Noise

Studies and Coordination

This section describes the methods and summarizes the results of the noise impact analysis for the proposed 20th Street SE road improvement project between the US 2 Trestle and a point 400 feet west of 91st Avenue SE. The noise analysis included measurements of existing sound levels and noise impact and mitigation modeling, consistent with Washington Department of Transportation (WSDOT) and Snohomish County policies and procedures. The complete report of the noise impact analysis can be found in Appendix B. A different Snohomish County 20th Street SE widening project between 91st Avenue SE and South Lake Stevens Road will begin construction in 2008. The noise impacts analysis for that project was completed by Jones & Stokes, Inc. The information from this section came from the following reports and documents:

- *Noise Technical Memorandum,* Geomatrix, Inc., November 2007.
- *Noise Impacts Analysis Report for 20th Street SE Road Improvement Project*, Jones & Stokes, 2005.
- *Project Alignment Drawings, CADD Files, and Traffic Analysis Data*, Perteet, Inc., 2007.
- *Procedures for Abatement of Highway Traffic Noise and Construction Noise. Federal-aid Highway Program Manual: Volume 7, Chapter 7, Section 3.* U.S. Department of Transportation, 1982.
- *FHWA Traffic Noise Model, Version 2.5.* U.S. Department of Transportation, Federal Highway Administration, 2006.
- *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. NTID300.1.* U.S. Environmental Protection Agency, 1971.
- *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety,* U.S. Environmental Protection Agency, 1974.

Existing and future traffic noise was predicted using the Federal Highway Administration's (FHWA) Traffic Noise Model (TNM) with traffic data provided by the County's roadway design consultant, Perteet, Inc. On site sound level measurements (SLMs) were recorded at various times in the Spring and Fall of 2007.

Noise Terminology and Human Hearing

Noise is sometimes defined as unwanted sound. This report makes no such distinction, and the terms noise and sound are used more or less synonymously. The human ear responds to a very wide range of sound intensities. The decibel (dB) scale used to describe and quantify sound is a logarithmic scale that provides a convenient system for considering the large differences in audible sound intensities. On this scale, a 10-dB increase represents a perceived doubling of loudness to someone with normal hearing. Therefore, a 70-dB sound level will sound twice as loud as a 60-dB sound level.

People generally cannot detect sound level differences (increases or decreases) of 1 dB in a given noise environment. Although differences of 2 or 3 dB can be detected under ideal laboratory conditions, such changes are difficult to discern in an active outdoor noise environment. A 5-dB change in a given noise source would likely be perceived by most people under normal listening conditions.

When addressing the effects of noise on people, it is necessary to consider the "frequency response" of the human ear, or those frequencies that people hear best. For this reason, sound-measuring instruments are often programmed to "weight" sounds based on the way people hear. The frequency-weighting most often used to evaluate environmental noise is A-weighting, and measurements using this system are reported in "A-weighted decibels" or dBA. All sound levels discussed in this evaluation are reported in A-weighted decibels.

As mentioned above, the decibel scale used to describe noise is logarithmic. On this scale, a doubling of sound-generating activity (i.e., a doubling of the sound energy) causes a 3-dBA increase in average sound produced by that source, not a doubling of the loudness of the sound (which requires a 10-dBA increase). For example, if traffic along a road is causing a 60-dBA sound level at some nearby location, twice as much traffic on this same road would cause the sound level at this same location to increase to 63 dBA. Such an increase might not be discernible in a complex acoustical environment.

Relatively long, multi-source "line" sources such as roads emit cylindrical sound waves. Due to the cylindrical spreading of these sound waves, sound levels from such sources decrease with each doubling of distance from the source at a rate of 3 dBA. Sound waves from discrete events or stationary "point" sources spread as a sphere, and sound levels from such sources decrease 6 dBA per doubling of the distance from the source. Conversely, moving half the distance closer to a source increases sound levels by 3 dBA and 6 dBA for line and point sources, respectively.

For a given noise source, a number of factors affect the sound transmission from the source, which in turn affects the potential noise impact. Important factors include distance from the source, frequency of the sound, absorbency and roughness of the intervening ground surface, the presence or absence of obstructions and their absorbency or reflectivity, and the duration of the sound. The degree of impact on humans also depends on existing sound levels, and who is listening. Typical sound levels of some familiar noise sources and activities are presented in Table 5.

Federal regulatory agencies often use the equivalent sound level (L_{eq}) to characterize sound levels and to evaluate noise impacts. The L_{eq} is the level that if held constant over the same period of time would have the same sound energy as the actual, fluctuating sound. As such, the L_{eq} can be considered an energy-average sound level. But this metric should not be confused with an arithmetic average which tends to de-emphasize high and low values, because the L_{eq} gives most weight to the highest sound levels as they contain the most sound energy.

In discussing sound level measurements and predictions, it is important to identify the time period being considered, because most sound-energy criteria and regulations address sound levels over some time period. In this way, noise criteria address both the intensity and the duration of sounds. Equivalent sound levels discussed in this analysis are for a one-hour period ($L_{eq(1)}$) during midday or peak period traffic.

Table 5. Common Sound Levels and Sources

Thresholds/ Noise Sources	Sound Level (in dBA)	Subjective Evaluations [a]	Possible Effects on Humans [a]
Human Threshold of Pain Carrier jet takeoff at 50 ft	140	Deafening	Continuous exposure to levels above 70 can cause hearing loss in majority of population
Siren at 100 ft Loud rock band	130		
Jet takeoff at 200 ft Auto horn at 3 ft	120		
Chain saw Noisy snowmobile	110		
Lawn mower at 3 ft Noisy motorcycle at 50 ft	100	Very Loud	
Heavy truck at 50 ft	90		
Pneumatic drill at 50 ft Busy urban street, daytime	80	Loud	
Normal automobile at 50 mph Vacuum cleaner at 3 ft	70		Speech Interference
Air conditioning unit at 20 ft Conversation at 3 ft	60	Moderate	
Quiet residential area Light auto traffic at 100 ft	50		Sleep Interference
Library Quiet home	40	Faint	
Soft whisper at 15 ft	30		
Slight rustling of leaves	20	Very Faint	
Broadcasting Studio	10		
Threshold of Human Hearing	0		

[a] Note that both the subjective evaluations and the physiological responses are continuums without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.

Source: EPA 1974 and Others

Noise Regulations and Impact Criteria

Snohomish County Noise Code

The Snohomish County noise code is pertinent as a reference for a portion of the review of potential environmental noise impacts and mitigation measures. Snohomish County establishes limits for environmental noise in Chapter 10.01 of the Snohomish County Code (SCC). These limits are expressed in terms of "maximum permissible environmental noise levels" for sounds crossing property boundaries based on the "district" of the sound source and the receiving properties. The districts are defined based on the property zoning, and the districts include rural, residential, commercial, and industrial zones. The Snohomish County noise limits are shown in Table 6.

Table 6. Snohomish County Maximum Permissible Sound Levels (in dBA)

District of Noise Source	District of Noise Receiver			
	Rural Day/Night [(a)]	Residential Day/Night [(a)]	Commercial	Industrial
Rural	49/39	52/42	55	57
Residential	52/42	55/45	57	60
Commercial	55/45	57/47	60	65
Industrial	57/47	60/50	65	70

[(a)] Between 10 p.m. and 7 a.m. on weekdays and between the hours of 10 p.m. and 9 a.m. on weekends, noise limits are reduced by 10 dBA for receiving properties within rural and residential districts.

Source: Snohomish County Code 10.01.030

The Snohomish County noise code allows noise limits to be exceeded for certain periods of time during any one hour without violating the limits (SCC Chapter 10.01.030(3)(a)). The allowed short-term increases are as follows: 5 dBA for no more than 15 minutes in any hour, or 10 dBA for no more than 5 minutes of any hour, or 15 dBA for no more than 1.5 minutes of any hour, up to a total of 15 minutes. These allowed increases can be described in terms of an interval percentile, or the percentage of time a certain level is exceeded. For example, L_{25} represents a sound level that is exceeded 25 percent of the time, or 15 minutes in an hour. Similarly, $L_{8.33}$ and $L_{2.5}$ are the sound levels that are exceeded 5 and 1.5 minutes in an hour, respectively. Although the Snohomish County noise code does not employ an hourly L_{eq} as the basis of the noise limits, it does apply the L_{eq} when addressing traffic noise (SCC Chapter 10.01.070(4)). The base "maximum permissible level," in conjunction with the allowed short-term increases described above, equate to an hourly L_{eq} about 2 dBA higher than the limits listed in Table 6.

Noise from the normal operation of traffic traveling on a public right-of-way is exempt from the Snohomish County environmental noise limits at all times (SCC Chapter 10.01.050(d)). These levels can nonetheless be used as a reference point for discussing the relative impacts of measured and predicted sound levels from traffic. Noise stemming from temporary construction activities are exempt from the County's noise limits during daytime hours (SCC Chapter

10.01.050(2)(a)). Daytime hours are defined as 7 a.m. to 10 p.m. on weekdays and 9 a.m. to 10 p.m. on weekends (SCC Chapter 10.01.020(5)). Any nighttime construction related to the proposed project would likely require a public disturbance exemption permit (SCC Chapter 10.01.040(5)).

Arterial Street Improvements

Under certain conditions, the Snohomish County noise rule requires the study of noise from arterial roadway improvement projects. These Snohomish County policies indicate the need for a noise analysis and an examination of possible mitigation options. In general, a residential district is considered impacted by an arterial street improvement when the existing or future expected noise levels reach or exceed 67 dBA, or when overall noise levels would increase by at least 10 dBA.

In deciding whether spending on noise mitigation measures related to arterial street improvements will be approved, the Snohomish County Council and County administrative agencies shall consider several factors, including whether reasonable noise mitigation measures are available, whether noise mitigation is cost-effective, whether the benefiting community would contribute to the cost or is in support of mitigation, and how the existing noise environment would compare to a mitigated noise environment.

FHWA/WSDOT Noise Impact and Mitigation Criteria

The Federal Highway Administration (FHWA) identified noise criteria and established procedures for evaluating road improvement projects in its Federal-Aid Highway Manual (U.S. Department of Transportation, 1982). These criteria and procedures are now codified in federal rules in 23 CFR 772. The FHWA defines a traffic noise impact as a measured or predicted traffic noise level "approaching or exceeding" the federal noise abatement criteria listed in Table 7, or a predicted traffic noise level that "substantially exceeds" an existing noise level. FHWA leaves the definition of "approaching" and "substantially exceeding" to the states.

The Washington State Department of Transportation (WSDOT) defines "approaching" the FHWA limits as sound levels within 1 dBA of a criterion level. WSDOT defines "substantially exceeding" existing noise levels as an increase of 10 dBA or more, if the calculated future sound level is greater than 50 dBA. WSDOT also defines a "severe" noise impact as a traffic noise level of 80 dBA L_{eq} or higher, or a predicted design year increase of 30 dBA or more over existing traffic noise levels.

Table 7. FHWA Roadway Noise Abatement Criteria (in dBA)

LAND USE CATEGORY		HOURLY Leq
(A)	Land on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.	57 dBA (exterior)
(B)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries and hospitals.	67 dBA (exterior)
(C)	Developed lands, properties, or activities not included in the above categories.	72 dBA (exterior)
(D)	Undeveloped lands	------
(E)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.	52 dBA (interior)

Source: Federal noise rules in 23 CFR 772

Affected Environment

Existing Terrain and Noise Environment

Between the US 2 Trestle and Cavalero Road, 20th Street SE is defined by a steep grade that rises to the east. Between Cavalero Road and 91st Avenue SE, the road is generally flat. The project area is composed of mostly residential properties and a few commercial properties. Residential density increases east of 83rd Avenue SE, north of the project. First row noise receivers are generally level with 20th Street SE, within 50 to 100 feet from the center of the roadway. Most of these noise receivers are accessed by driveways intersecting 20th Street SE.

Sound sources in the project area consist mostly of traffic noise, aircraft, and residential activity. Traffic noise, the dominant sound source, comes primarily from 20th Street SE. Several neighborhood streets adjacent to the project area and US 2 also contribute to traffic noise. However, these contributions are minimal compared to traffic noise from 20th Street SE.

Existing Sound Level Measurements

Sound level measurements (SLMs) were taken in March, May, and October 2007 to document the existing acoustical environment at locations potentially affected by the proposed project. All measurements were taken using Larson Davis 820 sound level meters. The SLM locations focused on existing residential and sensitive-use areas that would be affected by the proposed roadway expansion. Each measurement was taken at a location adjacent to the proposed project roadway, the dominant noise source in the area. Each short-term SLM lasted 15 minutes during which time visible traffic sources were counted and categorized, when possible.

In addition to short-term SLMs, a long term, 48-hour measurement was taken south of the roadway near the center of the project area to assess traffic noise trends and identify the loudest traffic hour for modeling purposes. SLM locations are summarized in Table 8, and are also depicted in Figures 12, 13, and 14.

Table 8. Existing Sound Level Measurements (in dBA)

Short-Term Sound Level Measurements			
Location	**Measured Time**	**Measured Date**	**Measured L_{eq}**
SLM1	11:30 AM	October 1, 2007	62.1 dBA
SLM2	2:15 PM	March 26, 2007	57.5 dBA
SLM3	7:15 AM	May 9, 2007	56.1 dBA
SLM4	8:00 AM	May 9, 2007	64.8 dBA
SLM5 [(a)]	3:45 PM	March 26, 2007	67.1 dBA
SLM6	9:30 AM	May 9, 2007	64.5 dBA
Long-Term Sound Level Measurements			
Location	**Measured Time and Date**	**Leq Range**	**Loudest Hour per Day**
LT-SLM	10:00 AM on May 8, 2007 to 10:00 AM on May 10, 0207	60.1 to 73.5 dBA	5-6 PM

Sound Level Measurement Description

Note: Traffic noise on 20th Street SE is the major source of noise at all SLMs.

SLM1 Measured at the front yard of 1833 74th Avenue SE, facing 20th Street SE, this measurement represents sound levels received by homes near the top of the hill on the western end of 20th Street SE.

SLM2 This measurement was taken from the front yard of 7622 20th Street SE, south of the roadway. This measurement represents itself, on land elevated and set back above the roadway.

SLM3 North of SLM2 and the project roadway, this measurement was located on the property of 7713 20th Street SE. This property is level to the existing roadway and the measurement here represents sound near the center of the project. Measured while morning commute traffic was primarily stop-and-go.

SLM4 Front yard of 1929 85th Drive SE. The entire home is level with 20th Street SE and has a clear view of the roadway.

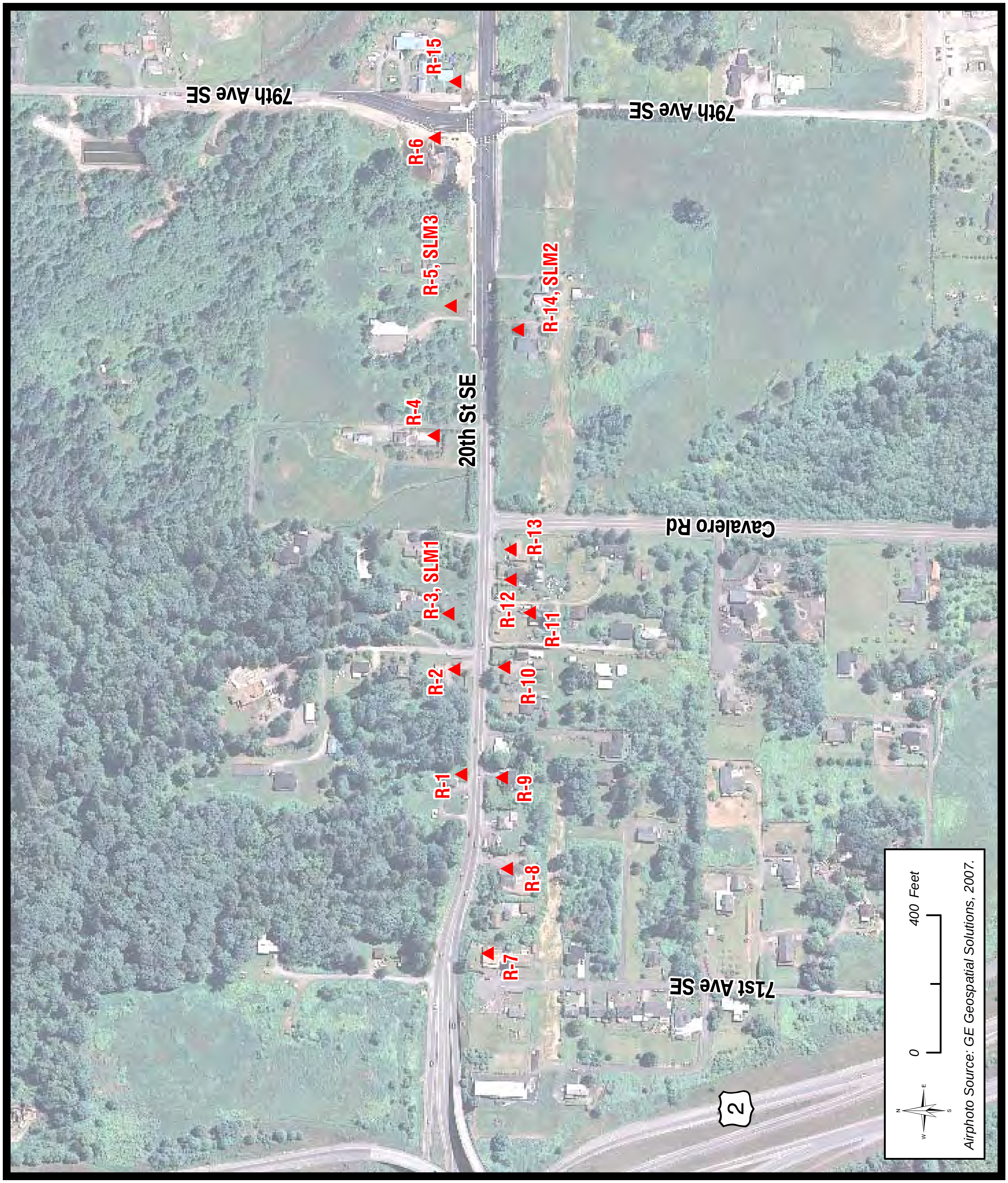
SLM5 Front yard of 8828 20th Avenue SE, south of the project roadway. This home is slightly elevated above the project roadway.

SLM6 Backyard of 8916 19th Place SE, north of the proposed road widening.

LT-SLM Measured near the center of the project, south of the roadway. The loudest traffic hour occurred during the afternoon traffic peak.

[(a)] Measured sound levels at this location exceeds the WSDOT 66-dBA noise abatement criteria

Source: Geomatrix Consultants, Inc. 2007

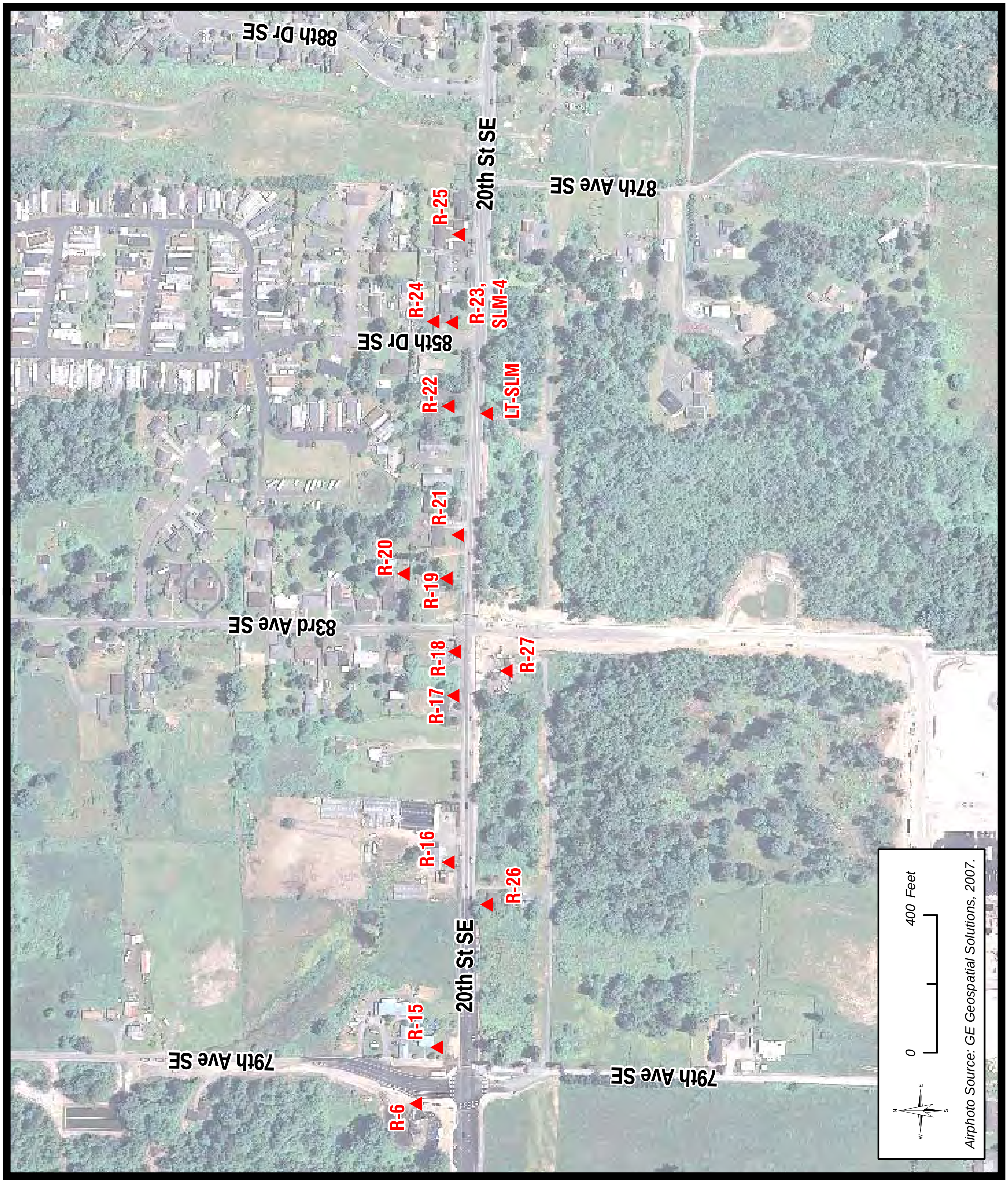


Key to Features:

▲ Receptor / SLM Location in Project Area

Figure 12: SLM and Noise Modeling Receptor Locations - Part 1 (West)

Snohomish County
Public Works

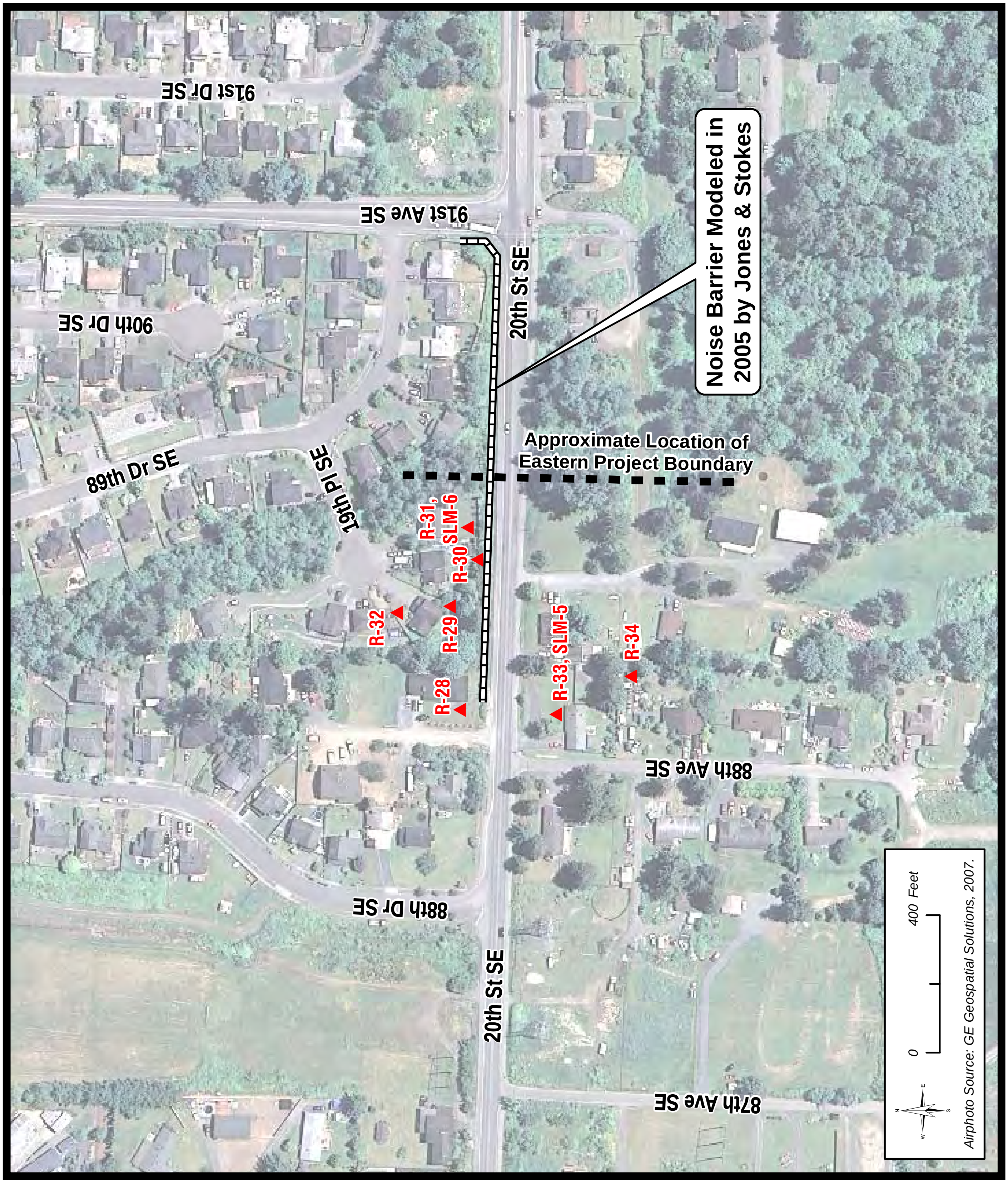


Key to Features:

▲ Receptor / SLM Location in Project Area

Figure 13: SLM and Noise Modeling Receptor Locations - Part 2 (Center)

Snohomish County
Public Works



Key to Features:

- ▲ Receptor / SLM Location in Project Area
- Noise Barrier Modeled in 2005 by Jones & Stokes

Figure 14: SLM and Noise Modeling Receptor Locations - Part 3 (East)

Snohomish County
Public Works

Impacts – Noise

Method of Analysis

Potential peak-hour traffic noise levels were calculated for traffic conditions under existing conditions (2006), the future No Action Alternative (2031), and the future Preferred Alternative (2031). Operational noise impacts were assessed by comparing modeled noise levels of existing and future years to the WSDOT 66-dBA noise abatement criteria. These calculations were performed using FHWA TNM version 2.5 software. This tool was used to calculate traffic noise levels at potentially affected receptors, and to examine the potential noise-reducing benefits of noise barriers. TNM considers traffic volumes, composition, travel speed, intervening terrain, ground types, and the presence or absence of obstructions like buildings or noise barriers to calculate hourly Leqs from traffic sources.

Sounds level are calculated by TNM at noise model receptor locations. Each receptor is representative of one or more residential noise receiver (i.e., usually an individual residence). Noise model receptors are representative of more than one receiver only when sound levels are not likely to be significantly different between each of the represented receivers. In many cases, the terms receptor and receiver are often used synonymously. However, for this study the distinction between the two terms provides a convenient way to summarize noise model results in terms of affected residences. The 34 modeled receptor locations, representing 49 residential noise receivers and one commercial property, are depicted in Figures 12, 13, and 14.

TNM's performance can be evaluated by comparing measured traffic noise levels with levels predicted by the model using traffic conditions observed during the measurements (including vehicle counts, classifications, estimated travel speeds, and all terrain and building features from the existing environment). Calculated and measured Leq sound levels agreed within ±2 dBA, indicating the model is accurately representing the project area near these receptors.

During Construction

Preferred Alternative

Construction equipment will cause temporary increases in sound levels. The increase in noise levels would depend on the type(s) of equipment being used and the amount of time it is in use. Excavation, grading, and construction would generate sounds audible on surrounding properties. Table 9 shows the typical range of noise levels for construction equipment that could be used during the expansion of 20th Street SE. Sounds from construction equipment and activities (usually point sources) decrease about 6 dBA for each doubling in distance from the source. Based on these levels, it is likely that most residences located near the construction areas would be temporarily impacted by construction noise.

Table 9. Typical Noise Levels from Construction Activities Equipment (in dBA)

Activity	Range of Hourly Leqs At 50'	At 100'	At 200'
Clearing	83	77	71
Grading	75-88	69-82	63-76
Paving	72-88	66-82	60-76
Types of Equipment	**Range of Noise Levels At 50'**	**At 100'**	**At 200'**
Bulldozer	77-96	71-90	65-84
Dump Truck	82-94	76-88	70-82
Scraper	80-93	74-87	68-81
Paver	86-88	80-82	74-76
Generators	71-82	65-76	59-70
Compressors	74-81	68-75	62-69
Source: EPA, 1971			

No Action Alternative

Under this alternative, the proposed project would not be built. No construction activities would occur and no noise impacts related to construction would be expected.

During Operation

Preferred Alternative

The proposed project would widen 20th Street SE, shifting traffic closer to nearby residences. However, because the morning HOV lane would likely encourage some commuters to ride-share, the Preferred Alternative would likely decrease the traffic volume on 20th Street SE compared to the No Action Alternative. In many instances, the decrease in traffic volume would offset increases in traffic noise levels caused by the widened road. Therefore, the resulting noise levels for the 2031 Preferred Alternative are similar, within ±2 dBA, to the No Action Alternative.

The model-calculated sound levels representing PM peak period hourly Leqs are shown in Table 10. Shaded cells denote values that comprise a noise impact under the WSDOT 66-dBA criterion level. Note that R-16 is a commercial property, subject to the WSDOT 71-dBA criterion level. In accordance with WSDOT policy, the primary focus of the noise impact analysis was exterior use areas near sensitive receiving locations (primarily homes) at ground-level locations.

Sound level impacts are expected at 21 of 34 receptor locations, representing 33 residential receivers (as stated, each noise model receptor location represents one or more residential noise receiver).

Table 10. TNM Calculated Peak-Hour Traffic Noise Levels (in dBA)

Project Alignment Study Area	TNM Receptor No.	Number of Residences Represented by TNM Receptor	2006 Existing	2031 No Action Peak-Hr Leq	2031 Preferred Alternative: Peak-Hour Leq	2031 Preferred Alternative: Change from Existing	2031 Preferred Alternative: Change from No Action
US 2 to 79th Ave SE	R-1	1	66	69	69	2.8	-0.5
	R-2	1	63	66	65	2.5	-0.7
	R-3	1	62	66	65	2.9	-0.5
	R-4	1	60	63	64	4.4	1.0
	R-5	1	63	66	66	3.5	0.1
	R-6	1	60	63	64	4.3	0.7
	R-7	2	60	64	64	3.9	0.7
	R-8	2	62	65	65	3.3	0.0
	R-9	2	64	67	67	3.1	-0.1
	R-10	2	64	68	68	3.5	0.2
	R-11	1	59	62	63	3.9	0.5
	R-12	1	66	69	69	2.9	-0.4
	R-13	1	66	69	69	3.1	-0.2
	R-14	2	64	67	67	2.7	-0.7
79th Ave SE to 88th Dr SE	R-15	1	65	68	68	3.0	-0.6
	R-16	1-commercial	64	68	67	2.6	-0.8
	R-17	1	68	71	71	3.4	0.0
	R-18	1	68	72	72	3.7	0.2
	R-19	1	64	68	67	3.1	-0.6
	R-20	1	55	59	61	5.1	1.5
	R-21	3	68	72	72	3.9	0.2
	R-22	3	63	67	67	3.9	0.2
	R-23	3	65	69	69	3.5	-0.3
	R-24	1	58	61	62	4.8	1.1
	R-25	2	66	70	69	3.4	-0.4
	R-26	1	69	72	72	3.3	0.0
	R-27	1	62	66	65	2.6	-0.8
88th Dr SE To 400 feet west of 91st Ave SE	R-28	1	65	68	68	3.7	0.0
	R-29	1	63	67	66	3.2	-0.6
	R-30	1	67	70	70	3.6	-0.1
	R-31	1	66	69	69	3.6	-0.2
	R-32	1	55	58	59	3.9	0.2
	R-33	3	67	70	70	3.7	0.1
	R-34	3	59	62	64	5.2	1.5

Note: Shaded cells represent receptors at which there are or would be noise impacts under WSDOT criteria.

Source: TNM modeling and tabulation by Geomatrix Consultants, Inc., 2007

When the East Everett residential housing development is built at the northwest corner of the Cavalero Road and 20th Street SE intersection, noise impacts may occur at residences of this development under the Preferred Alternative. The potential for impacts depends on the composition and orientation of residential buildings, their proximity to 20th Street SE, and the presence or absence of intervening structures or terrain.

No Action Alternative

By 2031, in the absence of the proposed project, expected growth would cause traffic volumes along 20th Street SE to roughly double over existing volumes. Such increases in volumes would result in a 3 dBA or more increase over existing traffic noise levels. With the No Action Alternative, noise impacts are predicted at 24 of the 34 modeled receptors, representing 36 residential noise receivers. Using WSDOT modeling guidance, the noise modeling assumed traffic would be traveling at the posted speed limit. For this reason, model-calculated peak-hour noise levels may be somewhat higher than would occur under expected No Action Alternative conditions. This would account for the likelihood of traffic congestion. When the East Everett residential housing development is built, traffic noise-related impacts may occur at future residences of this development. The potential for impacts depends on the composition and orientation of residential buildings, their proximity to 20th Street SE, and the presence or absence of intervening structures or terrain.

Because each receptor represents one or more sensitive receivers (usually residences), it is also possible to summarize these results in terms of the approximate number of residences that would be impacted by the 20th Street SE Improvement project. Table 11 summarizes the number of receivers that would be impacted by the No Action and Preferred alternatives under WSDOT criteria.

Table 11. Summary of Impacted Receptors and Receivers

Area of Project Alignment	Total Number of Receptors and Residential Receivers [a]	Total Number of Impacts [a]		
		Existing	No Action Alterative	Preferred Alternative
US 2 to 79th Ave SE	14 (19)	3 (3)	9 (12)	7 (10)
79th Ave SE to 88th Drive SE	13 (19)	5 (8)	10 (17)	9 (16)
88th Drive SE to 400 feet west of 91st Ave SE	7 (11)	3 (5)	5 (7)	5 (7)
Total Residential Units	*34 (49)*	*11 (16)*	*24 (36)*	*21 (33)*

[a] Receptors are presented outside of parentheses, residential receivers are presented inside parentheses. Receptor R-16 represents a commercial receiver and is not included in the total number of residential receivers.

Source: TNM modeling and tabulation by Geomatrix Consultants, Inc. 2007

Mitigation – Noise

During Construction

Preferred Alternative

Although construction noise is exempt from the County noise limits during daytime hours, noise from construction activities related to the proposed project could nonetheless disturb nearby residents. The potential for such disturbance could be reduced with the following practical and inexpensive noise mitigation techniques.

Construction noise could be minimized with properly sized and maintained mufflers, engine intake silencers, engine enclosures, and turning off equipment when not in use. Stationary construction equipment should be located away from sensitive receiving properties whenever possible. Where this is infeasible, or where noise impacts would still be likely to occur, portable noise barriers should be placed around the equipment with the opening directed away from the sensitive receiving property. These measures are especially effective for engines used in equipment such as pumps, compressors, and welding machines that operate continuously and contribute to high, steady background noise levels. The measures could provide an approximate 10-dBA reduction in equivalent sound levels.

Although back-up alarms used as safety warning devices are exempt from the County noise ordinance, these devices emit some of the most annoying sounds from a construction site. Where feasible, equipment operators should drive forward rather than backward to minimize this noise. Another very effective technique for reducing backup alarm noise would be to employ ambient-sensing alarms that test the noise environment and broadcast a sound loud enough to be heard, instead of using a pre-set (usually maximum) sound level. In addition, the use of broadband backup alarms instead of the typically employed pure tone alarms have been found to be very effective in reducing off-site annoyance due to these required warning devices. Noise from material handling can also be minimized by requiring operators to lift rather than drag materials whenever feasible. Substituting hydraulic or electric models for impact tools such as jack hammers, rock drills, and pavement breakers would also reduce construction noise.

The most important element in reducing construction noise impacts would be to restrict noisy work to daytime hours. Such a restriction is desirable because background noise would be more likely to mask construction noise during the day, and because most people are more sensitive to noises when they expect quiet and when they are trying to sleep.

No Action Alternative

With this alternative, no construction activities would occur that would result in construction-related noise impacts, so no mitigation would be required.

During Operation

Preferred Alternative

In most cases, the most effective form of mitigation for traffic noise is using noise barriers that are long enough and tall enough to block the line-of-sight from the receiver to the noise source. To be effective, barriers must be solid and continuous, without openings. For most residences adjacent to the project area where potential noise impacts have been identified, noise barriers are not feasible because they would require gaps for driveways intersecting 20th Street SE.

At the eastern end of the project area, between 88th Drive SE and 91st Avenue SE, one location was identified where a noise barrier could be feasible. The location of the barrier is depicted in Figure 14. A noise barrier at this location was evaluated previously in 2005 by the County's consultant, Jones and Stokes, as part of another 20th Street improvement project east of the current project. The environmental document and supporting technical report concluded that a noise barrier at this location would be feasible as per WSDOT and Snohomish County criteria but would not meet Snohomish County's *reasonableness* criteria. The County's conclusion was based on the following:

- future sound levels would exceed the County's 67-dBA arterial improvement noise criteria with or without the proposed project;
- the increase of the proposed project sound levels over a No Action scenario would be less than 1 dBA; and
- the cost of a noise barrier would exceed the benefit provided to the affected receivers (note that cost-effectiveness criteria established by the County are not included in the County Code)

Because Snohomish County concluded in 2005 that a barrier at this location would be feasible but not cost-effective, a re-evaluation as per Snohomish County policy was not warranted. As requested by Snohomish County, a mitigation analysis was completed as per WSDOT policy and procedures. This analysis is described in the Noise Technical Memorandum. **Any further discussions regarding mitigation will be resolved using only Snohomish County criteria.**

No Action Alternative

With the No Action Alternative, the proposed widening and other improvements to 20th Street SE would not occur and it would continue serving traffic in its current form. Noise modeling for this alternative likely overstates predicted noise levels because expected traffic congestion with a No Action alternative would likely decrease traffic speed and reduce the potential for noise impacts. Therefore, noise mitigation is not warranted.

Significant Unavoidable Adverse Impacts

Many noise sensitive receivers in the project area would, by the project design year of 2031, suffer unavoidable noise impacts due to traffic noise. These impacts would occur with or without the proposed project. Noise mitigation using noise barriers is not feasible at most potentially affected locations due to the many driveways accessing 20th Street SE. At locations where mitigation is feasible, barriers would not be cost-effective per Snohomish County criteria. Therefore, most first row homes along the project alignment are likely to suffer noise impacts with the proposed project.