estimate the vibration levels that might propagate from the construction equipment to the vibration sensitive locations. The vibration model is based on a combination of several previous works including measured equipment vibration emission data from the Federal Transit Administration and the Central Artery/Tunnel Project in Boston, and ground transmissibility relationships found in Charles Dowding’s reference textbook Construction Vibrations. The fundamental equation used in the model is based on propagation relationships of vibration through average soil conditions and distance, as follows:

$$PPV_{equipment} = PPV_{ref} \left(\frac{100}{D_{rec}}\right)^n$$

Where:
- $PPV_{ref}$ = reference PPV at 100 ft.
- $D_{rec}$ = distance from equipment to the receiver in ft.
- $n = 1.1$ (the value related to the attenuation rate through ground)

The suggested value for “n” is 1.1. Modifying the value of “n” based on soil classification is not necessary because the modeling presented in this study is intended to predict the most conservative or highest vibration levels for different construction activities. Vibration monitoring during construction will more accurately determine these actual values.

Vibration emission levels (PPV$_{ref}$) used in the model is shown in Table 7-1. They were taken from measurements performed and published from several projects including the FTA Manual, Central Artery/Tunnel Project in Boston, and Dowding’s textbook.

7.2 Construction Vibration Modeling

The predicted construction vibration levels for the different phases of construction activities presented in Section 2.0 are presented in Table 7-2 at the nearest historic properties and Table 6-3 at the non-historic residential properties. The contours of the predicted construction vibration are overlaid on aerial photographs of both the West and East Bridge approaches along with the historic properties and non-historic residential properties in Figure 7-1 through Figure 7-9. Also shown on these graphics are the recommended locations where vibration monitoring should be conducted.

---

Figure 7-1: West Approach Construction Activities: Pier 36
Figure 7-2: West Approach Construction Activities: Pontoons A and M Shaft Anchors
Figure 7-3: West Approach Construction Activities: Existing Bridge Demolition
Figure 7-4: East Approach Construction Activities: Piers 1 and 2
Figure 7-5: East Approach Construction Activities: Temporary Mooring Dolphins
Figure 7-6: East Approach Construction Activities: Pontoon W Shaft Anchors
Figure 7-8: East Approach Construction Activities: Site Access and Bridge Maintenance Facility
Figure 7-9: East Approach Construction Activities: Existing Bridge Demolition
### Table 7-1: Equipment Vibration Emission Levels

<table>
<thead>
<tr>
<th>Equipment Description</th>
<th>Vibration Type</th>
<th>Ref PPV at 100 ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auger Drill Rig</td>
<td>Steady</td>
<td>0.011125</td>
</tr>
<tr>
<td>Backhoe</td>
<td>Steady</td>
<td>0.011</td>
</tr>
<tr>
<td>Bar Bender</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Boring Jack Power Unit</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Chain Saw</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Compactor</td>
<td>Steady</td>
<td>0.03</td>
</tr>
<tr>
<td>Compressor</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Concrete Mixer</td>
<td>Steady</td>
<td>0.011</td>
</tr>
<tr>
<td>Concrete Pump</td>
<td>Steady</td>
<td>0.01</td>
</tr>
<tr>
<td>Concrete Saw</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Crane</td>
<td>Steady</td>
<td>0.001</td>
</tr>
<tr>
<td>Dozer</td>
<td>Steady</td>
<td>0.011</td>
</tr>
<tr>
<td>Dump Truck</td>
<td>Steady</td>
<td>0.01</td>
</tr>
<tr>
<td>Excavator</td>
<td>Steady</td>
<td>0.011</td>
</tr>
<tr>
<td>Flat Bed Truck</td>
<td>Steady</td>
<td>0.01</td>
</tr>
<tr>
<td>Front End Loader</td>
<td>Steady</td>
<td>0.011</td>
</tr>
<tr>
<td>Generator</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Grader</td>
<td>Steady</td>
<td>0.011</td>
</tr>
<tr>
<td>Horizontal Boring Hydraulic Jack</td>
<td>Steady</td>
<td>0.003</td>
</tr>
<tr>
<td>Hydra Break Ram</td>
<td>Transient</td>
<td>0.05</td>
</tr>
<tr>
<td>Impact Pile Driver</td>
<td>Transient</td>
<td>0.2</td>
</tr>
<tr>
<td>Insitu Soil Sampling Rig</td>
<td>Steady</td>
<td>0.011125</td>
</tr>
<tr>
<td>Jackhammer</td>
<td>Steady</td>
<td>0.003</td>
</tr>
<tr>
<td>Mounted Hammer hoe ram</td>
<td>Transient</td>
<td>0.18975</td>
</tr>
<tr>
<td>Paver</td>
<td>Steady</td>
<td>0.01</td>
</tr>
<tr>
<td>Pickup Truck</td>
<td>Steady</td>
<td>0.01</td>
</tr>
<tr>
<td>Pneumatic Tools</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Scraper</td>
<td>Steady</td>
<td>0.000375</td>
</tr>
<tr>
<td>Slurry Trenching Machine</td>
<td>Steady</td>
<td>0.002125</td>
</tr>
<tr>
<td>Soil Mix Drill Rig</td>
<td>Steady</td>
<td>0.011125</td>
</tr>
<tr>
<td>Tractor</td>
<td>Steady</td>
<td>0.01</td>
</tr>
<tr>
<td>Tunnel Boring Machine (rock)</td>
<td>Steady</td>
<td>0.0058</td>
</tr>
<tr>
<td>Tunnel Boring Machine (soil)</td>
<td>Steady</td>
<td>0.003</td>
</tr>
<tr>
<td>Vibratory Pile Driver</td>
<td>Steady</td>
<td>0.15</td>
</tr>
<tr>
<td>Vibratory Roller (large)</td>
<td>Steady</td>
<td>0.059</td>
</tr>
<tr>
<td>Vibratory Roller (small)</td>
<td>Steady</td>
<td>0.022</td>
</tr>
<tr>
<td>Welder</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Concrete Batch Plant</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Pumps</td>
<td>Steady</td>
<td>N/A</td>
</tr>
<tr>
<td>Blasting</td>
<td>Transient</td>
<td>0.75</td>
</tr>
<tr>
<td>Clam Shovel</td>
<td>Transient</td>
<td>0.02525</td>
</tr>
<tr>
<td>Rock Drill</td>
<td>Steady</td>
<td>0.011125</td>
</tr>
<tr>
<td>3-ton truck at 35 mph</td>
<td>Steady</td>
<td>0.0002</td>
</tr>
</tbody>
</table>
7.3 **Vibration Damage Risk Thresholds**

The Contract Specifications for this Project, Subsection 2.6.3.4, states that construction induced vibrations of ground adjacent to structures and utilities shall not exceed a maximum PPV of 2.0 in/sec determine by the structure or utility owner to cause damage to cause damage to the structure or utility, whichever is smaller.

The vibration criteria that are recommended by this Plan to avoid or limit damage risk to the properties that would be affected during construction are:

- 0.12 inches/second PPV for historic properties
- 0.50 inches/second PPV for non-historic properties

These limits, if exceeded, may result in likely cosmetic damage and, at higher levels, structural damage to buildings in each category.

It is recommended that Design Builder, being aware of these damage risk limits for historic and non-historic properties, set their vibration monitors to provide an alert when 0.50 inches/second PPV is exceeded. When this exceedance occurs the Design Builder should immediately contact the occupants of the nearest historic property to check on any potential damage that may have occurred.

7.4 **Construction Vibration Predictions for Historic Properties**

**West Approach Construction Activities**

The highest vibration levels from west approach construction activities will be from vibratory pile driving for the Pontoons A and B shaft anchors. The reference PPV level for vibratory pile driving is 0.14 in/sec at 100 feet. There is only one historic property near the west approach construction activities: The Edgewater Condominiums at 42nd Avenue East. The predicted vibration levels do not exceed the damage threshold of 0.12 in/sec for historic buildings.

**West Approach Demolition Activities**

The highest vibration levels from west approach demolition activities will be from mounted hammer hoe rams used to break concrete on the existing bridge. The reference PPV level for mounted hammer hoe rams is 0.19 in/sec at 100 feet. There is only one historic property near the west approach of the bridge: The Edgewater Condominiums at 42nd Avenue East. The condominiums are a minimum of 250 feet from the existing bridge. The predicted vibration levels do not exceed the damage threshold of 0.12 in/sec for historic buildings.

**East Approach Construction Activities**

The highest vibration levels from east approach construction activities will be from vibratory pile drivers. The reference PPV level for vibratory pile drivers is a PPV of 0.14 in/sec at 100 feet. The vibration predictions are based on the construction activity that will be closest to each historic property. The predicted vibration levels at Dixon House and James Arnston House do not exceed the damage threshold of 0.12 in/sec for historic buildings.

**East Approach Demolition Activities**

The highest vibration levels from the east approach demolition activities will be from mounted hammer hoe rams used to break concrete. The reference PPV level for a hydraulic ram is 0.19 in/sec at 100 feet. The distance used for the vibration predictions is the distance from the...
existing bridge to the historic property. The predicted vibration levels do exceed the vibration impact threshold 0.12 in/sec at the James Arnston House.

**Construction of Site Access and Bridge Maintenance Facility near East Approach**

The highest vibration levels associated with the construction of the temporary road and bridge maintenance facility is from a vibratory roller. The reference PPV level for a large vibratory roller is 0.059 in/sec at 100 feet. The distance used for the vibration prediction to each historic property is an estimate of the closest point of the activity to the historic property. The predicted vibration levels do not exceed the vibration impact threshold of 0.12 in/sec at the Dixon House or the James Arnston House.

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Street Address</th>
<th>Distance to Construction (ft)</th>
<th>Construction Equipment</th>
<th>Predicted Vibration PPV (in/sec)</th>
<th>Impact Threshold PPV (in/sec)</th>
<th>Exceeds Damage Risk Threshold?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>West Approach Construction Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edgewater Condominiums</td>
<td>2411 42nd Avenue East</td>
<td>490</td>
<td>Vibratory Pile Driver</td>
<td>0.024</td>
<td>0.12</td>
<td>No</td>
</tr>
<tr>
<td><strong>West Approach Demolition Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edgewater Condominiums</td>
<td>2411 42nd Avenue East</td>
<td>250</td>
<td>Hoe Ram</td>
<td>0.0069</td>
<td>0.12</td>
<td>No</td>
</tr>
<tr>
<td><strong>East Approach Construction Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dixon House</td>
<td>3267 Evergreen Point Road</td>
<td>780</td>
<td>Vibratory Pile Driver</td>
<td>0.015</td>
<td>0.12</td>
<td>No</td>
</tr>
<tr>
<td>James Arnston House</td>
<td>2851 Evergreen Point Road</td>
<td>750</td>
<td>Vibratory Pile Driver</td>
<td>0.015</td>
<td>0.12</td>
<td>No</td>
</tr>
<tr>
<td><strong>East Approach Demolition Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dixon House</td>
<td>3267 Evergreen Point Road</td>
<td>900</td>
<td>Hoe Ram</td>
<td>0.017</td>
<td>0.12</td>
<td>No</td>
</tr>
<tr>
<td>James Arnston House</td>
<td>2851 Evergreen Point Road</td>
<td>75</td>
<td>Hoe Ram</td>
<td>0.33</td>
<td>0.12</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Construction of Site Access and Bridge Maintenance Facility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dixon House</td>
<td>3267 Evergreen Point Road</td>
<td>680</td>
<td>Vibratory Roller (Large)</td>
<td>0.0022</td>
<td>0.12</td>
<td>No</td>
</tr>
<tr>
<td>James Arnston House</td>
<td>2851 Evergreen Point Road</td>
<td>275</td>
<td>Vibratory Roller (Large)</td>
<td>0.019</td>
<td>0.12</td>
<td>No</td>
</tr>
</tbody>
</table>

Notes: The distance to construction is the estimated closest distance to the historic property from the construction equipment.
7.5 Construction Vibration Levels at Non-Historic Residential Properties

The damage risk criteria recommended for non-historic residential properties is a PPV of 0.20 in/sec. The following equipment would generate the highest levels of vibration during the different phases of construction activities.

- West Approach Construction: Vibratory pile driving
- West Approach Demolition: Hoe ram
- East Approach Construction: Vibratory pile driving
- East Approach Demolition: Hoe ram
- Maintenance facility and access road: Large vibratory roller

The predicted vibration levels at the residence nearest to each construction activity are presented in Table 7-3. The distances from these activities beyond which the damage risk criteria would not be exceeded is presented in Table 7-4. Based on the construction activities described in Section 2.0 it is not expected that the damage risk threshold of 0.50 in/sec PPV will be exceeded at any of the non-historic properties.

The predicted vibration levels exceed the threshold of 0.50 in/sec PPV at the nearest residence during East Approach Bridge Demolition. The predicted vibration level approach, but do not exceed, the threshold during Pier 2 pile driving and Temporary Work Bridge pile driving.

<table>
<thead>
<tr>
<th>Construction Activity</th>
<th>Closest Receiver</th>
<th>Distance to Construction</th>
<th>Predicted PPV at Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pier 36, Vibratory Pile Driver</td>
<td>2411 42nd Avenue E</td>
<td>740 feet</td>
<td>0.015 in/sec</td>
</tr>
<tr>
<td>Pontoons A and B Shaft Anchors, Vibratory Pile Driver</td>
<td>2411 42nd Avenue E</td>
<td>490 feet</td>
<td>0.024 in/sec</td>
</tr>
<tr>
<td>West Approach Bridge Demolition, Mounted Hammer Hoe Ram</td>
<td>2411 42nd Avenue E</td>
<td>250 feet</td>
<td>0.069 in/sec</td>
</tr>
<tr>
<td>Pier 1 and 2 Pile Driving, Vibratory Pile Driver</td>
<td>3201 Evergreen Point Road</td>
<td>70 feet</td>
<td>0.21 in/sec</td>
</tr>
<tr>
<td>Temporary Mooring Dolphins, Vibratory Pile Driver</td>
<td>3241 Evergreen Point Road</td>
<td>770 feet</td>
<td>0.0015 in/sec</td>
</tr>
<tr>
<td>Pontoon W Shaft Anchors, Vibratory Pile Driver</td>
<td>3241 Evergreen Point Road</td>
<td>390 feet</td>
<td>0.031 in/sec</td>
</tr>
<tr>
<td>Temporary Work Bridge, Vibratory Pile Driver</td>
<td>3201 Evergreen Point Road</td>
<td>100 feet</td>
<td>0.14 in/sec</td>
</tr>
<tr>
<td>Construction of Maintenance Facility and Access Road, Vibratory Roller</td>
<td>3201 Evergreen Point Road, 3207 Evergreen Point Road</td>
<td>60 feet</td>
<td>0.10 in/sec</td>
</tr>
<tr>
<td>East Approach Bridge Demolition, Mounted Hammer Hoe Ram</td>
<td>2851 Evergreen Point Road, 2857 76th Avenue NE</td>
<td>60 feet</td>
<td>0.33 in/sec</td>
</tr>
</tbody>
</table>

Table 7-3: Construction Vibration Levels at Non-Historic Properties
Table 7-4: Distance to Construction Vibration Impact Threshold:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Reference PPV (in/sec) at 100 ft</th>
<th>Distance to Impact Threshold of 0.50 in/sec PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibratory Pile Driver</td>
<td>0.15</td>
<td>35 ft</td>
</tr>
<tr>
<td>Mounted Hammer Hoe Ram</td>
<td>0.18975</td>
<td>45 ft</td>
</tr>
<tr>
<td>Vibratory Roller (Large)</td>
<td>0.059</td>
<td>15 ft</td>
</tr>
<tr>
<td>Vibratory Roller (Small)</td>
<td>0.022</td>
<td>10 ft</td>
</tr>
</tbody>
</table>

Notes: Predicted vibration levels will not exceed the impact threshold when the distance between a building and the construction equipment is greater than the 'Distance to Impact Threshold'.
8 Mitigation Measures

8.1 Noise
When construction noise exceeds 87 dBA for non-impact equipment and 90 dBA for impact equipment the Contractor shall stop construction until either temporary noise control measures can be implemented or the means and methods of construction can be modified to lower the noise. As standard best practices the Contractor shall implement the following noise control measures:

- Ensure that all equipment is properly maintained so parts don’t rattle or bang.
- Line or cover storage bins, conveyors, and chutes with sound deadening material.
- Equip noise-producing equipment with acoustically attenuating shields or shrouds recommended by the manufacturers when necessary.
- Impact or impulse tools should not be used from 7 p.m. to 10 a.m.
- Use electric welders powered from utility main lines instead of electric generators/welders.
- Limit the use of public address systems during nighttime hours, except for emergency notifications.
- Grade surface irregularities on construction sites to prevent impact noise and ground vibrations generated by passing vehicles.
- Use concrete decking for cut-and-cover construction sites.

8.2 Vibration
Where the vibration threshold limits identified in Section 5 are exceeded at the monitoring locations the Contractor shall stop all work and either modify the activity causing the exceedance or modify the means and methods of construction to reduce the vibration levels.

In an effort to reduce vibration during construction, the contractor should be required to implement the following practices:

- Use as small an impact device (i.e., hoe ram, pile driver) as possible to accomplish necessary tasks while minimizing excess vibration
- Select non-impact demolition and/or construction methods such as saw or torch cutting and removal for off-site demolition, chemical splitting, or hydraulic jack splitting instead of high impact methods
- Avoid pavement breakers and vibratory rollers and packers near sensitive buildings
9 Monitoring

The recommended monitoring locations to be used by the Design Builder for the different phases of construction activities are shown on Figures 6-1 through 6-10 for noise monitoring and Figures 7-1 through 7-8 for vibration monitoring. In most cases the noise and vibration can be measured at the same monitoring locations. The monitors should be capable of continuously measuring vibration to manage the risk of building damage to historic structures and noise to residences to manage noise nuisance and limit complaints particularly during nighttime and weekend activities.

The monitors should be located at the outside of the buildings shown in these figures in a locked case that is physically secured to the building. They should be capable of measuring data unattended and sending the data by wireless modem to several different parties including the Resident Construction Manager and WSDOT to ensure that the levels do not exceed the thresholds defined in this report. The monitors should also be capable of generating an e-mail alert when the thresholds are exceeded so immediate corrective action can be taken.
References


A.1 FUNDAMENTALS OF NOISE

Sound is mechanical energy transmitted by pressure waves in a compressible medium such as air. Noise is generally defined as unwanted or excessive sound. Sound can vary in intensity by over one million times within the range of human hearing. Therefore, a logarithmic scale, known as the decibel scale (dB), is used to quantify sound intensity and compress the scale to a more manageable range.

Sound is characterized by both its amplitude and frequency (or pitch). The human ear does not hear all frequencies equally. In particular, the ear deemphasizes low and very high frequencies. To better approximate the sensitivity of human hearing, the A-weighted decibel scale has been developed. A-weighted decibels are abbreviated as “dBA.” On this scale, the human range of hearing extends from approximately 3 dBA to around 140 dBA. As a point of reference, Figure 10 includes examples of A-weighted sound levels from common indoor and outdoor sounds.

Using the decibel scale, sound levels from two or more sources cannot be directly added together to determine the overall sound level. Rather, the combination of two sounds at the
same level yields an increase of 3 dBA. The smallest recognizable change in sound level is approximately 1 dBA. A 3-dBA increase is generally considered perceptible, whereas a 5-dBA increase is readily perceptible. A 10-dBA increase is judged by most people as an approximate doubling of the perceived loudness.

Two of the primary factors that reduce levels of environmental sounds are increasing the distance between the sound source and the receiver and having intervening obstacles, such as walls, buildings, or terrain features that block the direct path between the sound source and the receiver. Factors that act to increase the loudness of environmental sounds include the proximity of the sound source to the receiver, sound enhancements caused by reflections, and focusing caused by various meteorological conditions.

Brief definitions of the measures of environmental noise used in this report are:

- **Equivalent Sound Level (Leq)**: Environmental sound fluctuates constantly. The equivalent sound level (Leq), sometimes referred to as the energy-average sound level, is the most common means of characterizing community noise. Leq represents a constant sound that, over the specified period, has the same sound energy as the time-varying sound.

- **Day-Night Sound Level (Ldn)**: Ldn is basically a 24-hour Leq with an adjustment to reflect the greater sensitivity of most people to nighttime noise. The adjustment is a 10-dB penalty for all sound that occurs between the hours of 10 p.m. and 7 a.m. The effect of the penalty is that, when calculating Ldn, any event that occurs during the nighttime is equivalent to 10 of the same event during the daytime. Ldn is the most common measure of total community noise over a 24-hour period.

- **Maximum Sound Level (Lmax)**: The maximum sound level over a period of time or for a specific event can also be a useful parameter for characterizing specific noise sources. Standard sound level meters have two settings, FAST and SLOW, which represent different time constants. Lmax using the FAST setting will typically be 1 to 3 dB greater than Lmax using the SLOW setting.

- **Percent Exceedance Level (Lxx)**: This is the sound level that is exceeded for xx percent of the measurement period. For example, L99 is the sound level exceeded 99 percent of the measurement period. For a one hour period, the sound level is less than L99 for 36 seconds of the hour and the sound level is greater than L1 for 36 seconds of the hour. L1 represents typical maximum sound levels, L33 is approximately equal to Leq when free-flowing traffic is the dominant noise source, L50 is the median sound level, and L99 is close to the minimum sound level.

- **Sound Exposure Level (SEL)**: SEL is a measure of the total sound energy of an event. In essence, all sound from the event is compressed into a one-second period. This means that SEL increases as the event duration increases and as the event sound level increases. SEL is useful for estimating the Ldn that would be caused by individual events such as train passbys.
A.2 FUNDAMENTALS OF VIBRATION

Vibration is an oscillatory motion that can be described in terms of the displacement, velocity, or acceleration of the motion. One potential effect from the proposed project is an increase in vibration that is transmitted from the tracks through the ground into adjacent houses. When evaluating human response, groundborne vibration is usually expressed in terms of decibels using the RMS vibration velocity. RMS is defined as the average of the squared amplitude of the vibration signal. To avoid confusion with sound decibels, the abbreviation VdB is used for vibration decibels. All vibration decibels in this report use a decibel reference of 1 µin/sec. Vibration can also be expressed as the peak particle velocity (PPV), which is generally used to evaluate whether vibration has potential to cause damage to fragile building structures. Peak particle velocity is normally expressed in inches per second.

The potential adverse effects of rail transit groundborne vibration are as follows:

- **Perceptible Building Vibration**: This is when building occupants feel the vibration of the floor or other building surfaces. Experience has shown that the threshold of human perception is around 65 VdB and that vibration that exceeds 75 to 80 VdB may be intrusive and annoying to building occupants.

- **Rattle**: The building vibration can cause rattling of items on shelves and hanging on walls, and various different rattle and buzzing noises from windows and doors.

- **Reradiated Noise**: The vibration of room surfaces radiates sound waves that may be audible to humans. This is referred to as groundborne noise. When audible groundborne noise occurs, it sounds like a low-frequency rumble. For surface rail systems the groundborne noise is usually masked by the normal airborne noise radiated from the transit vehicle and the rails.

- **Damage to Building Structures**: Vibration from rail systems is usually one to two orders of magnitude below the most restrictive thresholds for preventing building damage. However, fragile and extremely fragile structures may be susceptible to damage if the tracks are in sufficient proximity to the structure.

Figure 11 shows typical RMS vibration velocity levels from rail and nonrail sources as well as the human and structure response to such levels.
Figure 9-2: Typical RMS Vibration Velocity Levels

Often it is necessary to determine the contribution at different frequencies when evaluating vibration or noise signals. The 1/3-octave band spectrum is the most common procedure used to evaluate frequency components of acoustic signals. The term "octave" has been borrowed from music where it refers to a span of eight notes. The ratio of the highest frequency to the lowest frequency in an octave is 2:1. For a 1/3-octave band spectrum, each octave is divided into three bands where the ratio of the lowest frequency to the highest frequency in each 1/3-octave band is 21/3:1 (1.26:1). An octave consists of three 1/3 octaves.

The 1/3-octave band spectrum of a signal is obtained by passing the signal through a bank of filters. Each filter excludes all components except those that are between the upper and lower range of one 1/3-octave band. The FTA Guidance Manual is a good reference for additional information on transit noise and vibration and the technical terms used in this section.
APPENDIX B
CITY OF MEDINA TECHNICAL NOISE VARIANCE
BEFORE THE HEARING EXAMINER
FOR THE CITY OF MEDINA

In the Matter of the Application of
Kiewit/General/Manson, A Joint Venture (KGM)
For a Technical Noise Variance

No. PL-12-001
FINDINGS, CONCLUSIONS, AND DECISION

SUMMARY OF DECISION

The request for a technical noise variance from MMC 8.06.010, MMC 8.06.040, and Chapters 12.88 – 12.92 King County Code, as adopted by the City of Medina, for state highway construction in SR 520 WSDOT right-of-way, west of Evergreen Point Road, in Medina, Washington, is APPROVED. Conditions of approval are necessary to address specific impacts of the proposed project.

SUMMARY OF RECORD

Request:
Kiewit/General/Manson, A Joint Venture (KGM) requests a technical noise variance from MMC 8.06.010, MMC 8.06.040, and Chapters 12.88 – 12.92 King County Code, as adopted by the City of Medina, for state highway construction in the SR 520 right-of-way from the east shore of Lake Washington at milepost 3.98 to 108th Avenue NE at milepost 6.43.

Hearing Date:
The City of Medina Hearing Examiner held an open record hearing on the request on February 22, 2012. The City of Medina Hearing Examiner kept the record open until close of business on February 24, 2012 for City staff to submit a copy of King County noise regulations adopted by the City.

Testimony:
The following individuals presented testimony under oath at the open record hearing:

Erik Nelson, Project Director, Kiewit, Applicant Representative
Kate Snider, Permit Lead, Kiewit, Applicant Representative
Christopher Ruiz, RothHill Project Coordinator
Kristen Clem Kissinger, City Planning Consultant
John Andrews

Exhibits:
The following exhibits were admitted into the record:

Findings, Conclusions and Decision
City of Medina Hearing Examiner
Kiewit/General/Manson, A Joint Venture (KGM)
Noise Variance, No. PL-12-001
1. Staff Report, dated February 15, 2012
3. Legal Notices
   b. Notice of Application and Hearing, dated February 6, 2012
4. Supplemental Information/Project Narrative, undated
5. WSDOT ROW Plan, dated June 29, 2005
6. Construction Area and Offset Distances, dated December 30, 2011
7. Site Plan Detail, dated December 30, 2011
8. Equipment and Associated Noise Levels, Tables 6.1, 6.2 and 6.3, undated
9. Additional Correspondence with Applicant, dated February 2, 2012
12. Letter from George & Patricia Carpenter, dated February 21, 2012
13. PowerPoint presentation slides, KGM SR520 Floating Bridge and Landings Project, received February 22, 2012
14. PowerPoint presentation slides, SR520 Bridge Replacement and Maintenance Facility, Noise Variance (PL 2012-001)

The Hearing Examiner enters the following Findings and Conclusions based upon the testimony and exhibits admitted at the open record hearing:

**FINDINGS**

**Application and Notice**

1. Kiewit/General/Manson, A Joint Venture (KGM) (Applicant)\(^1\) requests a technical noise variance from Medina Municipal Code (MMC) 8.06.010, MMC 8.06.040, and Chapters 12.88 – 12.92 King County Code, as adopted by the City of Medina (City), for state highway construction in the SR 520 right-of-way from the east shore of Lake Washington at milepost 3.98 to 108\(^{th}\) Avenue NE at milepost 6.43. Exhibit 2.

2. The City determined that the application was complete on February 2, 2012.\(^2\) Exhibit 3.

The City posted notice of the applications and associated open record hearing at City

\(^1\) Kiewit/General/Manson, A Joint Venture (KGM) was selected as the contractor for construction of the bridge replacement and HOV segment of the SR 520, I-5 to Medina; Bridge Replacement and HOV Project, and tasked with the responsibility for requesting relief from maximum permissible noise levels under City of Medina code associated with project construction. *Technical Noise Variance, Exhibit 1, Staff Report, page 4.*

\(^2\) The Applicant also submitted a related and concurrent request for approval of a Construction Mitigation Plan (CMP) for the SR 520, I-5 to Medina; Bridge Replacement and HOV Project. The Applicant requested consolidated review of the technical noise variance request and the request for approval of a CMP by the Hearing Examiner under

*Findings, Conclusions and Decision*

City of Medina Hearing Examiner
Kiewit/General/Manson, A Joint Venture (KGM)
Noise Variance, No.PL12-001

Page 2 of 13
posting locations and within state highway right-of-way on Evergreen Point Road, NE 24th Street, and 80th Avenue NE; published notice in *The Seattle Times*; and mailed notice to owners of property within 1,000 feet of the subject property on February 6, 2012. *Exhibit 1, Staff Report, page 4; Exhibit 3.b.*

**Environmental Review**

3. John Andrews testified to inquire whether the impacts of a large, in-water platform have been considered. *Testimony of Mr. Andrews.* The City staff report states the variance request is exempt from review under the State Environmental Policy Act (SEPA), Ch. 43.21C RCW, in accord with Washington Administration Code (WAC) 197-11-800(6)(b). *Exhibit 1, Staff Report, page 9.*

**Comprehensive Plan, Zoning, and Surrounding Property**

4. The property proposed for development is designated SR 520 and Single Family Residential under the City Comprehensive Plan. *City Comprehensive Plan, Land Use Element, Figure 2: Land Use Plan, page 19 (May 19, 1994, as amended).*

5. The Comprehensive Plan recognizes SR 520 as an Essential Public Facility that may not be prohibited by the Comprehensive Plan or development regulations. The Comprehensive Plan also designates the SR 520 ROW within the City, including the existing SR 520 bridge to mid-span, as the SR 520 Corridor Special Planning Area. The Comprehensive Plan Land Use Element states that development of Special Planning Areas is guided by the need to limit or mitigate the impact of such development on surrounding areas and the City as a whole, seeking a balance between needs of a growing population, environmental preservation, and maintaining a high standard of living. *Comprehensive Plan, Land Use Element, page 13.*

6. The subject property is located within the City’s Single Family Residential (R-20) zoning district and within SR 520 ROW. WSDOT purchased five residential lots on the Lake Washington shoreline adjacent to the north of the existing SR 520 roadway and converted them to state highway ROW to provide for construction of the proposed SR 520 east approach. *Exhibit 2.* According to the City staff report, the five lots are located in the City’s Single Family Residential (R-20) zoning district, but Washington Administrative Code (WAC) 3, 4

Medina Municipal Code (MMC) 20.80.090. *Exhibit 2.* Both requests were heard by the Hearing Examiner at a consolidated oral record hearing on February 22, 2012.

3 WAC 197-11-800(6)(b) provides land use decisions that “[grant] variances based on special circumstances, not including economic hardship, applicable to the subject property, such as size, shape, topography, location or surroundings and not resulting in any change in land use or density” shall be exempt from SEPA review. *WAC 197-11-800(6)(b).*

4 WSDOT purchased five parcels identified by Tax Assessor Parcel Nos.: 2425049181; 2425049071; 2425049072; 2425049259; and 2425049177. *Exhibit 1, Staff Report, page 1.*

**Findings, Conclusions and Decision**

City of Medina Hearing Examiner,

Keveli General Manso, A Joint Venture (KGM)

Noise Variance, No PLY9-001

Page 3 of 13
365-196-550(3)(a)\textsuperscript{5} supersedes local zoning codes such that the SR 520 Essential Public Facility (EPF) may be located on these lots. Property to the north and south of the five purchased lots contains residential development and is also located in the City’s Single Family Residential (R-20) zoning district. SR520 lies adjacent to the east, and Lake Washington adjacent to the west. \textit{Exhibit 1, Staff Report, pages 1 to 3; Exhibit 7.}

\textbf{Technical Noise Variance Review}

7. Proposed state highway construction in the SR 520 right-of-way from the east shore of Lake Washington at milepost 3.98 to 108\textsuperscript{th} Avenue NE at milepost 6.43 is a part of the SR 520, I-5 to Medina: Bridge Replacement and HOV Project. The SR 520, I-5 to Medina: Bridge Replacement and HOV Project is a part of the SR 520 Bridge Replacement and HOV Program, a state safety enhancement project to replace the SR 520 floating bridge and make transit and roadway improvements along a 12.8-mile long corridor between I-5 in Seattle and SR 202 in Redmond. The Program includes four major components: Bridge Replacement and HOV Project; Eastside Transit and HOV Project; Pontoon Construction Project; and Variable Tolling Project. The City of Medina Hearing Examiner previously approved a technical noise variance request for construction work associated with the Eastside Transit and HOV Project and the Variable Tolling Project. \textit{Exhibit 1, Staff Report, page 3; Exhibit 10.}

8. Proposed construction associated with the technical variance request would occur between April 2012 and approximately late 2015. Proposed construction associated with the noise variance request would include the following activities, occurring in an area stretching from Evergreen Point Road to Lake Washington:

- Construction of the floating bridge structure, a fixed east approach, and transition structures between the fixed structures and the floating bridge;
- Towing, storage, and outfitting 33 pontoons constructed offsite for incorporation into the new floating bridge;
- Construction, storage, and outfitting of 44 supplemental stability pontoons, 58 anchors, and anchor cables for incorporation into the new floating bridge;
- Construction of a temporary construction work bridge and walkway to provide access to a temporary floating eastside staging area located approximately 100 feet north of the proposed bridge and 450 feet from the Lake Washington east shoreline;
- Construction of the final connection between the new bridge and the new, lidded roadway section at Evergreen Point Road;

\textsuperscript{5} Washington Administrative Code (WAC) 365-196-550(3)(a) provides “Cities and counties may not use their comprehensive plan or development regulations to preclude the siting of essential public facilities. Comprehensive plan provisions or development regulations preclude the siting of an essential public facility if their combined effects would make the siting of an essential public facility impossible or impracticable.”

\textit{Findings, Conclusions and Decision}

\textit{City of Medina Hearing Examiner}

\textit{Kiewit/General/Manson, A Joint Venture (KGM)}

\textit{Noise Variance, No.PL12-001}

Page 4 of 13
• Construction of a new bridge maintenance facility and dock located underneath the new east approach structure;
• Paving, striping, and installation of tolling gantries east of Evergreen Point Road after the new bridge and approach are constructed; and
• Demolition of the existing bridge after the new bridge is open for vehicle traffic.

Exhibit 1, Staff Report, pages 4 to 5; Exhibit 2.

9. Proposed construction would exceed daytime and nighttime noise levels set forth within City code. Ch. 8.06 MMC adopts King County Code (KCC) Chapters 12.86 – 12.100 to regulate noise within the City. See Ch. 8.06 MMC. Ch. 12.88 KCC establishes maximum permissible sound levels per Sound District Designation. The Districts identified within Ch. 12.88 KCC are the Rural, Residential, Commercial, and Industrial Districts. KCC 12.88.020 A. The City Director of Development, as City Manager’s designee, interpreted and applied the District Designation section of the KCC to the subject property. The Director applied the Commercial District to the subject property between the center lines of Evergreen Point Road and 80th Avenue NE, for the reason that the designation is consistent with the non-residential City zoning designation of property (Parks and Public Places) adjacent to that segment of state highway ROW. The Director applied the Residential District to remaining state highway area west of the center point of Evergreen Point Road and east of the center point of 80th Avenue NE, for the reason that the designation is consistent with the residential City zoning designation of property adjacent to those segments of the state highway ROW. Exhibit 1, Staff Report, page 6.

10. The maximum permissible sound level for sounds originating from Commercial Districts and affecting property within R-16, R-20, and SR-30 zones is 57 decibels, and the

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6 The project will produce construction noise along large segments of the SR520 corridor, but the City’s authority to regulate noise extends only to the City limits. The technical noise variance will apply only to noise originating within the City limits that exceeds the City’s maximum permissible noise levels. Noise originating outside the City limits is the responsibility of the jurisdiction from which the noise originates. The proposed construction zone to which the noise variance request applies is located over water within Lake Washington and on land within the City limits. Limits of construction for the new SR 520 east approach structure and maintenance facility extend inland from the Lake Washington shoreline approximately 800 linear feet. The east approach and maintenance facility construction area is approximately 800 feet long by 510 feet wide, at its widest point. Exhibit 1, Staff Report, page 5; Exhibit 6.

7 King County Code (KCC) 12.98.010 provides: “The administrator and sheriff are authorized to administer and enforce K.C.C. chapters 12.86 through 12.100 of this code.” KCC 12.98.010.

8 “Sound level” means the weighted sound pressure level measured by the use of a metering characteristic and weighted as specified in American National Standards Institute Specifications, Section 1.A. The sound pressure level of a sound expressed in decibels is twenty times the logarithm to the base ten of the ratio of the pressure of the sound to the reference sound pressure of twenty micropascals. In the absence of any specific modifier, the level is understood to be that of a root-mean-square pressure. KCC 12.89.300.
maximum permissible sound level for sounds originating from Residential Districts and affecting property within R-16, R-20, and SR-30 zones is 55 decibels. All standards are reduced by 10 decibels during nighttime hours between 10:00 pm and 7:00 am on weekdays and 10:00 pm and 9:00 am on weekends. KCC 12.88.020. KCC 12.88.040 provides a permissible noise level of 80 decibels for construction activities. KCC 12.88.040 also requires that noise level measurements be taken at the real property of another person or at 50 feet from noise-producing equipment, whichever is greater in distance from the noise source. Acceptable noise levels for impact equipment range from 90 to 99 decibels, as the KCC allows higher noise levels for impact equipment if impact is limited to one period of 7.5 to 30 minutes between 8:00 am and 5:00 p.m. weekdays and between 9:00 a.m. and 10:00 p.m. on weekends. KCC 12.88.040. KCC 12.88.050 establishes a maximum permissible noise level of 45 decibels between 10:00 p.m. and 7:00 a.m. weekdays and between 10:00 p.m. and 9:00 a.m. on weekends. Under MMC 8.06.030, allowable hours of construction are between 7:00 a.m. to 7:00 p.m. weekdays and 8:00 a.m. to 5:00 p.m. on Saturdays.

11. The Applicant’s preliminary Site Plan Detail depicts portions of properties identified by Tax Assessor Nos. 2425049217, 2425049099, and 2425049210 located within approximately 50 feet of the north boundary of the proposed construction area. Portions of properties identified by Tax Assessor Nos. 2425049217, 2425049099, 2425049249, and 2425049100 located within approximately 100 feet of the north boundary. Portions of properties identified by Tax Assessor Nos. 2425049074, 2425049075, and 2425049180 located within approximately 50 feet of the south boundary of the proposed construction area. Portions of properties identified by Tax Assessor Nos. 2425049074, 2425049075, 2425049180, and 2425049258 are located within approximately 100 feet of the south boundary. Exhibit 7.

12. The Applicant’s Equipment and Associated Noise Levels List estimates the nearest three properties to the north and south of the proposed construction site may experience daytime noise levels associated with typical construction work that exceed 80 decibels. The nearest three properties to the north and south of the proposed construction site may also experience daytime noise levels associated with typical pile driving that exceed the threshold of 80 decibels. The highest anticipated noise level at 50 feet from pile driving equipment is 88 decibels, and 82 decibels at 100 feet from equipment. For proposed demolition of the existing bridge, the highest anticipated noise level at 50 feet from the demolition equipment is 90 decibels. The four properties nearest to the south side of the

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9 An email message from Kate Snider, Applicant Representative, states pile driving would be conducted on consecutive days until completed. Exhibit 9.

10 Noise levels are modeled data based on published equipment information and measured monitoring results for equipment and activities used in Eastside Corridor Constructors work similar to those that would be conducted by the Applicant. Exhibit 8.

Findings, Conclusions and Decision
City of Medina Hearing Examiner
Kiewit/General/Manson, A John Ventures (KGM)
Noise Variance, No. PL12-001

Page 6 of 13
bridge may experience daytime noise levels associated with typical demolition work exceeding the allowable threshold of 80 decibels. Exhibit 4; Exhibit 8.

13. An email from Kate Snider, Applicant Representative, states that Applicant noise estimates for distances within 500 feet of proposed construction activity are conservative, in that estimates do not account for noise reduction associated with vegetation, topography, or other structures. According to the email, there is significant vegetation and topography in the vicinity of the proposed construction site, and the actual noise levels experienced by properties within 500 feet of the construction site are expected to be less than the levels estimated by the Applicant. Exhibit 9.

14. Supplemental Information submitted with the variance application states a portion of project construction must occur during nighttime hours, because work cannot occur without closing highway lanes to vehicles. The information states that lane closures must occur at night between the hours of 9:00 p.m. and 5:00 a.m. to protect the travelling public and reduce traffic congestion. Examples of work that would require lane closures include traffic barrier installation; tolling gantries construction; and temporary work walkway construction on the existing bridge. The Applicant estimates that there would be approximately 50 nights of work associated with lane closures. Construction of the new east approach also requires night work, as the segmental cast-in-place method that would be used in construction requires swing shift work between the hours of 4:00 p.m. and 12:00 a.m. This work would be quieter work such as concrete pour completion and rebar installation. Night work would also be required when traffic is shifted to the new bridge, with 24-hour operations for the duration of each closure. The Applicant estimates that shifting traffic to the new bridge would include up to six complete weekend closures. Exhibit 4.

15. Approximately 122 residences within 1,000 feet of the project site may experience noise levels exceeding the nighttime noise threshold of 45 decibels. According to the FEIS and FEIS Addenda, background noise levels in the project area already exceed the maximum permissible sound levels under City code, with highest existing peak hour noise levels on residential property in the City in the project vicinity at 68 decibels and 73 decibels on the north and south sides of the project site, respectively. The Applicant would take the following measures when night work is required: send notice to all affected residences at least seven days before work is scheduled or as soon as possible when otherwise unscheduled work is necessary; send notice including an explanation why night work is required; complete the noisiest work before 12:00 a.m., if possible; and avoid work on Saturday or Sunday nights, except during scheduled weekend road closures. Exhibit 4.

16. City code provides:

   It is a violation of this chapter to engage in any commercial construction and development activity or to operate any heavy equipment before the hours of 7:00 a.m. and after 7:00 p.m. Monday through Friday and before the hours of 8:00 a.m. on Saturday or Sunday nights, except during scheduled weekend road closures. Exhibit 4.

Findings, Conclusions and Decision
City of Medina Hearing Examiner
Klewitz General/Manson, A Joint Venture (KGM)
Noise Variance, No. PL12-001

Page 7 of 13
a.m. and after 5:00 p.m. on Saturday. No construction and development activity or use of heavy equipment may occur on Sundays or holidays that are holidays observed by the city.

**MHC 8.06.030.** The City Staff Report states that some construction work would occur beyond hours permitted under City ordinances, extending into later evening and early morning hours and into weekends. According to Supplemental Information submitted by the Applicant, work during early mornings would be required to prepare equipment and materials necessary for work; conduct preparatory work to other work that would require much or all of a day shift; start work that must finish within the day, but work is projected to take longer than a typical work day; conduct large concrete pours over shifts lasting more than 12 hours; and complete large work projects requiring more than one shift to complete. Supplemental Information submitted with the variance application states that workers would typically arrive on the construction site at 5:00 a.m. at the earliest on weekdays, and work would begin at 6:00 a.m. The earliest arrival on Saturdays would be 6:00 a.m., with work occurring between 7:00 a.m. and 5:00 p.m. Exhibit 1, Staff Report, page 3; Exhibit 4.

17. A letter from George and Patricia Carpenter, residents of 2414 80th Avenue NE located north and northeast of the existing SR 520, expresses concern about noise impacts of current and proposed SR520 construction. The letter states ongoing construction is noisy and takes place at night, which inhibits sleep, and that a great deal of continuous noise comes from the SR520 corridor between 80th and 92nd Avenue NE. The letter requests monetary compensation for depressed land values as a result of noise impacts, and construction of a permanent noise wall along the south side of SR520 from the lid over Evergreen Point Road at least as far as 92nd Avenue NE. Exhibit 12.

18. The Applicant would employ the following measures to minimize and mitigate noise impacts of proposed construction:

1. Require mufflers on all engine-powered equipment;
2. Inspect equipment regularly to replace parts not meeting manufacturers’ specifications;
3. Limit high-noise activities to daytime hours when feasible;
4. Limit pile driving to between 7:00 a.m. and 5:00 p.m. and use pile cushion pads when feasible;
5. Locate stationary construction equipment as far as possible from noise-sensitive properties;
6. Prohibit unnecessary equipment idling;
7. Minimize the use of standard back-up alarms, and investigate the possibility of using ambient alarms;
8. Prohibit truck tailgate banging;
9. Use electric tools and equipment when possible;

**Findings, Conclusions and Decision**

*City of Medina Hearing Examiner*

*Kiewit/General/Manson, A Joint Venture (KGM)*

*Noise Variance, No. PLJ2-001*

*Page 8 of 13*
10. Maintain a construction log to better address noise issues and exceedances, and notify nearby residents when pile driving or other noisy work would occur;
11. Notify all impacted households at least seven days in advance of scheduled nighttime work, or as soon as possible in the case of unscheduled work; and
12. Establish a 24-hour construction hotline to investigate noise complaints.

Exhibit 4.

19. Kate Snider, Applicant Representative, responded that proposed construction would also minimize noise impacts by maximizing the use of pre-cast components, the use of waterborne equipment delivery, and the use of segmental cantilevered construction techniques rather than scaffolding to lessen pile driving noise. Ms. Kissinger testified for the City that proposed construction would include screening to provide a barrier between the project site and adjacent properties, and that neighborhood meetings are being scheduled for input on screening. Ms. Kissinger added that monitoring must be performed on a continuous and regular basis and weekly reports must be submitted to the City. Ms. Kissinger also testified that it is her opinion as a professional planner that besides proposed mitigation, there are no additional means to bring noise that would result from proposed construction under permissible thresholds in City code. Ms. Kissinger added that the City will receive construction schedules, and the schedules can be accessed by the public through the City’s e-government website links. Erik Nelson, Applicant Representative, testified the Applicant would notify the City of all complaints received on the noise complaint hotline. Testimony of Ms. Snider; Testimony of Ms. Kissinger; Testimony of Mr. Nelson.

Staff Recommendation

20. Ms. Kissinger testified that City staff recommends approval of the variance request with nine proposed conditions of approval. Proposed conditions of variance approval concern providing construction schedules to the City; performing sound level testing and monitoring with quarterly reports to the City; complying with variance start and end dates; performing additional mitigation if construction activity sound levels exceed modeled sound levels; implementing construction best management practices; notifying neighbors of noise exceeding maximum permissible sound levels; providing a phone complaint number and designated contact person; and placing a copy of the noise variance decision on site to ensure compliance with noise mitigation measures at all times. Ms. Snider testified to request an additional condition that ambient back-up alarms be used or standard back-up alarms disabled and spotters used to limit vehicle noise. Exhibit 1, Staff Report, pages 11 to 12; Testimony of Ms. Kissinger; Testimony of Ms. Snider.
CONCLUSIONS

Jurisdiction
The Hearing Examiner has jurisdiction to hear and decide requests for technical noise variances from the Medina Municipal Code (MMC). MMC 8.06.010.B.4.

Criteria for Review
The MMC adopts portions of King County Code (KCC) Chapters 12.86 through 12.100 governing excessive noise and noise control by reference, with amendments set forth within MMC 8.06.010. Under MMC 8.06.010, KCC 12.96.010 is amended to read “no variance shall be granted pursuant to this section until the administrator or the hearing examiner has considered the relative interests of the applicant, other owners or possessors of property likely to be affected by the noise, and the general public. A technical or economic variance may be granted only after a public hearing on due notice. The administrator or hearing examiner may grant a variance, if she finds that:

A. The noise occurring or proposed to occur does not endanger public health or safety; and
B. The Applicant demonstrates the criteria required for temporary, technical or economic variance under Section 12.96.020."

MMC 8.06.010.B.5 amends KCC 12.96.020(B) to read as follows:

A technical variance may be granted by the hearing examiner on the grounds that there is no practical means known or available for the adequate prevention, abatement or control of the noise involved. Any technical variance shall be subject to the holder’s taking of any alternative measures that the hearing examiner may prescribe. The duration of each technical variance shall be until such practical means for prevention, abatement or control become known or available. The holder of a technical variance as required by the hearing examiner, shall make reports to the administrator detailing actions taken to develop a means of noise control or to reduce the noise involved and must relate these actions to pertinent current technology.

MMC 8.06.010.B.5.

The criteria for review adopted by the Medina City Council are designed to implement the requirement of Chapter 36.70B RCW to enact the Growth Management Act. In particular, RCW 36.70B.040 mandates that local jurisdictions review proposed development to ensure consistency with City development regulations considering the type of land use, the level of development, infrastructure, and the characteristics of development. RCW 36.70B.040.

Conclusions Based on Findings

1. With conditions, the noise occurring or proposed to occur does not endanger public health or safety. The King County Code, adopted by the City, sets maximum permissible sound levels for activities originating within a specific District and affecting specific environments. Ch. 12.96, King County Code, allows an applicant to apply for

Findings, Conclusions and Decision
City of Medina Hearing Examiner
Kelli/Glen/Manson, A Joint Venture (KGM)
Notice Variance, No. PL12-001
Page 10 of 13
relief from maximum permissible noise standards. The Applicant would employ the following mitigation measures to limit noise impacts: require mufflers on all engine-powered equipment; inspect equipment regularly to replace parts not meeting manufacturers’ specifications; limit high-noise activities to daytime hours when feasible; limit pile driving to between 7:00 a.m. and 5:00 p.m. and use pile cushion pads when feasible; locate stationary construction equipment as far as possible from noise-sensitive properties; prohibit unnecessary equipment idling; minimize the use of standard back-up alarms; and investigate the possibility of using ambient alarms; prohibit truck tailgate banking; use electric tools and equipment when possible; maintain a construction log to better address noise issues and exceedances, and notify nearby residents when pile driving or other noisy work would occur; notify all impacted households at least seven days in advance of scheduled nighttime work, or as soon as possible in the case of unscheduled work; and establish a 24-hour construction hotline to investigate noise complaints. Construction schedules provided to the City would be available for public review, and the City would be notified of all complaints received on the noise complaint hotline. Significant vegetation and topography in the vicinity of the proposed construction site would lessen noise levels experienced by properties within 500 feet of the construction site from noise levels estimated by the Applicant. The Applicant would conduct quieter work during swing shifts. The Applicant would also complete noisier work before 12:00 a.m. and avoid work on weekends except during scheduled weekend road closures. With implementation of mitigation and conditions of approval, public health and safety would not be endangered. Conditions are necessary to ensure City residents may register complaints about noise levels to spur prompt action by the Applicant and City, that affected residences receive adequate notice of noise-generating construction activities; and that ambient back-up alarms be used or standard back-up alarms disabled and spotters used to limit vehicle noise. Findings 1, 8, 10 – 20.

2. There are no practical means known or available for the adequate prevention, abatement or control of the noise involved. Proposed construction requires SR520 lane closures during nighttime hours to prevent endangerment of public health or safety by construction activities and to reduce traffic congestion. City ordinances otherwise prohibit construction activity during nighttime hours. City ordinances cannot prohibit siting of the Essential Public Facility under the Washington Administrative Code, but the City can require conditions to mitigate adverse effects of operation of the Facility, including elevated noise levels. Findings 1, 5, 6, 8 – 10, 12, 14 – 16, 20.

3. Noise duration would be until such practical means for prevention, abatement, or control becomes known or is available. Conditions of approval are necessary to ensure the duration of the variance would extend until July 13, 2012, with renewals of the variance granted for six month periods automatically except as provided in Condition 5. No renewal of the variance shall be granted after July 1, 2016, in step with WSDOT intent to complete construction by late 2015. Findings 1, 8, 20.

Findings, Conclusions and Decision
City of Medina Hearing Examiner
Kervin/General/Mason, A Joint Venture (KGM)
Noise Variance, No. PL12-001
Page 11 of 13
4. With conditions, the holder of the technical variance would make reports to the City Director of Development Services detailing actions taken to develop a means of noise control or to reduce the noise involved and would relate these actions to pertinent current technology. Conditions are necessary to ensure the Applicant tests and monitors sound levels and sends reports to the City, and that the Applicant provide additional mitigation if sound levels exceed those estimates at this time. Findings 1, 8, 20.

DECISION

Based on the preceding Findings and Conclusions, the request for a technical noise variance from MMC 8.06.010, MMC 8.06.040, and Chapters 12.88 – 12.92 King County Code, as adopted by the City of Medina, for state highway construction in the SR 520 right-of-way from the east shore of Lake Washington at milepost 3.98 to 108th Avenue NE at milepost 6.43 is APPROVED, with the following conditions:

1. The Applicant shall provide updated construction schedules to the City on a monthly basis, which identify work being performed outside of the work hours set forth in MMC 8.06.030 (Limitations on construction and development activity).

2. The Applicant shall conduct testing and monitoring of sound levels associated with construction activity. A quarterly report on the results of the testing and monitoring shall be submitted to the City on the first day of July, October, January and April for the duration of construction activity associated with the project.

3. Approval of the variance is granted until July 13, 2012. Renewals of the variance are granted for six month periods and shall be automatic except as provided in Condition 5. No renewal of the variance shall be granted after July 1, 2016.

4. If construction activity sound levels exceed the sound levels set forth in the Exhibit 8, the City may require that the Applicant to provide additional mitigation for those residences that are affected by noise levels exceeding those levels approved by this variance.

5. A renewal of the noise variance may be subject to Hearing Examiner approval after a public hearing, if the Applicant fails to comply with the conditions set forth in this decision, or if significant revisions to the project are made that increase noise levels from construction activity, or if monitoring reports indicate construction noise levels exceed the sound levels set forth in Exhibit 8 and additional mitigation or alternative accommodations fail to reduce the elevated sound levels to within the approved range.

6. Best management practices identified in the application shall be adhered to for the life of the project. This includes, but is not limited to:

   a. Construction and stationary equipment shall be strategically located as much as possible so that residents do not have direct line of site. Equipment such as light plans, generators, compressors, jackhammers, saw cutters, and rollers shall utilize WSDOT...
approved noise mitigation shields, noise blankets, skirts, concrete barriers or other means available to reduce noise.

b. Vehicles shall be equipped with ambient sensitive backup warning devices. Back-up observers may be used in lieu of back-up warning devices for all equipment, except dump trucks in compliance with WAC 296-155-610 and WAC 296-155-615, which shall use back-up observers and back-up warning devices in compliance with WAC 296-155-610.

c. Trucks performing export haul shall have well maintained bed liners that shall be inspected and approved by the Applicant's engineer.

d. Track tailgate banging is prohibited with tailgates secured to prevent banging.

e. As available, the use of electrically powered tools and equipment is preferred.

f. Whenever possible, the noisiest activities will be completed before midnight.

7. The Applicant shall provide and be responsible for written notification to all residences with the radius of a proposed construction activity affected by noise exceeding the maximum permissible sound levels. Notice shall be provided at least seven calendar days before the particular construction activity occurs. If a period of more than six months should elapse between construction activities occurring, a new written notification shall be sent.

8. Content of the written notification and a list of the households being notified shall be submitted to the City prior to it being mailed to residences. The notification shall include a phone complaint number and designated contact for residents to call with issues.

9. A copy of the decision on the noise variance shall be kept on the project site at all times. Supervisors on site shall ensure noise mitigation measures are complied with at all times.

Decided this 15th day of March 2012.

KIMBERLY A. ALLEN
Hearing Examiner
Sound Law Center