# TRAFFIC NOISE ANALYSIS TECHNICAL REPORT

***SR 167 – 8th Street E Vic. to S 277th Street Vic.***
***Southbound HOT Lane***

***SR 167 – 8th Street E Vic. to 15th Street SW Vic.***
***Northbound HOT Lane***

***August 2008***

***Prepared for:***

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ANSI | American National Standards Institute |
| CAD | computer aided drafting |
| CFR | Code of Federal Regulations |
| dB | decibel |
| dBA | A-weighted decibel |
| EPA | U.S. Environmental Protection Agency |
| FHWA | Federal Highway Administration |
| FTA | Federal Transit Administration |
| HOT | high-occupancy toll |
| HOV | high-occupancy vehicle |
| Hz | hertz |
| $L_{eq}$ | equivalent sound level |
| MP | milepost |
| NAC | noise abatement criteria |
| NEPA | National Environmental Policy Act |
| NIST | National Institute of Standards and Testing |
| OSHA | Occupational Safety and Health Administration |
| SEPA | State Environmental Policy Act |
| SR | State Route |
| TNM | Traffic Noise Model |
| USDOT | U.S. Department of Transportation |
| WAC | Washington Administrative Code |
| WSDOT | Washington State Department of Transportation |

## EXECUTIVE SUMMARY

### What is the proposed project and why is it needed?

The Washington State Department of Transportation (WSDOT) plans to widen the State Route (SR) 167 roadway to construct a new southbound high-occupancy toll (HOT) lane from the vicinity of 8th Street E (MP 10.2) in Pierce County, Washington to the vicinity of S 277th Street in Kent (MP 18.24), King County, Washington. The construction of the HOT lane will require widening of the southbound bridge at the SR 18 interchange. Ramp meters will be installed at southbound on-ramps at the SR 167 interchanges with 15th Street SW, Ellingson Road, and 8th Street E. In addition, new signals will be installed at the SR 167 southbound ramp terminals with Ellingson Road and 8th Street E. SR 167 is an important thoroughfare for cars, trucks, and transit in the Green River Valley. This additional capacity will relieve congestion and improve safety for commuters traveling southbound on SR 167.

WSDOT's SR 167 Corridor Plan includes adding a HOT lane for northbound SR 167 through this same project area (8th Street E to 15th Street SW) in the future. This northbound widening phase is currently unfunded. For the purposes of planning for noise walls the traffic model forecasts for 2030 traffic and associated noise has assumed that this northbound HOT lane has been constructed. This approach will ensure that any noise mitigation will be sufficient to accommodate both projects.

## How will the project affect noise levels?

Our noise analysis revealed that 29 residences currently meet or exceed WSDOT's noise abatement criteria (NAC) for noise of 66 dBA Leq (equivalent sound pressure level in A-weighted decibels). Under the No Build Alternative[1], the number of residential impacts is projected to increase to 31 residences in 2030 due to a slight increase of 1 dBA in area noise levels.

Under the 2030 Build Alternative, an estimated 71 residences are expected to exceed the NAC by the year 2030 without mitigation.

Analysts examined noise mitigation for all areas that will meet or exceed the NAC. With the new noise wall proposed in this report, 35 residential effects will be mitigated, leaving an estimated 37 residual residential noise effects under the Build Alternative. The proposed noise wall will vary in height from 7 to 12 feet with an average height of 10.85 feet. The approximate 4,340-foot-long wall will begin near 6th Avenue N, and continue along the shoulder of SR 167 to the vicinity of 5th Avenue S. Because it will not meet the WSDOT reasonableness and feasibility criteria, a noise wall is not proposed on the 1st Avenue overpass.

Overall, with the proposed noise wall, future noise levels between 6th Avenue N and 5th Avenue S will be 2 to 7 dBA lower than the current noise levels, 3 to 7 dBA lower than future No Build conditions, and 4 to 8 dBA lower than future Build conditions without the noise wall. The cost of the noise wall will be approximately $179,000 below the maximum allowable cost based on the WSDOT reasonableness criteria.

Unavoidable or residual noise impacts are expected on both sides of SR 167 where the noise abatement measures examined could not meet the WSDOT feasibility and reasonability requirements. No noise abatement is recommended at these locations. Exhibit 1 summarizes the locations that are predicted to exceed the NAC, and provides their existing, future No Build, and future Build noise levels for peak-hour traffic noise conditions.

[1] No Build Alternative assumed no HOV/HOT lane will be built by 2030.

**Exhibit 1**
**Residual Noise Effects Comparison**

| Receiver[1] | Land Use[2] | Noise Levels in dBA $L_{eq}$ | | | Change in Noise Levels | | Build Effects[3] |
|---|---|---|---|---|---|---|---|
| | | Existing | Future No Build | Future Build | Build over Existing | Build over No Build | |
| R1 | Res | **71** | **71** | **72** | 1 | 1 | 1 |
| R2 | Res | **71** | **72** | **73** | 2 | 1 | 2 |
| R3 | Res | **66** | **66** | **68** | 2 | 2 | 3 |
| R4 | Res | **71** | **72** | **72** | 1 | 0 | 2 |
| R5 | Res | **71** | **72** | **72** | 1 | 0 | 1 |
| R6 | Res | 63 | 63 | **66** | 3 | 3 | 5 |
| R25 | Res | **66** | **66** | **67** | 1 | 1 | 3 |
| R26 | Res | 65 | 65 | **66** | 1 | 1 | 3 |
| R27 | Res | 65 | 65 | **66** | 1 | 1 | 2 |
| R33 | Res | 65 | 65 | 66 | 1 | 1 | 1 |
| R34 | Res | 64 | 65 | 66 | 2 | 1 | 7 |
| R35 | Res | 65 | 65 | 66 | 1 | 1 | 6 |

Notes:

1. Residential receiver locations (e.g., R1) are shown on Exhibit 9.
2. Land Use: Res=residential
3. Number of dwellings expected to have noise levels that exceed NAC
4. Modeled noise levels from TNM version 2.5, numbers in **Bold-Red** meet or exceed the NAC.

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# CHAPTER 1 INTRODUCTION

## What is the proposed project and why is it needed?

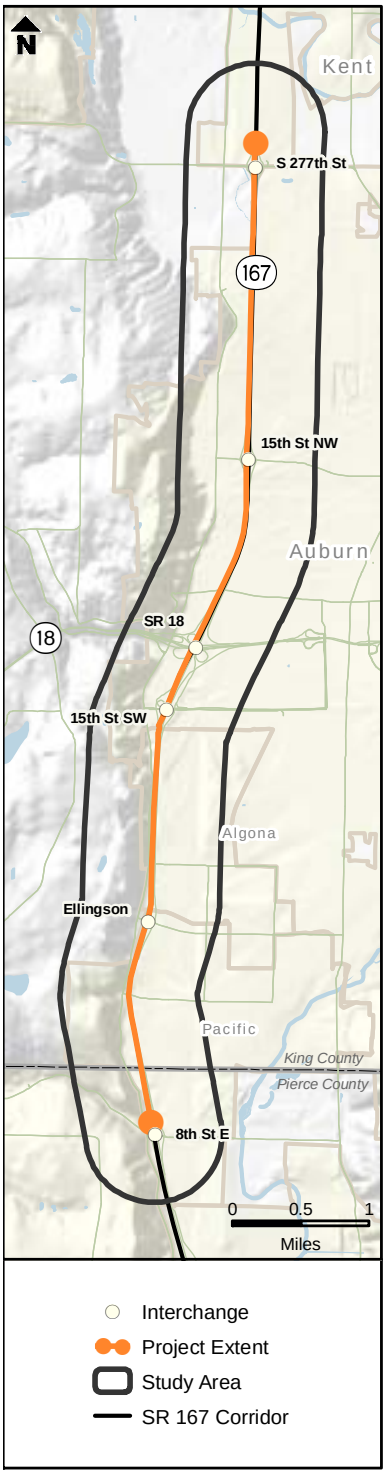
The Washington State Department of Transportation (WSDOT) plans to widen the State Route (SR) 167 roadway to construct a new southbound high-occupancy toll (HOT) lane from the vicinity of 8th Street E (MP 10.2) in Pierce County, Washington to the vicinity of S 277th Street in Kent (MP 18.24), King County, Washington (Exhibit 2). This new HOT lane will be a continuation of a southbound HOT lane that was constructed for the HOT Lane Pilot Project, which extends from the I-405 interchange in Renton to S 277th Street in Kent.

> High Occupancy Toll (HOT) lanes are managed lanes intended to increase mobility by allowing more vehicle use of the HOV lane. HOT lanes maintain free, priority status for transit and carpools, the same as a HOV lane, but also allow single occupancy vehicles to pay a toll to use the lane. Toll rates are variable, depending upon the level of congestion.

The construction of the HOT lane will require widening the roadway to the outside of the existing pavement between 6th Avenue N in Algona and 5th Avenue S in Pacific. In addition, it will require widening the southbound bridge at the SR 18 interchange. Ramp meters will be installed at southbound on-ramps at the SR 167 interchanges with 15th Street SW, Ellingson Road, and 8th Street E. In addition, new signals will be installed at the SR 167 southbound ramp terminals with Ellingson Road and 8th Street E. All of the proposed widening work will occur within the WSDOT right-of-way, with the exception of the stormwater site. The stormwater site will be purchased at the northwest quadrant of the SR 167 / SR 18 interchange area.

SR 167 is an important thoroughfare for cars, trucks, and transit in the Green River Valley. The additional capacity that this project will provide to SR 167 will relieve congestion and improve safety for commuters traveling southbound. This project, combined with other planned SR 167 projects, could make the highway a viable alternative to I-5.

**Exhibit 2**
**Vicinity Map**



## What is the purpose of this noise report?

This noise analysis was prepared at the request of the Washington State Department of Transportation (WSDOT). A traffic noise study is required whenever a roadway or highway improvement project adds a new highway or additional travel lane, or substantially changes the horizontal or vertical alignment of an existing highway.

Analysts produced this noise technical report as part of the SR 167 - 8th Street E Vic. to S 277th Street Vic. Southbound HOT Lane project environmental analysis.

## Why were two HOT lane projects analyzed in this report?

Because future plans include an additional HOT lane in both directions, the traffic noise analysis was performed assuming that both the SR 167 - 8th Street E Vicinity to S 277th Street Southbound HOT Lane and SR 167 - 8th Street E Vicinity to 15th Street SW Northbound HOT Lane highway improvement projects will be completed. This effort will assure that any noise mitigation will be sufficient to accommodate both projects.

## What are the two HOT lane projects analyzed in this report?

*SR 167 - 8th Street E to S 277th Street Southbound HOT Lane (Construction Funding 2010/2012)*

(This project is described on the previous page.)

*SR 167 - 8th Street E to 15th Street SW Northbound HOT Lane (Environmental/Design Funding 2008)*

This project will add a third lane in the northbound direction of SR 167 to extend the HOV/HOT lane for approximately three miles from the vicinity of 8th Street E (MP 10.68) to the vicinity of 15th Street SW (MP 13.85). In addition to extending the lane, this project will add a ramp meter to each of the northbound on-ramps at Ellingson Road and 8th Street E interchanges within the project limits.

## What regulatory requirements are associated with this analysis?

Analysts prepared this report as required by WSDOT and the Federal Highway Administration (FHWA). The methodology used is defined in *WSDOT's Traffic Noise Analysis and Abatement Policy and Procedures Manual,* March 2006, and the United States Department of Transportation (USDOT) Federal Highway Traffic Noise Standards (Title 23 of the Code of Federal Regulations (CFR) Part 722, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*). A complete description is provided of the procedures and methodology used in the analysis in the Methodology section in Chapter 2. A bibliography of the technical support documents used for this report is in Appendix A.

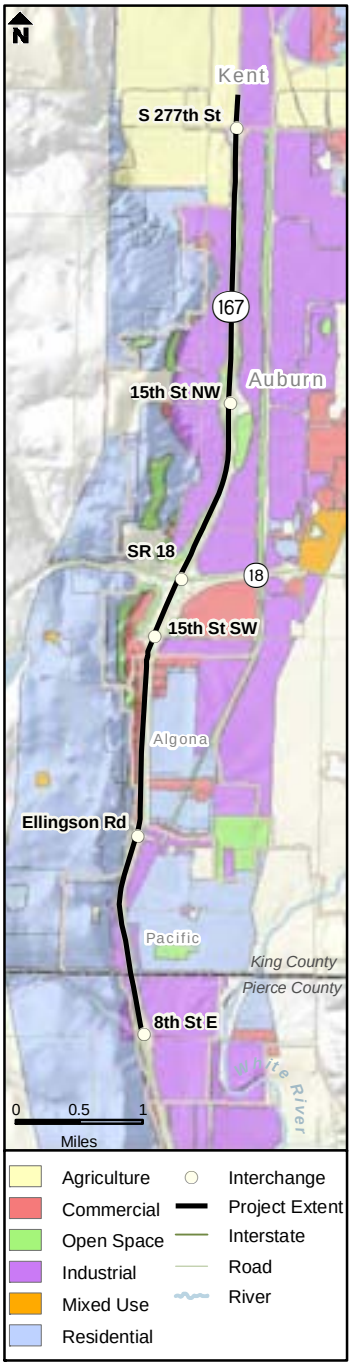
## What agencies and jurisdictions were involved?

The project study area is the area 500 feet from the pavement edge within the project boundaries. The City of Algona is a jurisdiction with residential land use within the project study area for the noise analysis. The City of Algona was contacted to determine if any permitted residential developments were planned in the project area. No permitted noise sensitive developments are planned in the project study area at this time. The City of Pacific has some residential projects in the southeast quadrant of the project and was contacted to determine the status of residential permits on the Beaver Meadows development. This project is analyzed in this report.

## What types of land uses occur within the project area?

Exhibit 3 illustrates the general zoning and land use categories in the project area, specifically, the land use includes areas of industrial, open space, commercial, and residential. Field investigations confirmed this general pattern, with current existing conditions of undeveloped parcels located within the project area along with agriculture use near S 277th Street. Along the east side of SR 167, north of Boundary Boulevard, land use is either undeveloped or commercial. Between 9th Avenue N and 11th Avenue N, land use is primarily residential, with some commercial use between 8th Avenue and 9th Avenue N. Between 8th Avenue N and 4th Avenue N, land use is a mixture of residential, commercial, and undeveloped. South of 4th Avenue N to 5th Avenue NW, land use is all single-family residential. South of 5th Avenue NW, land use is entirely commercial.

**Exhibit 3**
**Land Use**



On the west side of SR 167, land use is primarily commercial and undeveloped. Several single-family homes can be found west of the West Valley Highway S near 4th Avenue N. A few other noise sensitive properties occur near the Ellingson Road ramps.

South of 3rd Avenue SW and north of County Line Road the Beaver Meadows residential development is under construction with six duplex and 51 single family residences. The development is approximately 300 feet from the existing shoulder. Proposed lot locations are provided in the appendix. No other noise sensitive properties were identified in the study area.

# CHAPTER 2 EXISTING CONDITIONS

This section provides an introduction to acoustics and general information on traffic noise analysis methods. Federal and state traffic noise regulations along with Washington State construction noise regulations are also included.

## How is noise quantified and what are some typical noise levels?

Human response to sound is subjective and can vary greatly from person to person. Factors that can influence an individuals' response include:

- Loudness
- Frequency
- The amount of background noise present
- The nature of the work or activity (e.g., sleeping) that the sound affects

When sounds become unpleasant or undesirable, people tend to classify them as noise.

Traffic noise is measured in decibels (dB), a unit of measure calculated as ten times the base 10 logarithm of sound pressure, divided by the reference sound pressure of 20 micro-Pascals. In general, the dB scale is a logarithmic conversion of absolute air pressure to units that are more convenient and easier to understand.

To better approximate the sensitivity of the human ear to sounds of different frequencies, the A-weighted decibel scale was developed. The human ear is less sensitive to higher and lower frequencies; thus, the A-weighted scale, expressed as dBA, reduces the sound level contributions of these frequencies.

As an example, a 10-dBA increase in noise levels is judged by most people as a doubling of sound level. The smallest change in noise level that a human ear can perceive is about 3 dBA, and increases of 5 dBA or more are clearly noticeable. Normal conversation ranges between 44 and 65 dBA when speakers are 3 to 6 feet apart. Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. In contrast, noise levels during the day in an urban area can be frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable and then painful, while levels higher than 80 dBA over continuous periods can result in hearing loss.

Exhibit 4 provides a scale of several different noise sources and typical subjective impressions.

All noise levels referred to in this report are expressed in terms of the A-weighted scale (dBA). The A-weighted scale is used in most ordinances and standards, including the applicable standards for this project.

To account for the time-varying nature of noise, several noise metrics are useful. We define the equivalent sound pressure level ($L_{eq}$) as the average noise level, on an energy basis, for a stated time period (for example, hourly). The $L_{eq}$ is the preferred noise level descriptor for traffic noise analysis and was used for this report. When conducting ambient noise level measurements for traffic noise studies, the Federal Highway Administration (FHWA) and the Washington State Department of Transportation (WSDOT) approve a 15 minute sampling period to quantify the ambient hourly $L_{eq}$.

**Exhibit 4**
**Sound Levels and Relative Loudness of Typical Noise Sources**

| Noise Source or Activity | Sound Level (dBA) | Subjective Impression | Relative Loudness (human judgment of different sound levels) |
|---|---|---|---|
| Jet aircraft takeoff from carrier (50 ft) | 140 | Threshold of pain | 64 times as loud |
| 50-hp siren (100 ft) | 130 | | 32 times as loud |
| Loud rock concert near stage, Jet takeoff (200 ft) | 120 | Uncomfortably loud | 16 times as loud |
| Float plane takeoff (100 ft) | 110 | | 8 times as loud |
| Jet takeoff (2,000 ft) | 100 | Very loud | 4 times as loud |
| Heavy truck or motorcycle (25 ft) | 90 | | 2 times as loud |
| Garbage disposal, food blender (2 ft), Pneumatic drill (50 ft) | 80 | Moderately loud | Reference loudness |
| Vacuum cleaner (10 ft), Passenger car at 65 mph (25 ft) | 70 | | 1/2 as loud |
| Large store air-conditioning unit (20 ft) | 60 | | 1/4 as loud |
| Light auto traffic (100 ft) | 50 | Quiet | 1/8 as loud |
| Bedroom or quiet living room, Bird calls | 40 | | 1/16 as loud |
| Quiet library, soft whisper (15 ft) | 30 | Very quiet | |
| High quality recording studio | 20 | | |
| Acoustic Test Chamber | 10 | Just audible | |
| | 0 | Threshold of hearing | |

*Sources: Beranek (1988) and EPA (1971).*

## What methods were used in the analysis?

The following terminology will be useful toward understanding the methods we used in this analysis:

1. **Monitoring Location:** A residence or structure where noise monitoring was performed. A total of ten noise monitoring locations were included in this analysis.
2. **Modeling Location:** A residence or structure, or group of residences or structures, where the noise levels were projected using the FHWA noise level prediction model (Traffic Noise Model version 2.5 – TNM 2.5). A total of 36 noise modeling locations were included in this analysis.
3. **Receiver Location:** Any residence or noise sensitive structure (or group of residences or structures) located within the project area.

4. **Impacted Receiver:** Any residence or noise sensitive structure (or group of residences or structures) that approaches or exceeds the noise impact NAC.

5. **Benefited Receiver:** A receiver that receives at least a 3 dBA benefit from noise mitigation measures. For example, one resident (receiver) is measured to be at 64 dBA with the project, which is not considered an effect. However, if a noise wall must be installed for other receivers, which will be affected, and the noise levels experienced by the first receiver are decreased by 3 dBA or more, that receiver will be considered "benefited" by the mitigation measure and will be included in the feasible and reasonableness calculations.

Projected traffic noise level conditions were calculated using the FHWA Traffic Noise model (TNM version 2.5). Input to the model included existing and future traffic volumes, as well as mixtures (percentage of cars, medium trucks, and heavy trucks) and speeds generated by project traffic engineers. A complete listing of the traffic data is provided in Appendix B. Noise emission levels used in the model were nationwide averages for automobiles, medium trucks, and heavy trucks. The noise-reducing effects of front-row[2] residences, roadway depressions, and topography were included in the calculations, where appropriate. The TNM computer model outputs are in the Appendix C-CD ROM.

*Traffic Noise Impact Criteria*

The traffic noise impact criteria, against which the project traffic noise levels were evaluated, were taken from Title 23 of the *Code of Federal Regulations* (CFR*) Part 772*, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*. The range of criteria for reaching a potential abatement for the different land uses are illustrated in Exhibit 5. The criteria applicable for residences, churches, schools, recreational uses, and similar areas are an exterior hourly $L_{eq}$ that approaches or exceeds 67 dBA. The criterion applicable for other developed lands, such as commercial and industrial uses, is an exterior $L_{eq}$ that approaches or exceeds 72 dBA. No criteria exist for undeveloped lands.

[2] For the purpose of this report, "front-row" refers to noise sensitive receivers located directly adjacent to the project roadway.

**Exhibit 5**
**FHWA Roadway Noise Abatement Criteria**

| Land Use Category | Hourly $L_{eq}$ (dBA) |
|---|---|
| **Type A:** Lands 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 (exterior) |
| **Type B:** Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, (exterior) motels, hotels, schools, churches, libraries and hospitals. | 67 (exterior) |
| **Type C:** Developed lands, properties or activities not included in the above categories. | 72 (exterior) |
| **Type D:** Undeveloped land. | |
| **Type E:** Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums. | 52 (interior) |

*Source: Title 23 of CFR Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise*

### *State Noise Regulations*

The traffic noise criteria for WSDOT is outlined in the *Traffic Noise Analysis and Abatement Policy and Procedures Manual*, Revised 2006. WSDOT considers a traffic noise impact to occur when predicted project-related noise levels approach the criteria level within 1 dBA, or substantially exceed existing levels. Therefore, residential impacts occur at 66 dBA, and commercial impacts at 71 dBA. WSDOT also considers a 10 dBA increase over the existing noise levels as a substantial increase.

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# CHAPTER 3 EXISTING NOISE ENVIRONMENT

The existing noise environment is composed primarily of traffic noise from SR 167 and other major arterial roads, such as 15th Street SW and Ellingson Road. Additional noise sources include commercial and industrial activities, ongoing minor construction activities, and other general noise sources, such as residential activities.

## How were noise levels in the project area monitored?

On-site noise monitoring was performed at nine locations along the project corridor. The noise measurement data was used to validate the noise prediction model and aid in establishing the existing noise environment. Equipment used for the noise measurements was a Larson Davis Model 820 sound level meter. The sound level meter meets or exceeds American National Standards Institute (ANSI) S1.4-1983 for Type 1 Sound Measurement Devices. All measurement procedures complied with ANSI S1.13-1971. System calibration was performed before and after each measurement session. The meter is calibrated by an accredited laboratory on an annual basis.

*Measured Noise Levels*

The noise monitoring was performed on Monday, April 24, 2006, between 1:00 pm and 4:00 pm with supplemental monitor readings taken on June 23, 2008 at approximately 9:30 am. These time periods were selected because weekday traffic is free-flowing and noise levels are highest. As traffic slows from congestion during the peak hours of 6:00 am to 8:00 am and again from 4:00 pm to 6:00 pm, noise levels are lower than when traffic is free flowing.

Measured noise levels ranged from 64 to 71 dBA $L_{eq}$. In general, front-row receivers (receivers directly adjacent to the project roadway) have existing noise levels of 69 to 71 dBA $L_{eq}$ during peak noise hours. Second line receivers (receivers behind the front-row receivers with some shielding) have noise levels of 64 dBA $L_{eq}$. Exhibit 6 provides a summary of the measured noise levels. The noise monitoring locations and the location of the new development are shown on Exhibit 7.

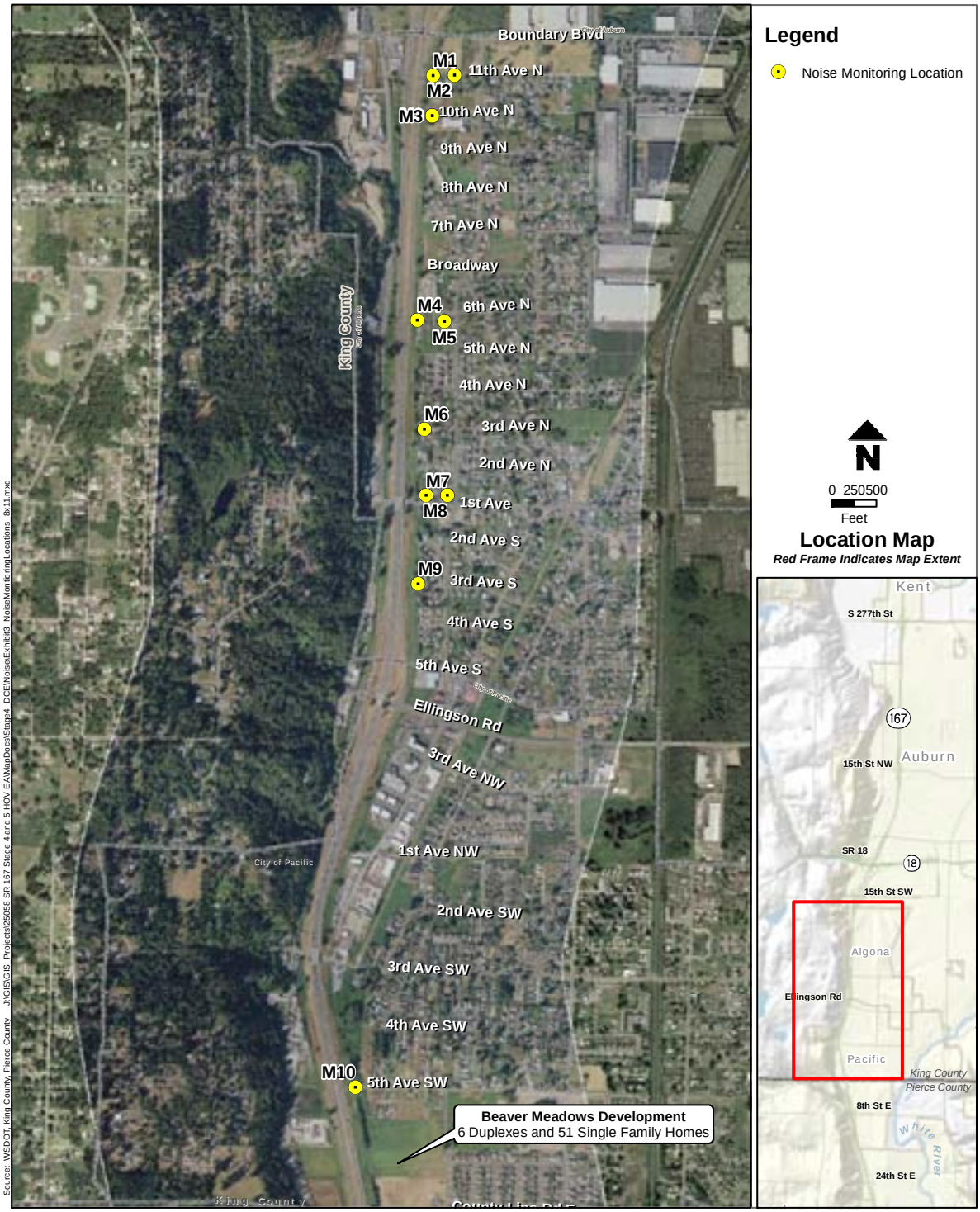
**Exhibit 6**
**Measured Noise Levels**

| Site #[1] | Address[2] | $L_{eq}$ dBA[3] | Notes[4] |
|---|---|---|---|
| M1 | 11th Avenue North | **71** | SFR Front Row Receiver |
| M2 | 11th Avenue North | 64 | SFR Second/Third Row Receiver |
| M3 | 10th Avenue North | **69** | SFR Front Row Receiver |
| M4 | 6th Avenue North | **70** | SFR Front Row Receiver |
| M5 | 6th Avenue North | 64 | SFR Second/Third Row Receiver |
| M6 | 3rd Avenue North | **69** | SFR Front Row Receiver |
| M7 | 1st Avenue North | **66** | MFR Front Row Receiver |
| M8 | 1st Avenue North | 64 | MFR Second/Third Row Receiver |
| M9 | 3rd Avenue South | 64 | SFR Front Row Receiver |
| M10 | 5th Avenue SW | **66** | Near SFR and new development |

**Notes:**

1. Monitoring Locations shown on Exhibits 7 and 8.
2. Address nearest to monitoring location.
3. Measures 1-hour $L_{eq}$ based on 15 minute reading with BOLD reading approach or exceed the NAC.
4. SFR = Single-family residence; MFR = Multi-family residence (apartments, condos, duplexes).

**Exhibit 7**
## Noise Monitoring Locations



## How were noise levels in the project area modeled?

Existing and future peak-hour noise levels were determined using the FHWA TNM version 2.5 computer noise model, as described in the Methods section of this report. Analysts conducted the modeling for 27 representative receiver locations. Each of the modeled representative receiver locations were used to represent a group of nearby structures that were expected to have the same noise levels. The following paragraphs provide details on noise model validation, along with existing and future noise levels with and without the project.

*Model Validation*

Prior to modeling existing and future peak-hour noise conditions, the nine, on-site measurement sites were modeled to ensure that the model accurately predicts actual conditions. Analysts used traffic volumes and speeds they observed during the noise monitoring as input parameters for the model. Exhibit 8 provides the results of the noise model validation.

The modeled and measured noise results agree within 2 dBA. Because a 2 dBA change in noise levels is barely perceptible to the average human ear, a modeling standard of +/- 2 dBA or less is considered acceptable for modeled and measured noise level deviations.

**Exhibit 8**
**Noise Model Validation Results**

| Site # | $L_{eq}$ (dBA) | | |
|---|---|---|---|
| | Measured[1] | Modeled[2] | Difference[3] |
| M1 | 71 | 70.8 | -0.2 |
| M2 | 64 | 64.7 | 0.7 |
| M3 | 69 | 70.8 | 1.8 |
| M4 | 70 | 70.3 | 0.3 |
| M5 | 64 | 64.3 | 0.3 |
| M6 | 69 | 68.1 | -0.9 |
| M7 | 66 | 65.0 | -1.0 |
| M8 | 64 | 62.7 | -1.3 |
| M9 | 64 | 65.5 | 1.5 |
| M10 | 66 | 64.9 | -1.1 |

Notes:
1. Measured noise levels from on-site measurements illustrated on Exhibit 7.
2. Modeled noise levels from TNM version 2.5 using traffic counts.
3. Modeled noise level minus measured noise level.

*Existing Peak–Hour Modeled Noise Levels*

Analysts modeled existing noise levels at 36 representative receivers along the project corridor. Exhibit 9 shows the noise modeling receivers.

The input parameters to the noise model included existing (year 2006) traffic data prepared by WSDOT (*Traffic Report, SR 167 8th Street E to S 277th Street Managed Lanes*, WSDOT, June 2007). The project traffic data are in Appendix B.

Overall, modeled existing noise levels along the corridor varied from 60 to 71 dBA $L_{eq}$ during the peak evening traffic hours. An estimated 29 residences along the project corridor have predicted noise levels that exceed the NAC of 66 dBA $L_{eq}$. Of the affected properties, 26 are located along the east side of SR 167, and three are located on the west side of SR 167. Exhibit 10 provides a list of representative receivers, number of dwellings represented by each receiver, land use at the receptor site, and existing conditions peak-hour noise level results.

**Exhibit 9**
## Noise Modeling Locations

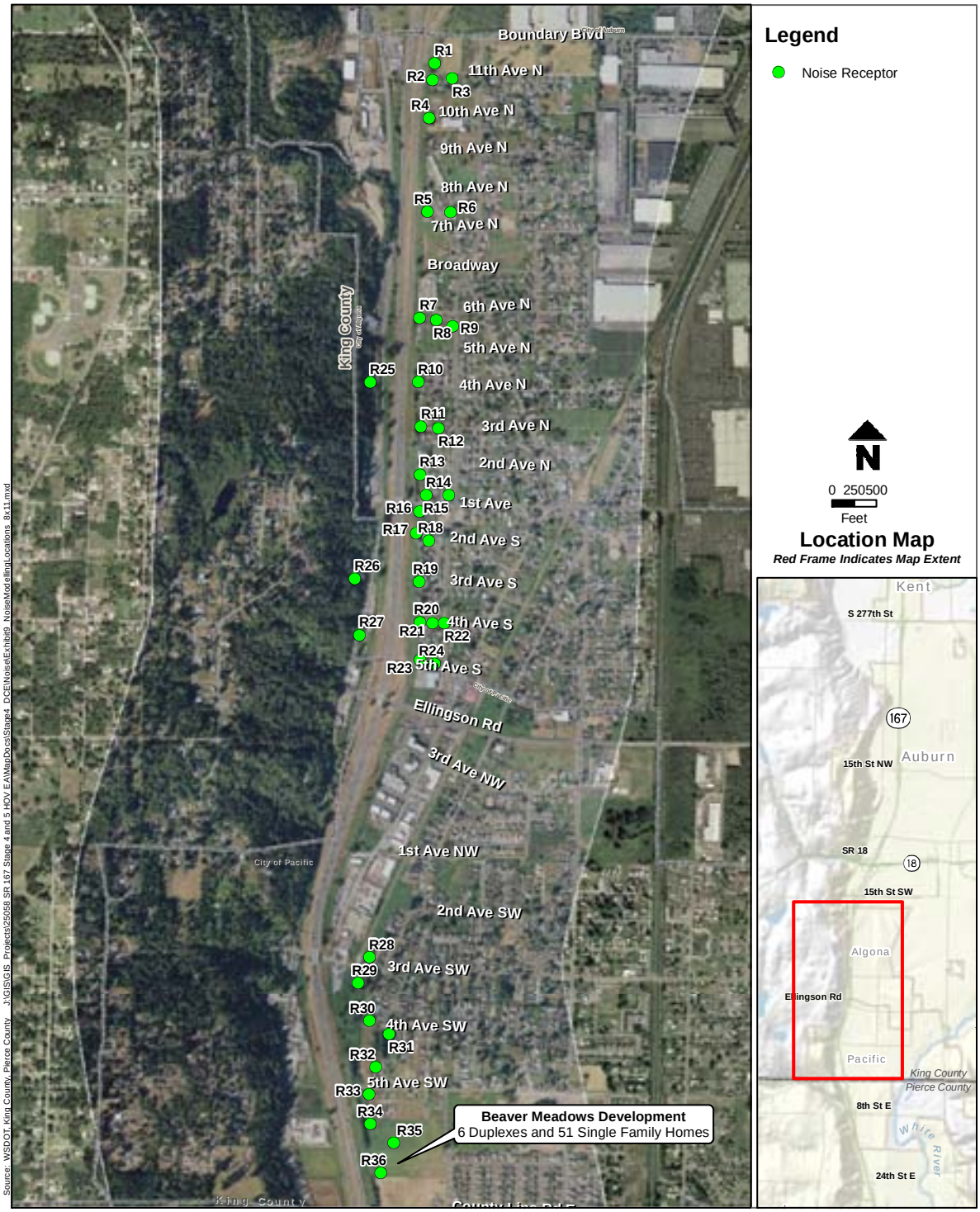


**Exhibit 10**
**Existing Modeled Noise Levels**

| Receiver[1] | Dwellings Represented[2] | Land Use[3] | Effects Criteria[4] | Existing Noise Level (dBA $L_{eq}$)[5] | Effects[6] |
|---|---|---|---|---|---|
| R1 | 1 | Res | 66 | 71 | 1 |
| R2 | 2 | Res | 66 | 71 | 2 |
| R3 | 3 | Res | 66 | 66 | 3 |
| R4 | 2 | Res | 66 | 71 | 2 |
| R5 | 1 | Res | 66 | 71 | 1 |
| R6 | 5 | Res | 66 | 64 | 0 |
| R7 | 2 | Res | 66 | 71 | 2 |
| R8 | 1 | Res | 66 | 67 | 1 |
| R9 | 4 | Res | 66 | 64 | 0 |
| R10 | 2 | Res | 66 | 69 | 2 |
| R11 | 3 | Res | 66 | 68 | 3 |
| R12 | 6 | Res | 66 | 63 | 0 |
| R13 | 3 | Res | 66 | 68 | 3 |
| R14 | 8 | Res | 66 | 64 | 0 |
| R15 | 10 | Res | 66 | 62 | 0 |
| R16 | 1 | Res | 66 | 68 | 1 |
| R17 | 2 | Res | 66 | 68 | 2 |
| R18 | 4 | Res | 66 | 65 | 0 |
| R19 | 3 | Res | 66 | 67 | 3 |
| R20 | 2 | Res | 66 | 65 | 0 |
| R21 | 6 | Res | 66 | 63 | 0 |
| R22 | 4 | Res | 66 | 62 | 0 |
| R23 | 2 | Res | 66 | 63 | 0 |
| R24 | 4 | Res | 66 | 61 | 0 |
| R25 | 3 | Res | 66 | **66** | 3 |
| R25 | 3 | Res | 66 | 65 | 0 |
| R27 | 2 | Res | 66 | 65 | 0 |
| R28 | 4 | Res | 66 | 61 | 0 |
| R29 | 1 | Res | 66 | 63 | 0 |
| R30 | 3 | Res | 66 | 62 | 0 |
| R31 | 2 | Res | 66 | 60 | 0 |
| R32 | 6 | Res | 66 | 61 | 0 |
| R33 | 1 | Res | 66 | 65 | 0 |
| R34 | 7 | Res | 66 | 64 | 0 |
| R35 | 6 | Res | 66 | 65 | 0 |
| R36 | 8 | Res | 66 | 62 | 0 |
| **Total** | | | | | **29** |

Notes:

1. Receiver locations shown on Exhibit 9.
2. Number of dwellings expected to have the same noise level as this receiver location based on acoustical properties and area topographical conditions.
3. Land Use: Res=residential; Sch=School; Ch=Church; Pk=Park/play area; Comm=commercial.
4. WSDOT Traffic Noise Criteria from Methodology section.
5. Modeled noise levels from TNM version 2.5, numbers in **Bold-Red** approach or exceed the NAC.
6. Number of structures or locations predicted to meet or exceed the NAC.

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# CHAPTER 4 POTENTIAL NOISE EFFECTS

Future noise levels were projected for the No Build and Build peak-hour traffic conditions. The future conditions analysis is based on traffic data for the year 2030. The 2030 traffic data for the No Build and Build alternatives are given in Appendix B. The following paragraphs provide the analyses for both the No Build and the Build alternatives.

## Will any effects result from the No Build Alternative?

Under the No Build alternative, there would be no change in the existing highway alignment, number of lanes, or profile, and the existing ramps and guard rails would remain in their current configuration.

Overall, noise levels along the corridor are projected to increase by 0 to 1 dBA and are predicted to range from 60 to 72 dBA $L_{eq}$ during the peak evening traffic hours. This is because traffic volumes are predicted to increase even without additional lanes.

An estimated 31 residences along the project corridor would exceed the WSDOT traffic noise criteria of 66 dBA $L_{eq}$. All but three of the affected properties occur on the east side of the highway.

## Will any effects result from the Build Alternative?

Noise levels for the future Build Alternative were modeled using TNM version 2.5. Input parameters to the Build Alternative model include the proposed SR 167 alignment with the North and South-bound HOT lane improvements and traffic data for the year 2030.

Under the Build Alternative with no mitigation, noise levels along the corridor are predicted to range from 61 to 73 dBA $L_{eq}$ during peak hours. The highest noise levels are expected for residences located directly adjacent to the project corridor. Noise levels increase by up to 3 dBA when compared to the existing conditions or the No Build Alternative.

A total of 71 projected residential properties will exceed the NAC of 66 dBA $L_{eq}$ prior to mitigation illustrated in Exhibit 10 in Chapter 3. There are 49 properties on the east side of SR 167 and eight properties on the west side. An additional 14 residences south of Ellingson Rd, including the six proposed duplexes, also approach or exceed the NAC. Exhibit 11 provides a detailed summary of the

predicted existing and future Build noise levels, a comparison of the Existing, 2030 No Build, and 2030 Build noise levels, and the number of noise effects predicted under each condition.

**Exhibit 11**

**Future No Build and Build Noise Levels without Mitigation**

**Comparison of existing conditions, number of potential noise impacts and corridor summary.**

| Receiver Information | | | Existing Conditions | | 2030 No Build Alternative | | | 2030 Build Alternative (Southbound + Northbound) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rec[1] | Homes[2] | Effects Criteria[3] | Noise Levels[4] | Effects[5] | Noise Levels[6] | Change[7] (over exist) | Effects[8] | Noise Levels[9] | Change[10] (over exist) | Effects[11] | Change[12] (over No-Bld) |
| R1 | 1 | 66 | 71 | 1 | 71 | 0 | 1 | 72 | 1 | 1 | 1 |
| R2 | 2 | 66 | 71 | 2 | 72 | 1 | 2 | 73 | 2 | 2 | 1 |
| R3 | 3 | 66 | 66 | 3 | 66 | 0 | 3 | 68 | 2 | 3 | 2 |
| R4 | 2 | 66 | 71 | 2 | 72 | 1 | 2 | 72 | 1 | 2 | 0 |
| R5 | 1 | 66 | 71 | 1 | 72 | 1 | 1 | 72 | 1 | 1 | 0 |
| R6 | 5 | 66 | 64 | 0 | 65 | 1 | 0 | 66 | 2 | 5 | 1 |
| R7 | 2 | 66 | 71 | 2 | 71 | 0 | 2 | 72 | 1 | 2 | 1 |
| R8 | 1 | 66 | 67 | 1 | 67 | 0 | 1 | 68 | 1 | 1 | 1 |
| R9 | 4 | 66 | 64 | 0 | 65 | 1 | 0 | 66 | 2 | 4 | 1 |
| R10 | 2 | 66 | 69 | 2 | 70 | 1 | 2 | 71 | 2 | 2 | 1 |
| R11 | 3 | 66 | 68 | 3 | 69 | 1 | 3 | 70 | 2 | 3 | 1 |
| R12 | 6 | 66 | 63 | 0 | 64 | 1 | 0 | 64 | 1 | 0 | 0 |
| R13 | 3 | 66 | 68 | 3 | 68 | 0 | 3 | 69 | 1 | 3 | 1 |
| R14 | 8 | 66 | 64 | 0 | 65 | 1 | 0 | 66 | 2 | 8 | 1 |
| R15 | 10 | 66 | 62 | 0 | 62 | 0 | 0 | 63 | 1 | | 1 |
| R16 | 1 | 66 | 68 | 1 | 68 | 0 | 1 | 69 | 1 | 1 | 1 |
| R17 | 2 | 66 | 68 | 2 | 69 | 1 | 2 | 69 | 1 | 2 | 0 |
| R18 | 4 | 66 | 65 | 0 | 65 | 0 | 0 | 66 | 1 | 4 | 1 |
| R19 | 3 | 66 | 67 | 3 | 67 | 0 | 3 | 67 | 0 | 3 | 0 |
| R20 | 2 | 66 | 65 | 0 | 66 | 1 | 2 | 66 | 1 | 2 | 0 |
| R21 | 6 | 66 | 63 | 0 | 64 | 1 | 0 | 64 | 1 | 0 | 0 |
| R22 | 4 | 66 | 62 | 0 | 63 | 1 | 0 | 63 | 1 | 0 | 0 |
| R23 | 2 | 66 | 63 | 0 | 63 | 0 | 0 | 64 | 1 | 0 | 1 |
| R24 | 4 | 66 | 61 | 0 | 62 | 1 | 0 | 62 | 1 | 0 | 0 |
| R25 | 3 | 66 | 66 | 3 | 66 | 0 | 3 | 67 | 1 | 3 | 1 |
| R26 | 3 | 66 | 65 | 0 | 65 | 0 | 0 | 66 | 1 | 3 | 1 |

**Exhibit 11**

## Future No Build and Build Noise Levels without Mitigation

**Comparison of existing conditions, number of potential noise impacts and corridor summary.**

| Receiver Information | | | Existing Conditions | | 2030 No Build Alternative | | | 2030 Build Alternative (Southbound + Northbound) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rec[1] | Homes[2] | Effects Criteria[3] | Noise Levels[4] | Effects[5] | Noise Levels[6] | Change[7] (over exist) | Effects[8] | Noise Levels[9] | Change[10] (over exist) | Effects[11] | Change[12] (over No-Bld) |
| R27 | 2 | 66 | 65 | 0 | 65 | 0 | 0 | **66** | 1 | 2 | 1 |
| R28 | 4 | 66 | 61 | 0 | 61 | 0 | 0 | 62 | 1 | 0 | 1 |
| R29 | 1 | 66 | 63 | 0 | 63 | 0 | 0 | 64 | 1 | 0 | 1 |
| R30 | 3 | 66 | 62 | 0 | 62 | 0 | 0 | 63 | 1 | 0 | 1 |
| R31 | 2 | 66 | 60 | 0 | 60 | 0 | 0 | 61 | 1 | 0 | 1 |
| R32 | 6 | 66 | 61 | 0 | 62 | 1 | 0 | 63 | 2 | 0 | 1 |
| R33 | 1 | 66 | 65 | 0 | 65 | 0 | 0 | **66** | 1 | 1 | 1 |
| R34 | 7 | 66 | 64 | 0 | 65 | 1 | 0 | **66** | 2 | 7 | 1 |
| R35 | 6 | 66 | 65 | 0 | 65 | 0 | 0 | **66** | 1 | 6 | 1 |
| R36 | 8 | 66 | 62 | 0 | 63 | 1 | 0 | 64 | 2 | 0 | 1 |

## *Corridor Summary*

| | *Existing Conditions* | *2030 No Build Alternative* | *2030 Build Alternative* |
|---|---|---|---|
| ***Number of sensitive receivers*** | ***127*** | ***127*** | ***127*** |
| ***Noise level range (min to max)*** | ***60 to 71*** | ***60 to 72*** | ***61 to 73*** |
| ***Change in noise levels over existing conditions*** | ***—*** | ***0 to 1*** | ***0 to 2*** |
| ***Change in noise levels over No Build Alternative*** | ***—*** | ***—*** | ***0 to 2*** |
| ***Potential effects*** | ***29*** | ***31*** | ***71*** |

Notes:

1. Receiver locations shown on Exhibit 9.
2. Number of dwellings expected to have the same noise level as this receiver location.
3. WSDOT Traffic Noise Criteria from Methodology section.
4. Modeled existing noise levels from TNM version 2.5, numbers in **Bold-Red** meet or exceed the NAC.
5. Number of structures or locations currently predicted to exceed the NAC.
6. Modeled future No Build levels from TNM version 2.5, numbers in **Bold-Red** meet or exceed the NAC.
7. Increase in noise levels over the existing (exist) conditions.
8. Number of structures or locations predicted to exceed the NAC under the No Build.
9. Modeled future Build (southbound + northbound) noise levels from TNM version 2.5, numbers in **Bold-Red** meet or exceed the NAC.
10. Increase over the existing (exist) conditions.
11. Number of structures or locations predicted to exceed the NAC under the Build (southbound + northbound).
12. Increase in noise levels over the No Build (No-Bld) option.

# CHAPTER 5 NOISE MITIGATION

## How are noise mitigation measures evaluated?

When project-related noise effects are identified, traffic noise mitigation measures must be examined. Mitigation measures that meet WSDOT's reasonableness and feasibility criteria may be recommended for inclusion into the project.

- *Reasonableness* assesses the practicality of the abatement measure given a number of factors. Such factors include cost, amount of noise reduction, and future traffic noise levels.
- *Feasibility* deals primarily with engineering considerations, such as whether substantial noise level reductions can be achieved, or whether a negative effect on property access will occur.

The following discussion describes the established criteria for reasonableness and feasibility for noise mitigation. The discussion also provides an introduction to traffic noise impact mitigation and potential mitigation measures that were examined for this project.

### *Reasonableness and Feasibility Criteria for Noise Mitigation*

WSDOT has established reasonableness and feasibility criteria for noise barrier mitigation. The decision to recommend or not recommend that a noise barrier be implemented will normally be determined based on the factors given below:

1. **Reasonableness:** The noise mitigation cost per residence (or residential equivalent) is at or less than indicated in Exhibit 12. This cost is determined by counting all residences (including owner-occupied residences, rental units, and mobile homes) benefited by the noise barrier in any subdivision and/or given development, and dividing that number into the total cost of the noise abatement measure. Each unit in a multi-family building will be counted as a separate residence. Exhibit 12 shows that as the predicted future noise level increases, it is reasonable to implement more costly measures, if necessary, to mitigate traffic noise.
2. **Feasibility:** A majority of the front-row receivers must obtain a minimum 5 dBA insertion loss, and at least one receiver must have at least a 7 dBA reduction.

3. Noise levels in the design year must approach or exceed the noise abatement criteria, as shown in Exhibit 12, when considering the allowable cost per household.

**Exhibit 12**
**Allowance for Impacts Caused by Total Traffic Noise Levels**

| Design Year Traffic Noise Decibel Level | Allowed Cost Per Household w/ 3dBA Reduction | Equivalent Wall Surface Area Per Household |
|---|---|---|
| 66 dBA | $37,380 | 65.0 sq. meters (700 sq. ft.) |
| 67 dBA | $41,110 | 71.5 sq. meters (770 sq. ft.) |
| 68 dBA | $44,640 | 77.7 sq. meters (836 sq. ft.) |
| 69 dBA | $48,270 | 84.0 sq. meters (904 sq. ft.) |
| 70 dBA | $51,900 | 90.3 sq. meters (972 sq. ft.) |
| 71 dBA | $55,530 | 96.6 sq. meters (1040 sq. ft.) |
| 72 dBA | $59,160 | 103.0 sq. meters (1108 sq. ft.) |
| 73 dBA | $62,790 | 109.2 sq. meters (1176 sq. ft.) |
| 74 dBA | $66,420 | 115.6 sq. meters (1244 sq. ft.) |

*Based on $53.40 per square foot construction cost based on WSDOT criteria for cost evaluation.*

The use of the property should be included when considering the reasonableness of abatement. For example, churches and parks may be in use only during specific hours or days of the week. Noise barriers will be considered where land use is changing rapidly if there is local zoning or ordinances that specifically control the new development that is noise sensitive such as residential, churches, or parks. Noise barriers will not likely be considered for an area that is transitioning away from sensitive residential land uses to non-sensitive commercial or industrial land use. An exception would be considered for areas with long-term established sensitive uses (i.e., residential subdivisions) where the local government has agreed, in writing, to implement measures to prohibit the development of non-sensitive land uses within and adjacent to sensitive land uses. The location of a noise barrier to the receptors to be protected will be considered in making a feasibility determination.

### *Types of Noise Mitigation Measures*

Analysts evaluate several different traffic noise abatement measures whenever noise effects are expected. Under WSDOT policy, the six abatement measures listed in the Federal Highway Administration (FHWA) *Procedures for Abatement of Highway Traffic Noise and Construction Noise*, 23 CFR 772, US Code of Federal Regulations, 1996 must be considered, as follows:

1. Implementation of traffic management measures (e.g., traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive land designations)
2. Alteration of highway design measures, such as horizontal and vertical alignments
3. Acquisition of property rights (either in fee or lesser interest) for noise barrier construction
4. Construction of noise barriers (including landscaping for aesthetic purposes) whether within or outside the highway right-of-way. Interstate construction funds may not participate in landscaping
5. Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development that would be adversely affected by traffic noise. This measure may be included in Type I projects only
6. Noise insulation of public use or nonprofit institutional structures

**Traffic Management Measures:** Traffic management measures include modification of speed limits and restricting or prohibiting truck traffic. Restricting truck use on the project roadways will reduce noise levels at nearby receivers since trucks are louder than cars. However, displacing truck traffic from one roadway to another will conflict with the project objective and merely shift noise effects from one area to another. Lowering the speed limits will have the effect of lowering traffic noise levels; however, lower travel speeds will conflict with the project objective to improve travel times through the project study area.

**Highway Design Measures:** Highway design measures include altering the roadway alignment and depressing roadway cut sections. Altering the roadway alignment can decrease noise levels by moving the noise source farther away from the affected receivers. Noise effects occur along both sides of the project roadway. Subsequently, altering the particular alignments can lower noise levels for residences on one side of the roadway, but increase noise levels for residences on the other side of the roadway.

Lowering the vertical alignment of SR 167 in the project study area will lower the source of the vehicle noise from the sensitive receivers. The resulting cut and retaining walls will effectively block the line of sight between the vehicles and the residences along the freeway. Altering the vertical alignment will effectively lower noise levels; however, the costs and effects associated with this highway design measure are not likely to meet the WSDOT criteria for reasonableness.

**Acquisition of Property Rights for Construction of Noise Barriers:** Depending on the final placement of any recommended noise barrier mitigation (berms or walls), additional property rights may be needed for noise barrier construction. Under WSDOT policy, noise barriers are normally evaluated and constructed within WSDOT rights of way. There may be cases in which WSDOT right of way is not the most prudent location for abatement; however, abatement may be reasonable if the noise barrier is constructed on adjacent property. WSDOT notes the following considerations in such cases:

- The WSDOT mitigation cost reasonableness allowance is limited to normal cost for abatement on WSDOT right of way
- The adjacent property owners allow access and easements, as necessary, to construct and maintain the abatement
- Any additional cost to acquire access, acquire property, provide alternative access, or provide additional infrastructure to accommodate access must be added to the barrier cost calculation and compared to the normal reasonableness cost allowance of the abatement to determine whether the proposed abatement is reasonable

- During final design, noise abatement recommendations may change due to design changes and actual right-of-way acquisitions

**Noise Barriers:** Construction of noise barriers between the roadways and the affected receivers will reduce noise levels by physically blocking the transmission of traffic-generated noise. Barriers can be constructed as walls or earthen berms. Earthen berms require more right-of-way than walls, and are usually constructed with a 3-to-1 (horizontal to vertical) slope. For this project, berms are not feasible due to topographical and environmental conditions between the highway and residences. Noise barriers should be high enough to break the line-of-sight between the noise source and the receiver. They must also be long enough to prevent significant flanking of noise around the ends of the walls. For a noise barrier to be considered feasible a majority of front-row receivers must achieve a minimum of 5 dBA insertion loss; and at least one receiver must have a 7 dBA reduction. Openings in the wall, such as for driveways and walkways, can significantly reduce the barrier effectiveness and, in many cases, will cause the barrier to fail to meet the noise reduction requirements.

**Acquisition of Real property for Buffer Zones:** Consideration is given to acquisition of property that may be a buffer between the project and the noise receivers. However, due to the topography of the corridor and adjacent properties, there is not a viable property for such a mitigation approach.

### What is proposed for noise mitigation?

Noise mitigation was considered for all receivers where noise levels exceed the WSDOT traffic noise criteria. After reviewing the locations of the predicted noise effects, WSDOT staff and noise analysts determined that noise barriers were the only feasible form of noise mitigation. The following sections provide details on mitigation considered for the project.

#### Eastside of SR 167 Between Ellingson Road and 15th Avenue

There were five noise wall options evaluated for the eastside of SR 167 (the west side is discussed later in this chapter) to mitigate the properties identified with effects. First, noise walls were examined along the residences' property lines. Noise walls were examined along property lines first because they provide easy access to the

undeveloped right-of-way between the homes and the highway. Because the elevation of SR 167 is higher than the residences, the heights of the noise wall had to be raised to block the line-of-sight from those residences. Breaking the line-of-sight is required for a noise wall to be effective at reducing traffic noise. An opening in the wall will be required at the SR 167 overpass of 1st Avenue.

Under this scenario, two noise walls will be required:

- North Wall - the area north of 1st Avenue N
- South Wall – the area south of 1st Avenue N

Two combinations were evaluated for the northern wall: a full-length wall, from Boundary Road SW to 1st Avenue N; and a reduced length, split-noise wall that will not provide noise mitigation in the sparsely populated area between 8th Avenue N and 5th Avenue N. Exhibit 13 provides an aerial view of the evaluated noise wall locations.

Analysts evaluated the full-length northern noise wall from Boundary Road to 1st Avenue N and found it did not meet the WSDOT cost effectiveness criteria. This failure was due to the added cost of the wall along the undeveloped lands near 7th Avenue N. A second attempt was made to meet the criteria by eliminating the portion of the wall near the undeveloped properties; however, the reduced-length wall was determined to also exceed the WSDOT cost criteria. Exhibit 14 shows a summary of the noise reduction for the north wall and Exhibit 15 shows a summary of the noise reduction for the south wall. Both exhibits show the potential available mitigation dollars for the evaluated noise walls. Exhibit 16 provides a summary of the north and south noise wall configurations and the overall cost and amount by which it will exceed the WSDOT criteria.

Under the option of placing the noise wall along the residential property lines, the average noise reduction at front-row receivers will be 5.8 dBA. The overall average reduction for all receivers exceeding the criteria will be 4.6 dBA; the overall average noise reduction for the area will be 4.2 dBA. An estimated six residual noise effects will result with the modeled wall size.

**Exhibit 13**
## Noise Wall Evaluated at Residential Property Line

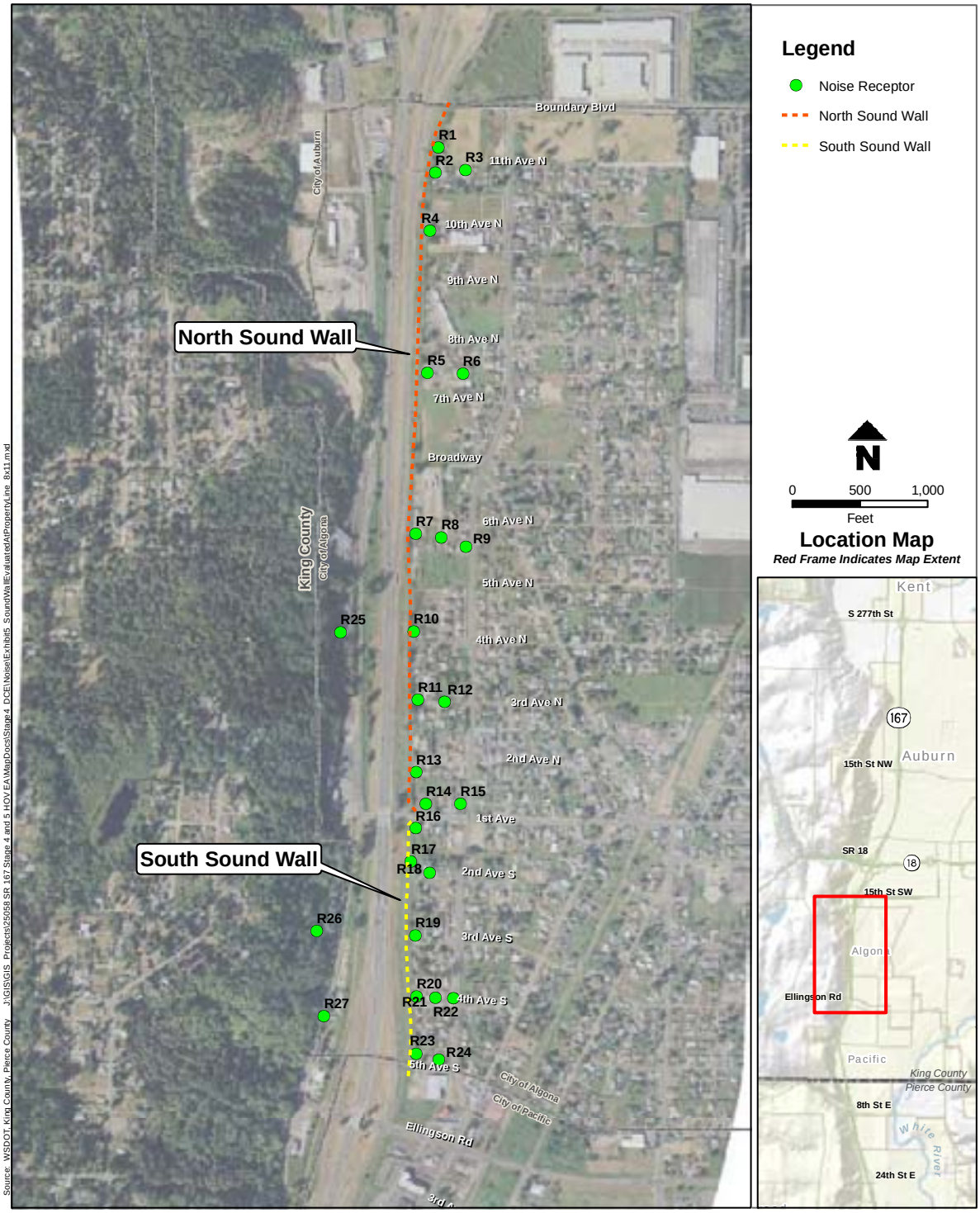


**Exhibit 14**

**Northern Property Line Noise Wall Noise Reduction Summary**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R1 | **72** | 64 | 8 | 1 | $59,160 |
| R2 | **73** | 64 | 9 | 2 | $125,580 |
| R3 | **68** | 63 | 5 | 3 | $133,920 |
| R4 | **72** | 65 | 7 | 2 | $118,320 |
| R5 | **72** | **66** | 6 | 1 | $59,160 |
| R6 | **66** | 63 | 3 | 5 | $186,900 |
| R7 | **72** | **66** | 6 | 2 | $118,320 |
| R8 | **68** | **67** | 1 | 0 | $0 |
| R9 | **66** | 65 | 1 | 0 | $0 |
| R10 | **71** | 65 | 6 | 2 | $103,800 |
| R11 | **70** | 64 | 5 | 3 | $144,810 |
| R12 | 64 | 64 | 0 | 0 | $0 |
| R13 | **69** | 63 | 6 | 3 | $144,810 |
| R14 | **66** | 63 | 3 | 8 | $299,040 |
| R15 | 63 | 63 | 0 | 0 | $0 |
| **Total Available for Noise Mitigation** | | | | | **$1,493,820** |

Notes:

1. Receivers shown on Exhibit 13 with noise wall evaluated.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction of noise wall.
5. Number of homes with a 3 dBA noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

**Exhibit 15**
**Southern Property Line Noise Wall Noise Reduction Summary**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R16 | **69** | 65 | 4 | 1 | $48,270 |
| R17 | **69** | **66** | 3 | 2 | $96,540 |
| R18 | **66** | 65 | 1 | 0 | $0 |
| R19 | **67** | 61 | 6 | 3 | $123,330 |
| R20 | **66** | 61 | 5 | 2 | $74,760 |
| R21 | 64 | 63 | 1 | 0 | $0 |
| **Total Available for Noise Mitigation** | | | | | **$342,900** |

Notes:
1. Receivers shown on Exhibit 13 with noise wall evaluated.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction in dB of noise wall.
5. Number of homes with a 3 dBA or greater noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

**Exhibit 16**
**Property Line Noise Wall Cost Analysis**

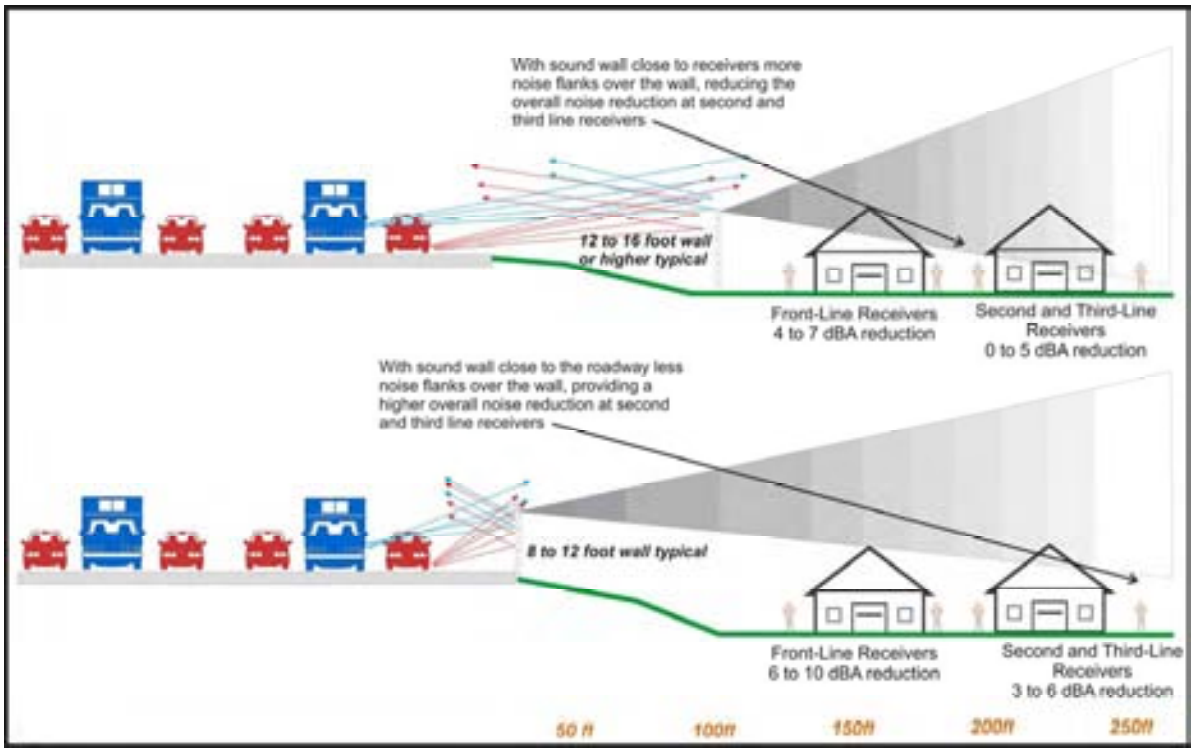
| Wall Name[1] | Heights along Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] (Cost Available) |
|---|---|---|---|---|---|---|---|---|
| | Min | Avg | Max | | | | | |
| **South Wall** | 14 | 16.42 | 20 | 1865 | 30632 | $1,635,736 | $342,900 | **($1,292,836)** |
| **North Wall** | 12 | 13.44 | 16 | 4650 | 62487 | $3,336,818 | $1,493,820 | **($1,842,998)** |

Notes:
1. Noise walls shown on Exhibit 13.
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed walls in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation for North Wall – Exhibit 14 and South Wall - Exhibit 15.
7. Residential mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value is in black, the mitigation is within the allowable capital based on WSDOT criteria.

Exhibit 16 summarizes how placing the noise wall along the residential property lines will result in higher walls of thirteen to sixteen feet and still not meet the WSDOT reasonableness criteria. This noise wall alignment option will not be recommended for inclusion with the project due to the high cost.

Based on an evaluation of the topographical conditions along the project corridor, analysts determined that a noise wall along the roadway shoulder will have a better chance of providing adequate noise reduction and meeting the cost criteria. Because the roadway is slightly higher than the elevation of the residences, it is expected that a noise wall constructed near the highway will provide greater noise reduction benefits than a wall placed along the residential property lines. In this scenario, the required height of the walls is lower, thereby reducing the overall cost of the mitigation. Exhibit 17 illustrates that placing the noise walls close to the residents will require a higher wall, yet will not provide the same level of noise reduction.

**Exhibit 17**
**Noise Wall along Roadway versus Noise Wall at Residence**



Several additional noise wall options were evaluated along the shoulder of the highway. Due to the added cost of providing a wall on the 1st Avenue N bridge structure, walls were evaluated with and without a wall on the structure. Wall Options 1, 2, and 3 do not include the wall on the structure, while Wall Option 4 does include the structure mounted wall. The walls evaluated include:

Option 1

- A single southern noise wall to protect receivers R16 to R24

Option 2

- A single central noise wall to protect receivers R7 to R15

Option 3

- A two-piece noise wall system from R7 to R24

Option 4

- A one piece noise wall from R7 to R24 that includes a noise wall on the 1st Avenue N Structure

Option 5

- A northern noise wall from R1 to R6, with an option of reducing the length to cover R1 to R4 (Option 5A), if the longer wall from R1 to R6 does not meet WSDOT cost-effectiveness criteria

Exhibit 18 shows noise wall options 1, 2, 3, and 5. Exhibit 19 shows noise wall options 4, 5 and 5A.

**Exhibit 18**

## SR 167 Noise Wall Options 1, 2, 3, and 5

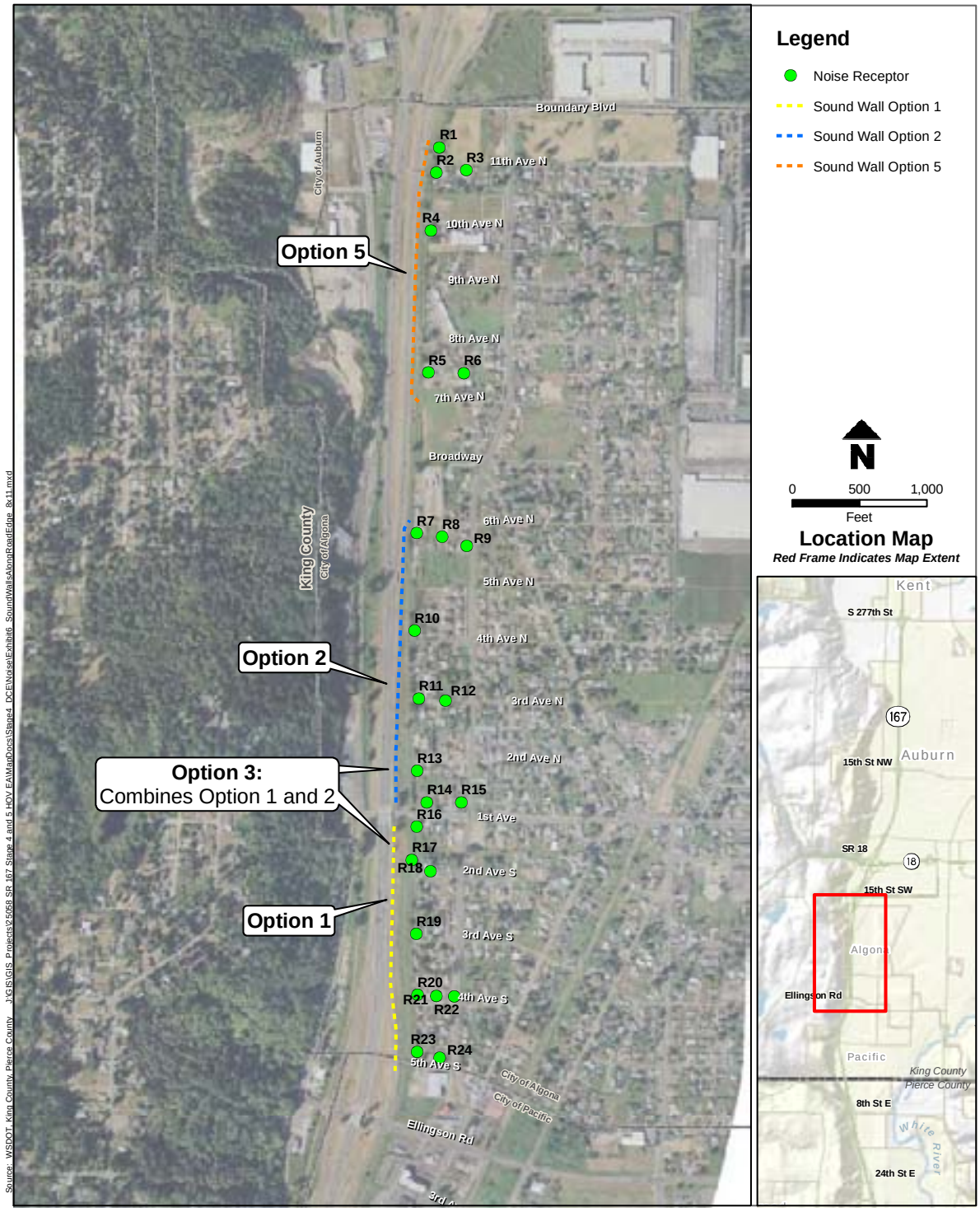
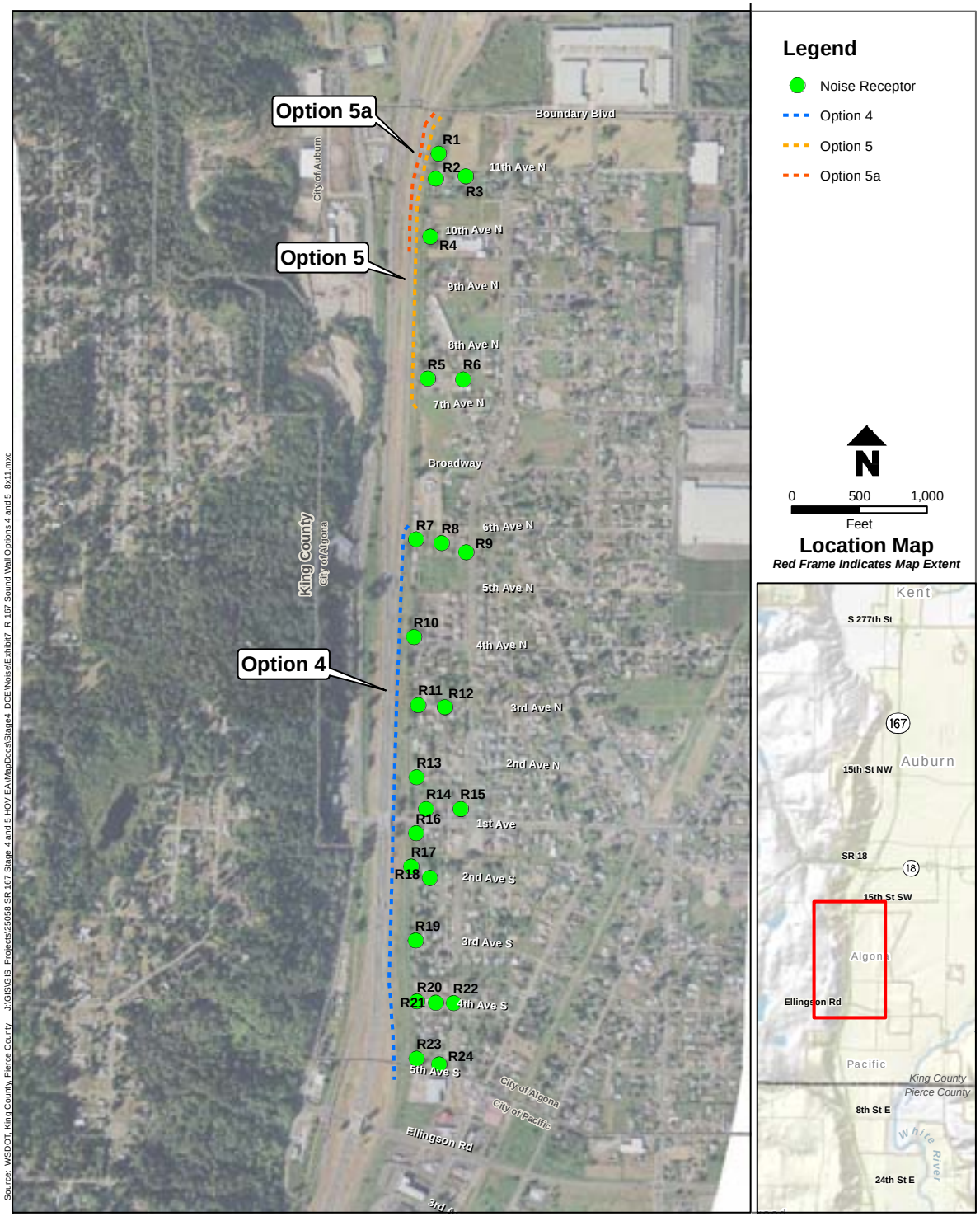


**Exhibit 19**
## SR 167 Noise Wall Options 4, 5, and 5a



## Noise Wall Option 1

Noise Wall Option 1, with an average height of 11.7 feet, was optimized to provide maximum noise reduction for receivers R16 through R24, all located south of 1st Avenue N. The selection of 1st Avenue N as the dividing point is due to the SR 167 bridge structure over 1st Avenue N. The wall will have an overall average noise reduction of 5.4 dBA with an average reduction for front-row receivers of 6.0 dBA. The wall will eliminate all noise effects with future noise levels of 58 to 64 dBA $L_{eq}$ after reductions of 4 to 7 dBA from the noise wall. Exhibit 20 provides a summary of the noise reduction characteristics of the noise wall.

**Exhibit 20**
**Highway Noise Wall Option 1 Noise Reduction**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R16 | **69** | 64 | 5 | 2 | $96,540 |
| R17 | **69** | 63 | 6 | 1 | $48,270 |
| R18 | **66** | 60 | 6 | 4 | $149,520 |
| R19 | **67** | 60 | 7 | 2 | $82,220 |
| R20 | **66** | 60 | 6 | 3 | $112,140 |
| R21 | 64 | 59 | 5 | 6 | $224,280 |
| R22 | 63 | 58 | 5 | 3 | $112,140 |
| R23 | 64 | 59 | 5 | 8 | $299,040 |
| R24 | 62 | 58 | 4 | 10 | $373,800 |
| **Total Available for Noise Mitigation** | | | | | **$1,497,950** |

Notes:
1. Receivers shown on Exhibit 18 with noise wall considered.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction of noise wall.
5. Number of homes with a 3 dBA or greater noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

The technical dimensions of Option 1 are a length of 2,088 feet, ranges in height from 9 to 12 feet tall, with an average height of 11.7 feet. The estimated cost of the wall using $53.40/square feet is $1,305,237, and the allowable capital for mitigation is $1,497,950; therefore, the wall is considered to meet the WSDOT cost effectiveness criteria. Exhibit 21 provides the results of the cost analysis.

**Exhibit 21**
**Highway Noise Wall Option 1 Cost Analysis**

| | Height Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| Option 1 | 9 | 11.71 | 12 | 7197 | 66010 | $1,305,237 | $1,497,950 | $192,713 |

Notes:

1. Noise wall shown on Exhibit 18.
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation from Exhibit 20.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

## Noise Wall Option 2

Noise Wall Option 2, with an average height of 10.1 feet, was optimized to mitigate noise effects to receivers R7 through R15, north of the 1st Avenue N overpass. The optimized noise wall will provide an overall reduction of 3 to 7 dBA and an average reduction for front-row receivers of 5.2 dBA. Future noise levels with this wall will range from 60 to 65 dBA $L_{eq}$ Noise Wall. Exhibit 22 provides the result of noise reductions and the available capital available for mitigation under WSDOT/FHWA criteria for Option 2 configuration.

The technical dimensions of the Option 2 are a length of 2,313 feet, ranges in heights of 10 to 11 feet, with an average height of 10.13 feet. Exhibit 23 provides the results of the cost analysis and the cost of the wall was estimated at $1,250,566, which is within the available amount of $$1,621,170 by $370,604. The wall meets the WSDOT reasonableness criteria. This wall was carried forward for final mitigation considerations with other effective wall(s).

**Exhibit 22**

**Highway Noise Wall Option 2 Noise Reduction**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R7 | **72** | 65 | 7 | 2 | $118,320 |
| R8 | **68** | 63 | 5 | 1 | $44,640 |
| R9 | **66** | 63 | 3 | 4 | $149,520 |
| R10 | **71** | 64 | 7 | 2 | $111,060 |
| R11 | **70** | 63 | 7 | 3 | $155,700 |
| R12 | 64 | 61 | 3 | 6 | $224,280 |
| R13 | **69** | 64 | 5 | 3 | $144,810 |
| R14 | **66** | 63 | 3 | 8 | $299,040 |
| R15 | 63 | 60 | 3 | 10 | $373,800 |
| **Total Available for Noise Mitigation** | | | | | **$1,621,170** |

Notes:

1. Receivers shown on Exhibit 18 with noise wall considered.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction of noise wall.
5. Number of homes with a 3 dBA or greater noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

**Exhibit 23**

**Highway Noise Wall Option 2 Cost Analysis**

| | Height of Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| **Option 2** | 10 | 10.13 | 11 | 2313 | 23419 | $1,250,566 | $1,621,170 | **$370,604** |

Notes:

1. Noise wall shown on Exhibit 18.
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation from Exhibit 22.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

## Noise Wall Option 3

Noise Wall Option 3, with an average height of 10.9 feet, is a combination of Noise Wall Option 1 and Noise Wall Option 2, with no noise wall on the 1st Avenue N overpass, and optimized for receivers R7 through R24. Exhibit 24 provides the result of noise reductions and the available capital available for mitigation under WSDOT/FHWA criteria for Option 3 configuration. The overall noise reduction for this wall will range from 4 to 8 dBA, producing an average reduction for all receivers of 5.9 dBA, an average reduction of 6.9 dBA for front-row receivers and an average reduction for locations with effects of 6.5 dBA.

**Exhibit 24**
**Highway Noise Wall Option 3 Noise Reduction**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R7 | **72** | 64 | 8 | 2 | $118,320 |
| R8 | **68** | 62 | 6 | 1 | $44,640 |
| R9 | **66** | 62 | 4 | 4 | $149,520 |
| R10 | **71** | 63 | 8 | 2 | $103,800 |
| R11 | **70** | 63 | 7 | 3 | $144,810 |
| R12 | 64 | 60 | 4 | 6 | $224,280 |
| R13 | **69** | 62 | 7 | 3 | $144,810 |
| R14 | **66** | 60 | 6 | 8 | $299,040 |
| R15 | 63 | 58 | 5 | 10 | $373,800 |
| R16 | **69** | 63 | 6 | 1 | $48,270 |
| R17 | **69** | 62 | 7 | 2 | $96,540 |
| R18 | **66** | 59 | 7 | 4 | $149,520 |
| R19 | **67** | 60 | 7 | 3 | $123,330 |
| R20 | **66** | 59 | 7 | 2 | $74,760 |
| R21 | 64 | 59 | 5 | 6 | $224,280 |
| R22 | 63 | 57 | 6 | 4 | $149,520 |
| R23 | 64 | 59 | 5 | 2 | $74,760 |
| R24 | 62 | 58 | 4 | 4 | $149,520 |
| **Total Available for Noise Mitigation** | | | | | **$2,693,520** |

Notes:

1. Receivers shown on Exhibit 18 with noise wall considered.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction of noise wall.
5. Number of homes with a 3 dBA or greater noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

The technical dimensions of the Option 3 are a length of 4,340 feet, ranges in heights of 7 to 12 feet, with an average height of 10.9 feet.

Exhibit 25 provides the results of the cost analysis and the cost of the wall is estimated at $2,514,122 with $2,693,520 available for noise mitigation. The wall is approximately $179,398 under the available cost for noise mitigation under WSDOT cost effectiveness criteria. This wall was carried forward for final mitigation considerations with other effective wall(s).

**Exhibit 25**
**Highway Noise Wall Option 3 Cost Analysis**

| | Height Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| **Option 3** | 7 | 10.85 | 12 | 4340 | 47081 | $2,541,122 | $2,693,520 | $179,398 |

Notes:
1. Noise wall shown on Exhibit 18.
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation from Exhibit 24.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

## Noise Wall Option 4

Noise Wall Option 4, with an average height of 10.3 feet, is identical to Noise Wall Option 3, with the exception that Noise Wall Option 4 also provides the noise wall along the 1st Avenue N overpass to reduce noise from flanking from the structure to the residences in the area. Exhibit 26 provides the result of noise reductions and the available capital available for mitigation under WSDOT/FHWA criteria for Option 4 configuration. This wall will provide an average 5 dBA reduction for front-row receivers.

The technical dimensions of the Option 4 are a length of 4,444 feet, ranges in heights of 8 to 10 feet, with an average height of 10.3 feet.

Exhibit 27 provides the cost analysis and shows that the wall will exceed the criteria by over $1,100,000 because of the added cost of placing a noise wall on the structure. Installation of the noise wall along the structure will add significant cost to the overall noise wall due to structural modifications. The estimated added cost of

$1,500,000 will cause any noise wall along this section of SR 167 not to meet the WSDOT cost criteria. Because the wall greatly exceeds the WSDOT cost criteria, it was removed from further consideration.

**Exhibit 26**
**Highway Noise Wall Option 4 Noise Reduction**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R7 | **72** | 64 | 8 | 2 | $118,320 |
| R8 | **68** | 63 | 5 | 1 | $44,640 |
| R9 | **66** | 62 | 4 | 4 | $149,520 |
| R10 | **71** | 64 | 7 | 2 | $103,800 |
| R11 | **70** | 63 | 7 | 3 | $144,810 |
| R12 | 64 | 61 | 3 | 6 | $224,280 |
| R13 | **69** | 64 | 5 | 3 | $144,810 |
| R14 | **66** | 62 | 4 | 8 | $299,040 |
| R15 | 63 | 59 | 4 | 10 | $373,800 |
| R16 | **69** | 64 | 5 | 1 | $48,270 |
| R17 | **69** | 65 | 4 | 2 | $96,540 |
| R18 | **66** | 62 | 4 | 4 | $149,520 |
| R19 | **67** | 62 | 5 | 3 | $123,330 |
| R20 | **66** | 61 | 5 | 2 | $74,760 |
| R21 | 64 | 60 | 4 | 6 | $224,280 |
| R22 | 63 | 59 | 4 | 4 | $149,520 |
| R23 | 64 | 60 | 4 | 2 | $74,760 |
| R24 | 62 | 59 | 3 | 4 | $149,520 |
| **Total Available for Noise Mitigation** | | | | | **$2,693,520** |

Notes:

1. Receivers shown on Exhibit 19 with noise wall considered.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction of noise wall.
5. Number of homes with a 3 dBA or greater noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

**Exhibit 27**
**Highway Noise Wall Option 4 Cost Analysis**

| | Height Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| **Option 4** | 8 | 9.93 | 10 | 4444 | 44137 | $3,856,913 | $2,639,520 | **$1,163,393** |

Notes:

1. Noise wall shown on Exhibit 19.
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation with an additional $1,500,000 for structure modification to accommodate the noise wall from WSDOT bridge and structure department.
6. Available capital for noise mitigation from Exhibit 26.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

## Noise Wall Option 5

Two alternatives were evaluated for the north end receivers Option 5 and 5A. Option 5, with an average height of 10.6 feet, covers the area of receivers R1 through R6, attempting to mitigate all receivers in this area (R1 – R6).

Exhibit 28 provides the result of noise reductions and the available capital available for mitigation under WSDOT/FHWA criteria for Option 5 configuration. The technical dimensions of the Option 5 are a length of 2,254 feet, ranges in heights of 10 to 12 feet, with an average height of 10.69 feet.

**Exhibit 28**
**Highway Noise Wall Option 5 (R1 – R6) Noise Reduction**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R1 | **72** | 65 | 7 | 1 | $59,160 |
| R2 | **73** | 64 | 9 | 2 | $125,580 |
| R3 | **68** | 63 | 5 | 3 | $133,920 |
| R4 | **72** | 65 | 7 | 2 | $118,320 |
| R5 | **72** | 65 | 7 | 1 | $59,160 |
| R6 | **66** | 61 | 5 | 5 | $186,900 |
| **Total Available for Noise Mitigation** | | | | | **$683,040** |

Notes:
1. Receivers shown on Exhibit 19 with noise wall area considered.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction of noise wall.
5. Number of homes with a 3 dBA or greater noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

Exhibit 29 provides the cost analysis for Option 5 and shows that the wall will exceed the criteria by over $604,012.00.

**Exhibit 29**
**Highway Noise Wall Option 5 (R1 – R6) Cost Analysis**

| | Height Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| **SR167 Wall** | 10 | 10.69 | 12 | 2254 | 24102 | $1,287,052 | $683,040 | **$604,012** |

Notes:
1. Noise wall shown on Exhibit 19.
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation from Exhibit 28.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

## Noise Wall Option 5A

Noise Wall Option 5A, with an average height of 9 feet, is smaller length wall in the northern end for receivers R1 through R4. Exhibit 30 provides the result of noise reductions and the available capital available for mitigation under WSDOT/FHWA criteria for Option 5 configuration.

**Exhibit 30**
**Highway Noise Wall Option 5A (R1 – R4) Noise Reduction**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R1 | **72** | **68** | 4 | 1 | $59,160 |
| R2 | **73** | **66** | 7 | 2 | $125,580 |
| R3 | **68** | 64 | 4 | 3 | $133,920 |
| R4 | **72** | **68** | 4 | 2 | $118,320 |
| **Total Available for Noise Mitigation** | | | | | **$436,980** |

Notes:
6. Receivers shown on Exhibit 19 with noise wall area considered.
7. Future noise levels with no mitigation.
8. Future noise levels with mitigation.
9. Noise reduction of noise wall.
10. Number of homes with a 3 dBA or greater noise reduction.
11. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

The technical dimensions of the Option 5A are a length of 990 feet, with a height of 9 feet.

Exhibit 31 provides the cost analysis for Option 5A and shows that the wall will exceed the criteria by $38,814.

**Exhibit 31**
**Highway Noise Wall Option 5A (R1 – R4) Cost Analysis**

| | Height Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| **SR167 Wall** | 9 | 9 | 9 | 990 | 8910 | $475,794 | $436,980 | **$38,814** |

Notes:
1. Noise wall shown on Exhibit 19.
2. Minimum area, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation from Exhibit 30.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

Because neither Option 5 nor 5A Noise Wall options met the cost criteria, Option 5 and 5A were removed from further consideration. Neither wall will meet the WSDOT cost criteria, even at the minimum square footage and noise reductions.

### West Side of SR 167 between Ellingson Road and 15th Avenue

Three individual small groups of residential land uses with traffic noise impacts are on the west side of SR 167 within the project area. These groups of homes are represented by receivers R25, R26, and R27. Mitigation was considered for all three groups of residences. The location of the noise wall examined for the west side of SR 167 is shown on Exhibit 32.

*Receiver R25*

R25 represents a group of three homes located on the west side of West Valley Highway S in the vicinity of 4th Avenue N. Future noise levels at these residents were predicted at 67 dBA Leq under the Build Alternative. Noise mitigation was examined by placing a noise wall along the edge of SR 167; however, due to the low noise reduction benefits and high cost, the wall could not meet the WSDOT reasonableness and feasibility requirements.

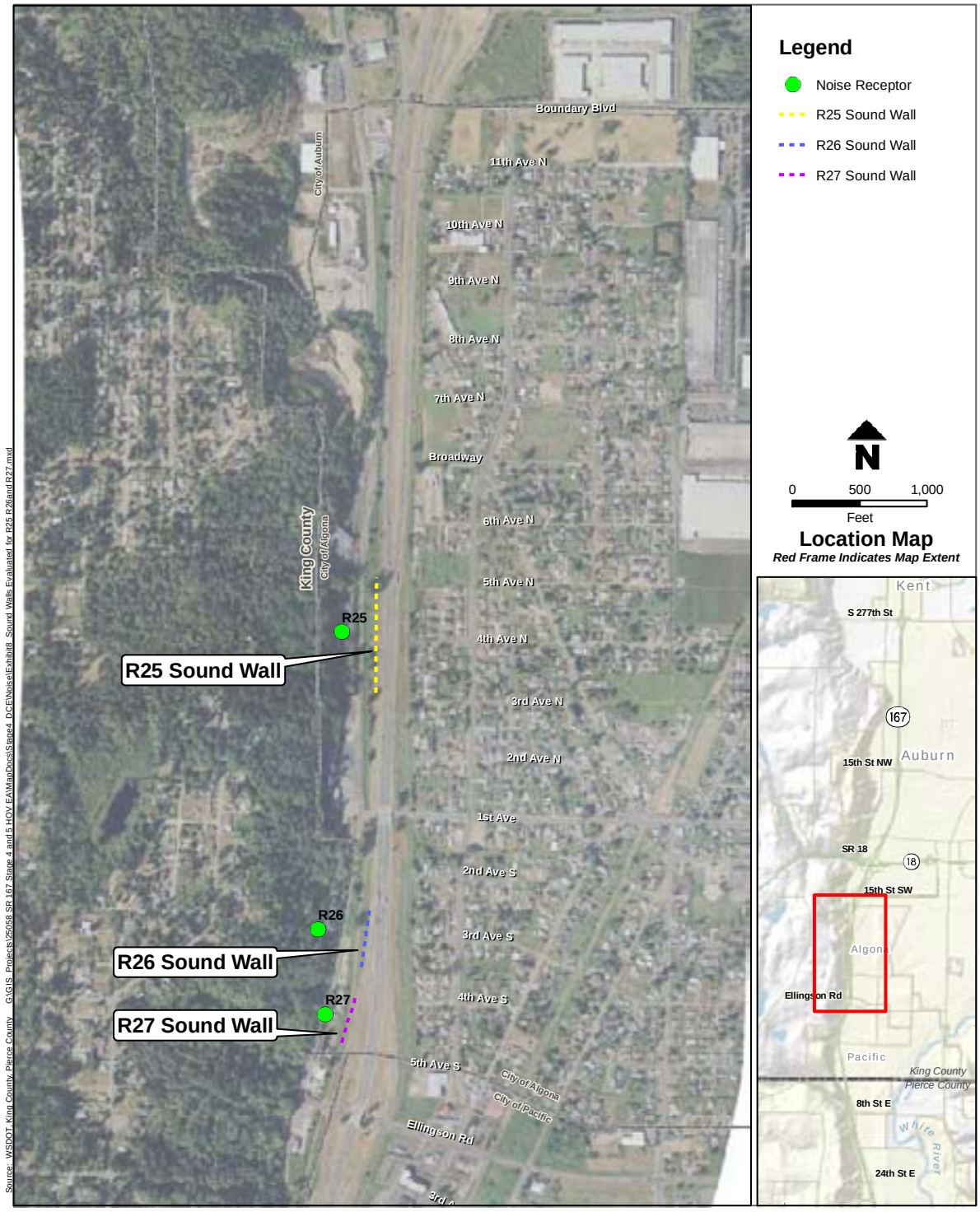
At a height of 20 feet, and a cost of approximately $800,000, a noise wall will reduce noise levels at these residences by approximately 4 dBA, which is less than the requirement of a 7 dBA reduction at one of the front-row residences. In addition, with only three homes and future noise levels of 67 dBA, the maximum capital allowable for noise abatement is $123,330, which is $677,604 below the estimated cost of a 20-foot high barrier. The reason for the low insertion loss at these residences is the large distance from the roadway to the homes (over 250 feet). Optional locations for a noise wall, such as close to the residences, were also rejected due to vehicle and pedestrian access to the properties from West Valley Highway S.

*Receivers R26 and R27*

Receivers R26 and R27 are near the southbound off-ramp to Ellingson Road. Receiver R26 represents three residences located west of West Valley Highway S. This group of homes is slightly uphill from the roadway. Receiver R27 represents two residences on the eastside of the West Valley Highway S, near the Ellingson Road ramps. Because these receivers are close together, the noise wall analysis was performed for both groups in an effort to have the noise walls benefit all five residences.

With two, 16-foot high noise walls at an expected cost of $980,155, the noise reductions at these residences will not meet the minimum 7 dBA reduction requirement. Given that the five residences have future noise levels of 66 dBA, the maximum amount of capital for noise abatement is $112,140 for R26 and $74,760 for R27. The estimated cost for the 16-foot high walls will be $575,317 for R26 and $404,838 for R27. Because neither wall will meet the minimum 7 dBA reduction requirement, and the cost of the walls will exceed the WSDOT criteria, the walls will not meet the WSDOT reasonableness and feasibility requirements. Therefore, these walls were eliminated from further consideration.

**Exhibit 32**
**Noise Walls Evaluated for R25, R26, and R27**



### East Side of SR 167 South of Ellingson Road

Sound walls were also evaluated for the noise effects identified at the proposed Beaver Meadows development. As with the locations north of Ellingson Road, several analyses were made to meet the criteria for an effective noise barrier for this location.

The distance between the nearest noise sensitive receivers, represented by R33 through R34, and SR 167 is over 270 feet. Typically receivers at this distance are second- or third-line receivers and receiver a benefit of 3 to 6 dBA, while closer receivers have reductions of 7 to 10 dBA. In order to provide a wall that would achieve the required 7 dBA at one receiver, while maintaining a 5 dBA average; the sound wall would need to have a length of 1,486 feet and an average height of 16.9 feet. This was the most effective wall analyzed and the wall provided a 7 dBA reduction at R34, while the average reduction for front line residences is 6 dB. The wall benefited receivers R32 through R36. The cost of the wall was estimated to be at $1,343,974; however the available capital falls short if the allowable $1,046,640. Because the wall would not meet the WSDOT criteria, no mitigation is recommended for this area. The location of the sound wall evaluated is illustrated in Exhibit 35.

**Exhibit 33**
**Noise Wall Reduction Pacific Receivers R32 – R36**

| Receiver #[1] | Build Noise Levels[2] | Build Noise Levels W/Mitigation[3] | Noise Reduction[4] | Benefited Homes[5] | Capital Available for Mitigation[6] |
|---|---|---|---|---|---|
| R32 | 63 | 60 | 3 | 6 | $224,280 |
| R33 | 66 | 60 | 6 | 1 | $37,380 |
| R34 | 66 | 59 | 7 | 7 | $261,660 |
| R35 | 66 | 62 | 4 | 6 | $224,280 |
| R36 | 64 | 59 | 5 | 8 | $299,040 |
| **Total Available for Noise Mitigation** | | | | | **$1,046,640** |

Notes:
1. Receivers shown on Exhibit 19 with noise wall area considered.
2. Future noise levels with no mitigation.
3. Future noise levels with mitigation.
4. Noise reduction of noise wall.
5. Number of homes with a 3 dBA or greater noise reduction.
6. Available capital for noise mitigation based on the number of homes multiplied by the appropriate value from Exhibit 12.

**Exhibit 34**

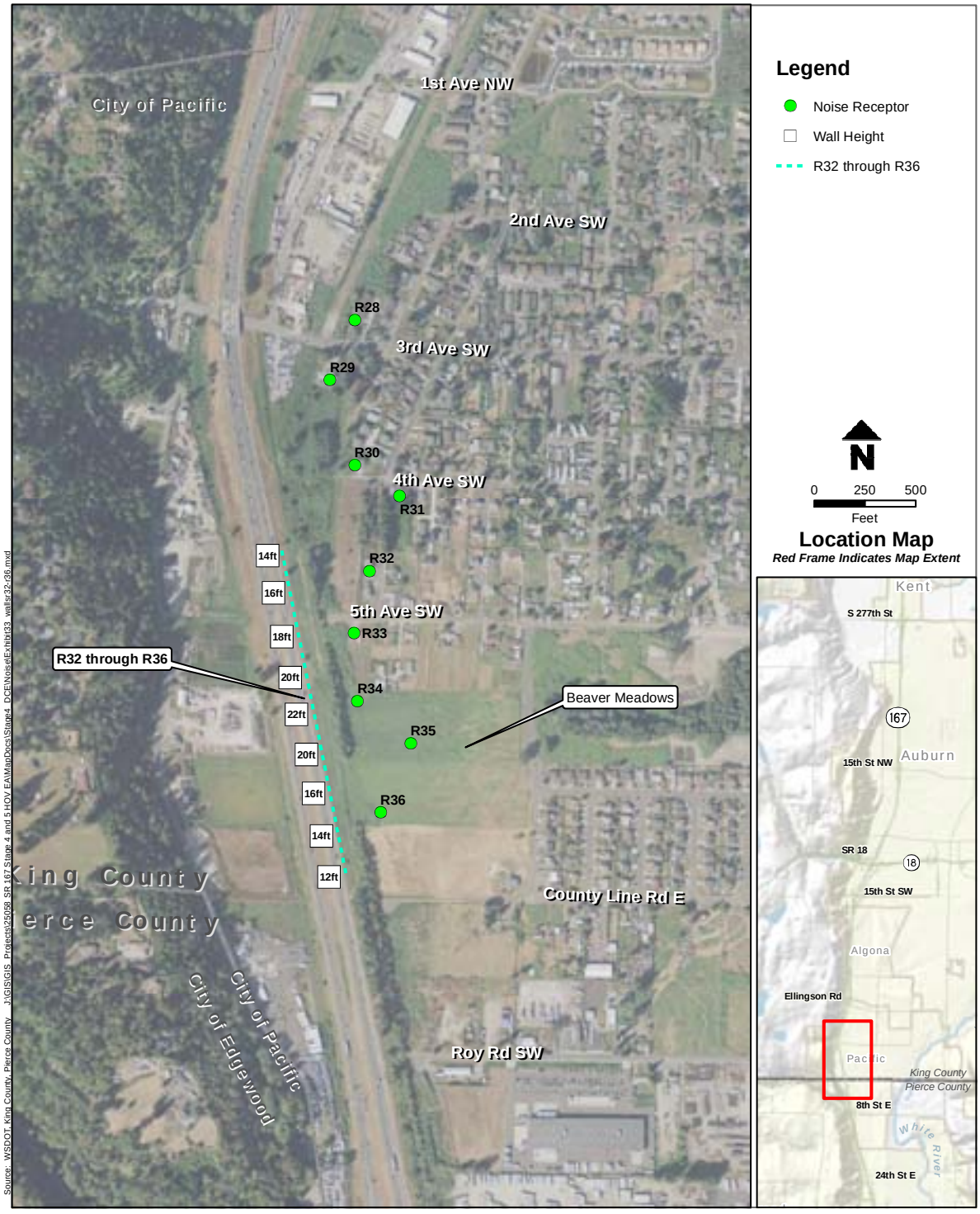
**Noise Wall Cost Analysis Pacific Receivers R32 – R36**

| | Height Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| **SR167 Wall** | 12 | 16.94 | 22 | 1486 | 25168 | $1,343,974 | $1,046,640 | **$297,334** |

Notes:

1. Noise wall shown on Exhibit 35 (it's the new figure showing just R28-R36).
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation from Exhibit 28.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

**Exhibit 35**
## Noise Walls Evaluated for R32 through R36



## Proposed Project Mitigation Measures

### Mitigation Ellingson Road to Boundary Road

Based on the evaluation of the different noise wall options, Noise Wall Option 3 is the best overall option for the SR 167 project. Noise Wall Option 3 is a combination of Noise Wall Option 1 and Noise Wall Option 2, with no noise wall on the 1st Avenue N overpass, and optimized for receivers R7 through R24. The overall noise reduction for this wall will range from 4 to 8 dBA, have an average noise reduction for all receivers of 6 dBA, and an average reduction of 7 dBA for front-row receivers. The wall provides a benefit of at least 5 dBA at 67 residential properties.

The cost of the wall is estimated at $2,514,122 with $2,693,520 available for noise mitigation. The wall will be approximately $179,000 below the available cost for noise mitigation under WSDOT cost effectiveness criteria. Exhibit 34 summarizes the technical findings from page 44 and 45, which provides the conclusion for the most feasible and effective noise reduction and cost factors is Noise Wall Option 3.

**Exhibit 36**
**Recommended Mitigation Cost Analysis**

| | Height Barrier (ft)[2] | | | Length (ft)[3] | Wall Area[4] | Cost[5] | Available[6] | Over/Under[7] |
|---|---|---|---|---|---|---|---|---|
| Wall Name[1] | Min | Avg | Max | | | | | |
| **Option 3** | 7 | 10.85 | 12 | 4340 | 47081 | $2,541,122 | $2,693,520 | $179,398 |

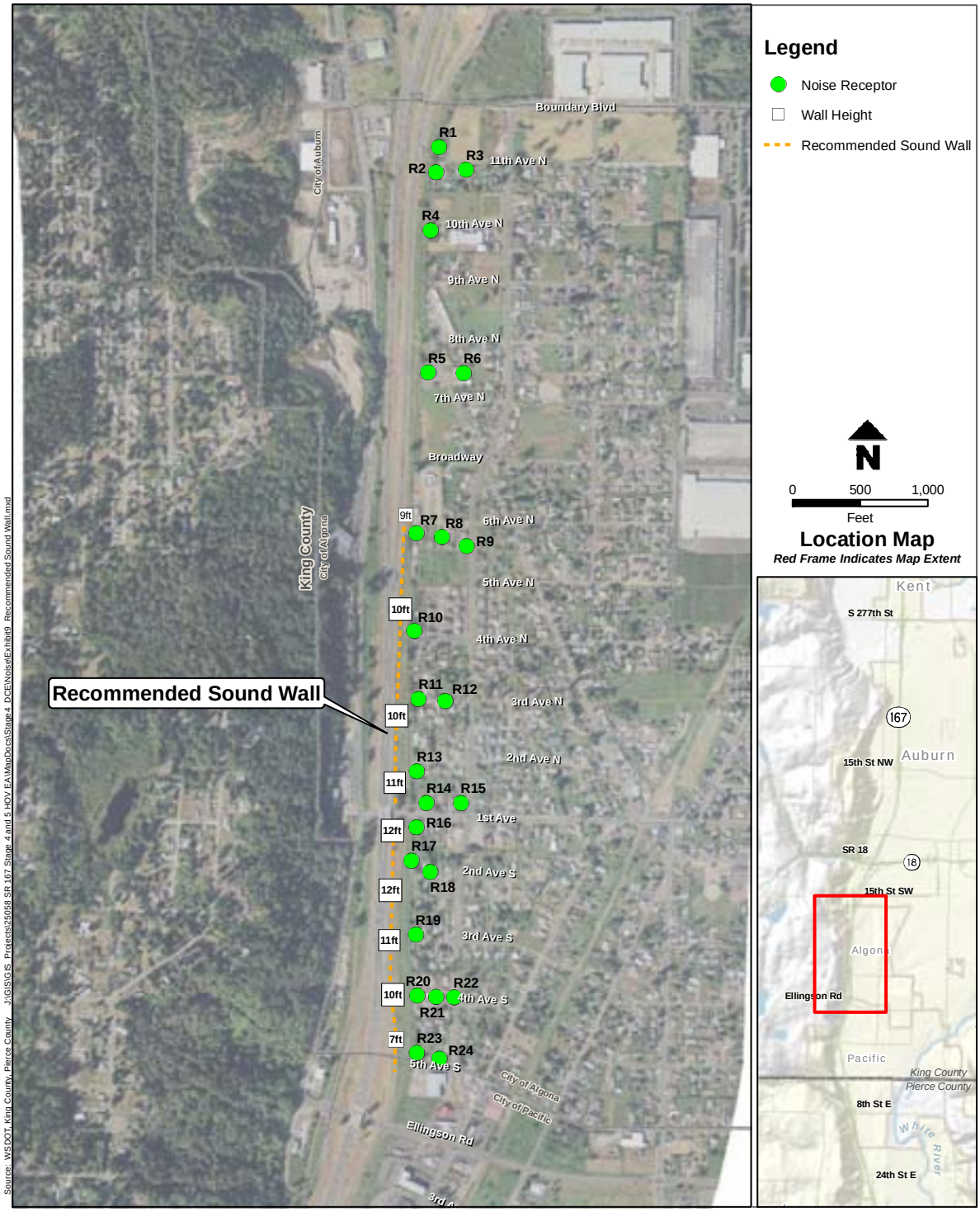
Notes:
1. Noise wall shown on Exhibit 10.
2. Minimum, average and maximum noise wall heights in feet.
3. Length of proposed wall in feet.
4. Total area of noise wall.
5. Cost of noise wall based on $53.40/square foot from WSDOT criteria for cost evaluation.
6. Available capital for noise mitigation from Exhibit 25.
7. Residual mitigation capital: if value is in **Bold-Red**, the mitigation exceeds the criteria; if the value in black, the mitigation is within the allowable capital based on WSDOT criteria.

***SR 167 – 8th Street E Vic. to S 277th Street Vic. Southbound HOT Lane***
***SR 167 – 8th Street E Vic. to 15th Street SW Vic. Northbound HOT Lane***

By locating the noise wall near the edge of pavement on SR 167, the overall height of the wall will be lower, and the noise reduction characteristics will be improved. With this noise wall option, the average noise reduction of front-row residents will be 6.9 dBA, with receiver R7 having a reduction of 8 dBA and all front-row receivers modeled to have at least a 6 dBA noise reduction. For all receivers with effects, the average noise reduction is 6.5 dBA, and for all receivers considered in this segment (R7 – R24), the average reduction is 5.9 dBA.

Because this noise wall will meet all of WSDOT's reasonableness and feasibility requirements, it is recommended that the wall be included with the highway widening project. Exhibit 35 shows the location of the recommended noise wall and approximate wall heights for the area north of Ellingson Road and south of 15th Avenue SW.

**Exhibit 37**
## Recommended Project Noise Mitigation



# CHAPTER 6 UNAVOIDABLE EFFECTS

## Are there any unavoidable project effects?

Currently, 29 residences meet or exceed the WSDOT noise criteria. Under the No Build Alternative, that number is increased to 31 residences. An estimated 71 residences are forecasted to exceed the WSDOT traffic noise criteria by the year 2030 with the Build Alternative and no mitigation. Noise mitigation was examined for all areas that will meet or exceed the WSDOT criteria. With the recommended noise mitigation, an estimated 37 residential noise effects will occur under the Build Alternative.

Receivers R1 through R6 could not be mitigated within the WSDOT cost feasibility criteria. Also, receivers, R25, R26, and R27, are located on the west side of SR 167 where noise abatement could not meet the WSDOT reasonableness and feasibility requirements; therefore, no noise abatement was recommended at these locations. Finally, the new Beaver Meadows development is located too far from the roadway for noise mitigation to meet the WSDOT reasonableness and feasibility requirements; therefore, no noise abatement was recommended at this location. Exhibit 38 summarizes the locations that are expected to exceed the criteria and provides their existing, 2030 No Build, and 2030 Build noise levels for the peak noise hour.

**Exhibit 38**
**Residual Noise Impacts Comparison**

| Receiver #[1] | Land Use[2] | Noise Levels in dBA $L_{eq}$ | | | Change in Noise Levels | | Build Impacts[8] |
|---|---|---|---|---|---|---|---|
| | | Existing[3] | Future No Build[4] | Future Build[5] | Build – Existing[6] | Build – No Build[7] | |
| R1 | Res | **71** | **71** | **72** | 1 | 1 | 1 |
| R2 | Res | **71** | **72** | **73** | 2 | 1 | 2 |
| R3 | Res | **66** | **66** | **68** | 2 | 2 | 3 |
| R4 | Res | **71** | **72** | **72** | 1 | 0 | 2 |
| R5 | Res | **71** | **72** | **72** | 1 | 0 | 1 |
| R6 | Res | 63 | 63 | **66** | 3 | 3 | 5 |
| R 25 | Res | **66** | **66** | **67** | 1 | 1 | 3 |
| R 26 | Res | 65 | 65 | **66** | 1 | 1 | 3 |
| R 27 | Res | 65 | 65 | **66** | 1 | 1 | 2 |
| R33 | Res | 65 | 65 | 66 | 1 | 1 | 1 |
| R34 | Res | 64 | 65 | 66 | 2 | 1 | 7 |
| R35 | Res | 65 | 65 | 66 | 1 | 1 | 6 |

Notes:

1. Receiver locations shown on Exhibit 9 and Exhibit 35 (recommended project mitigation).
2. Land Use: Res = residential; Sch = School; Ch = Church; Pk = Park or play area; Comm = commercial.
3. Modeled existing noise levels from TNM version 2.5, numbers in **Bold-Red** meet or exceed the WSDOT criteria.
4. Modeled future No Build (year 2030) noise levels from TNM version 2.5, numbers in **Bold-Red** meet or exceed the WSDOT criteria.
5. Modeled future Build (year 2030) noise levels from TNM version 2.5, numbers in **Bold-Red** meet or exceed the WSDOT criteria.
6. Change in noise levels, Build minus Existing.
7. Change in noise levels, Build minus No Build.
8. Number of structures or locations predicted to exceed the WSDOT criteria under the Build Alternative.

## Do any regulations apply to construction noise and vibration?

Construction noise and vibration as related to the SR 167 project are given in the following paragraphs. Information provided includes the Washington State Construction Noise Regulations, potential construction noise levels, and construction noise mitigation. Sections on vibration and vibration mitigation are also provided.

### Washington State Construction Noise Regulations

The *Washington State Administrative Code (WAC)*, Chapters 173-60 and 173-62, is typically used for construction noise analysis in Washington State.

The majority of project construction can be performed within the noise regulations, if the work is performed during normal daytime hours when construction activities are allowed, given the exemptions. If construction were to be performed during nighttime hours, WSDOT will have to meet the noise level requirements presented in Exhibit 39, or obtain a noise variance from the governing jurisdiction.

**Exhibit 39**
**Washington State Noise Control Regulation**

| | Maximum Allowable Sound Level in dBA[1] | | |
|---|---|---|---|
| **Land Use** | **Residential** | **Commercial** | **Industrial** |
| Residential | 55 | 57 | 60 |
| Commercial | 57 | 60 | 65 |
| Industrial | 60 | 65 | 70 |
| *Between the hours of 10:00 pm and 7:00 am the levels given above are reduced by 10 dBA.* | | | |

In addition to the property line noise standards in Exhibit 39, there are exemptions for short-term exceedance of the criteria, including those outlined in Exhibit 40, which are based on the minutes per hour that the noise limit is exceeded.

**Exhibit 40**
**Exemptions for Short-Term Noise Exceedance**

| Minutes Per Hour | Adjustment to Maximum Sound Level |
|---|---|
| 15 | +5 dBA |
| 5 | +10 dBA |
| 1.5 | +15 dBA |

The State of Washington has developed a set of construction-specific allowable noise level limits that will apply to project construction. These noise regulations are divided by type of noise and include general construction equipment, impulse equipment, such as jack hammers and pile drivers; as well as haul trucks and safety alarms, such as back-up beepers.

### General Construction Equipment Criteria

For construction activities, the limits in Exhibit 41 may be exceeded between 7:00 am and 10:00 pm on weekdays, and between 9:00 am and 10:00 pm on weekends and holidays.

**Exhibit 41**
**Washington State General Construction Allowable Exceedance**

| Allowable Exceedance | Equipment Covered |
|---|---|
| 25 dBA | Equipment on construction sites, including, but not limited to, crawlers, tractors, dozers, rotary drill and augers, loaders, power shovels, cranes, derricks, graders, off-highway trucks, ditchers, trenchers, compactors, compressors, and pneumatic-powered equipment. |
| 20 dBA | Portable powered equipment used for temporary locations in support of construction activities, such as chainsaws, log chippers, lawn and garden equipment, and powered hand tools. |
| 15 dBA | Powered equipment used in temporary repair or periodic maintenance of the grounds such as lawn mowers and powered hand tools. |

### Impact Construction Equipment Criteria

Impact construction equipment may exceed the noise level limits given in Exhibit 42 in any one-hour period between 8:00 am and 5:00 pm on weekdays and 9:00 am and 5:00 pm on weekends and holidays. This equipment includes, but is not limited to, pavement breakers, pile drivers, jackhammers, and sandblasting tools. This allowable noise limit exceedance also applies to other types of equipment or devices that create impulse or impact noise, or that are used as impact equipment, as measured at a property line or at 50 feet from the equipment, whichever is greater.

**Exhibit 42**
**Washington State General Construction Prohibited Noise Levels**

| Noise Level (in dBA $L_{eq}$) | Time Duration Exceedance Prohibited |
|---|---|
| 90 | Continuously |
| 93 | 30 minutes |
| 96 | 15 minutes |
| 99 | 7½ minutes, with noise variance for noise levels over 99 dBA |

### Haul Truck Criteria

Maximum permissible sound levels for haul trucks are limited to 86 dBA for speeds of 35 mph or less, and 90 dBA for speeds over 35 mph when measured at 50 feet.

### Alarm Criteria

Sounds created by backup alarms are exempt if operated for less than 30 minutes per incident, except between 10:00 pm and 7:00 am, when backup alarms are prohibited and on-site spotters will be required by Occupation and Health and Safety Administration (OSHA) regulations. Ambient sensitive backup alarms can be used at night or WSDOT may use back-up observers in lieu of back-up

warning devices for all equipment except dump trucks in compliance with WAC Chapter 296-155-610 and 296-155-615. WSDOT will use back-up observers and back-up warning devices for dump trucks in compliance with WAC Chapter 296-155-610.

### Will any unavoidable impacts result from construction noise?

Construction noise will be generated by heavy equipment used during major construction periods under the Build Alternative. Construction activities will occur throughout the project area as close as 50 feet from existing residences/businesses. Estimates of maximum hourly noise levels at the closest receivers for various stages of construction are provided in Exhibit 43.

**Exhibit 43**
**Estimated Peak-Hour Construction Noise Levels**

| Construction Phase | Loudest Equipment | Maximum Noise Level at 50 feet (dBA $L_{max}$) |
|---|---|---|
| Clearing and grubbing | Bulldozer, backhoe | 86 |
| Earthwork | Scraper, bulldozer | 88 |
| Foundation | Backhoe, loader | 85 |
| Base preparation | Trucks, bulldozer | 88 |
| Paving | Paver, trucks | 89 |

*Source: U.S. Department of Transportation. Highway Construction Noise: Measurement, Prediction, and Mitigation. 1977.*

Currently, no Federal Highway Administration (FHWA) criteria exist for construction noise impacts. Offsetting the relatively high noise levels is the fact that the construction will be of short duration and the levels in Exhibit 43 can be expected only when the equipment is within 50 feet of the receiver. All buildings bordering on project roadways can expect maximum construction noise levels in the 80 to 90 dBA range when equipment is operating on the roadway immediately next to them. These noise levels will decrease as the construction operations move farther away.

### What mitigation measures will be taken during construction?

Several construction noise abatement methods can be implemented to limit project effects. Operation of construction equipment can be prohibited within 1,000 feet of any occupied dwelling unit during nighttime hours (10:00 pm to 6:00 am) or on Sundays or legal holidays, when noise will have the most severe effect. All engine-powered equipment is required by the Washington State Administrative Code (WAC) to have mufflers installed according to the manufacturer's specifications, and all equipment can be required to comply with pertinent equipment noise standards of the U.S. Environmental Protection Agency (EPA).

If specific noise complaints are received during construction, WSDOT may implement one or more of the following noise mitigation measures during construction:

- Locate stationary construction equipment as far from nearby noise-sensitive properties as possible
- Shut off idling equipment
- If possible, install any proposed noise walls early in the construction process
- Reschedule construction operations to avoid periods of noise annoyance identified in the complaint
- Notify nearby residents whenever extremely noisy work will be occurring
- Install temporary or portable acoustic barriers around stationary construction noise sources
- Obtain a noise variance, if required by the local noise ordinance, for construction activities outside allowable hours

No specific regulations or criteria are applicable to vibration related to construction activities. However, State Environmental Protection Act (SEPA) and National Environmental Policy Act (NEPA) guidelines allow federal, state, and local agencies the authority to determine acceptable levels of construction vibration using guidelines, research, and professional standards. For this project, WSDOT will rely on the U.S. Department of Transportation (USDOT) guidelines for acceptable vibration levels from construction activities. The guidelines recommend that the maximum peak-particle velocity levels remain

below 1.27 inches per second at structures nearest the construction site. Vibration levels above 1.27 inches per second have the potential to cause architectural damage to normal dwellings. The USDOT also states that vibration levels above 0.64 inches per second can be annoying to people and disrupt normal working or living environments (USDOT, 1978).

## What mitigation measures will be taken during the project operation?

Mitigation of operational noise includes the recommended noise barrier. The barrier will have an average height of 10.85 feet and a maximum height of 12 feet. The approximate length will be 4,340 feet and the wall surface area will be approximately 47,081 square feet. The exact location and top of wall elevations of the proposed wall will be determined during the final design phase of this project.

## APPENDIX A REFERENCES

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United States Department of Transportation (USDOT) Federal Highway Traffic Noise Standards (Title 23 of the Code of Federal Regulations (CFR) Part 722, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*).

WSDOT (Washington State Department of Transportation). 2006. *Traffic Noise Analysis and Abatement Policy and Procedures Manual*. Washington State Department of Transportation. March 2006.

WSDOT (Washington State Department of Transportation). 2003. *Environmental Procedures Manual*. Section 446. Washington State Department of Transportation. September 2003.

*Washington State Administrative Code (WAC)*, Chapters 173-60 and 173-62.

## APPENDIX B TRAFFIC DATA

| **Existing (2006) Traffic Volumes** | | |
|---|---|---|
| **Northbound** | | **PM Peak** |
| | 8th St E On to Ellingson Off | 2,760 |
| | Ellingson Off to Ellingson On | 2,540 |
| | Ellingson On to 15th St SW Off | 2,850 |
| | 15th St SW Off to SR 18 Off | 2,430 |
| **Southbound** | | |
| | 15th St SW On to Ellingson Rd Off | 3,780 |
| | Ellingson Rd Off to Ellingson Rd On | 3,460 |
| | Ellingson Rd On to 8th St SE Off | 3,940 |
| | 8th St SE Off to 8th St SE On | 3,450 |

| **Future No Build (2030) Traffic Volumes** | | |
|---|---|---|
| **Northbound** | | **PM Peak** |
| | 8th St E On to Ellingson Off | 2,982 |
| | Ellingson Off to Ellingson On | 2,744 |
| | Ellingson On to 15th St SW Off | 3,079 |
| | 15th St SW Off to SR 18 Off | 2,625 |
| **Southbound** | | |
| | 15th St SW On to Ellingson Rd Off | 4,270 |
| | Ellingson Rd Off to Ellingson Rd On | 3,909 |
| | Ellingson Rd On to 8th St SE Off | 4,451 |
| | 8th St SE Off to 8th St SE On | 3,897 |

| **Future Build (2030) Traffic Volumes** | | |
|---|---|---|
| **Northbound** | | **PM Peak** |
| | 8th St E On to Ellingson Off | 3,094 |
| | Ellingson Off to Ellingson On | 2,847 |
| | Ellingson On to 15th ST SW Off | 3,195 |
| | 15th St SW Off to SR 18 Off | 2,724 |
| **Southbound** | | |
| | 15th St SW On to Ellingson Rd Off | 5,141 |
| | Ellingson Rd Off to Ellingson Rd On | 4,706 |
| | Ellingson Rd On to 8th St SE Off | 5,359 |
| | 8th St SE Off to 8th St SE On | 4,692 |

## APPENDIX C FIELD MEASUREMENTS, PHOTOS AND TRAFFIC COUNTS

| Site #[1] | Address[2] | $L_{eq}$ dBA[3] | Notes[4] |
|---|---|---|---|
| M1 | 11th Avenue North | 71 | SFR Front Row Receiver |
| M2 | 11th Avenue North: | 64 | SFR Second/Third Row Receiver |
| M3 | 10th Avenue North: | 69 | SFR Front Row Receiver |
| M4 | 6th Avenue North: | 70 | SFR Front Row Receiver |
| M5 | 6th Avenue North: | 64 | SFR Second/Third Row Receiver |
| M6 | 3rd Avenue North: | 69 | SFR Front Row Receiver |
| M7 | 1st Avenue North: | 66 | MFR Front Row Receiver |
| M8 | 1st Avenue North: | 64 | MFR Second/Third Row Receiver |
| M9 | 3rd Avenue South: | 64 | SFR Front Row Receiver |

**Notes:**

1. Monitoring sites shown on Exhibit 2.
2. Address nearest to monitoring location.
3. Measured 1-hour $L_{eq}$ based on 15-minute reading.
4. SFR = Single-family residence; MFR = Multi-family residence (apartments, condos, duplexes).

| **Traffic Volumes at M3** | | |
|---|---|---|
| **Northbound LEQ= 69.2** | | |
| **Autos** | **Medium Trucks** | **Heavy Trucks** |
| 488 | 38 | 77 |
| **Southbound LEQ= 69.6** | | |
| **Autos** | **Medium Trucks** | **Heavy Trucks** |
| 418 | 27 | 88 |

***SR 167 – 8th Street E Vic. to S 277th Street Vic. Southbound HOT Lane***

M1


M2


M3


M4


M5

M6

M7


## Supplemental Noise Monitoring Data

**WASHINGTON STATE DEPARTMENT OF TRANSPORTATION**

**FIELD NOTE SOUND LEVEL MEASUREMENTS**

SR 167 Project HOT Lanes MP _____ Work Order _____

Personnel: T. Sexton Date 10/23/08

Metrology:

Temperature 62° Humidity 71% Cloud Cover 60% Wind Speed / Direction ESE 13 MPH

Notes _____

Site Characteristics and Measured Levels:

Site # _____ Location _____ Time (Start) 921 am (End) 936

Photo Roll / # _____ / _____ Description _____

Background Level _____ Source ☐ Auto's ☐ Trucks ☐ Buses ☐ Motorcycles ☐ Aircraft ☐ Other _____ ☐ Other _____

Duration 15m Leq 66.2 Le 95.7 Lmax 72.3 $L_{pk}$ 84.1 $L_{05}$ 68.4 $L_{10}$ 67.9 $L_{50}$ 66.0 $L_{90}$ 63.4 $L_{95}$ 62.3

Notes _____

Equipment:

Site # 1 Sound Level Meter Model / Serial Number LA 4350 / 1241 00692 Mic 1880

Calibrator B&K Calibration 93.8 Weighting A Response Speed F Range 30-100

Notes _____

Traffic Counts:

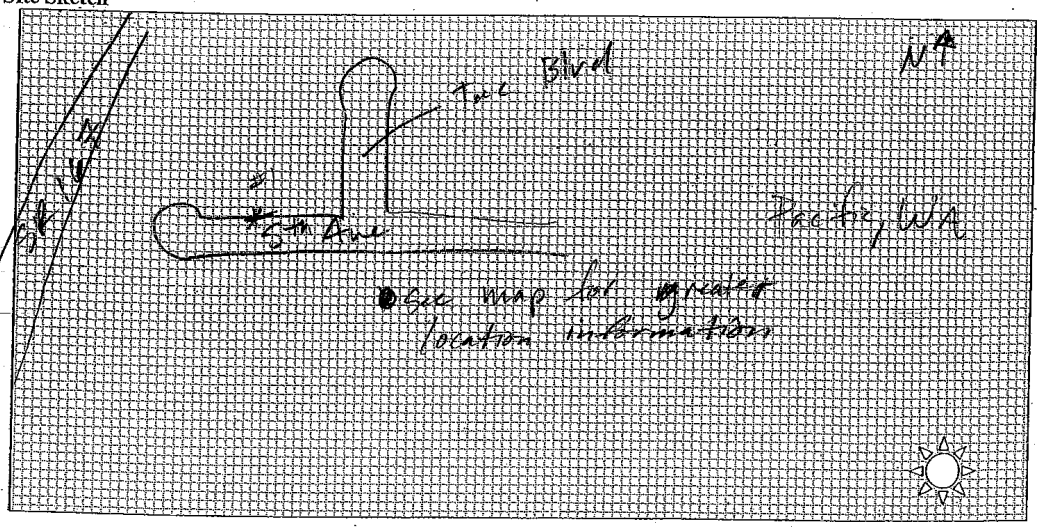
~~Count Location~~ 15 min count Start Time 921

Traffic Notes _____

| Roadway Name & Dir | SR167 NB | | SR 167 SB | | | | | |
|---|---|---|---|---|---|---|---|---|
| Vehicle Type | Count | Vehicle / hr. | Count | Vehicle / hr. | Count | Vehicle / hr. | Count | Vehicle / hr. |
| Automobiles | 591 | | 556 | | | | | |
| Med. Trucks | 40 | | 32 | | | | | |
| Hvy Trucks | 85 | | 73 | | - | | - | |
| Busses | | | | | | | | |
| Motorcycles | | | | | | | | |
| Other | | | | | | | | |
| Duration / *Speed | 60 | | 60 | | | | | |

* Speed should be Posted or Average if traffic appears to be moving at other than posted speeds

Site Sketch



***SR 167 – 8th Street E Vic. to S 277th Street Vic. Southbound HOT Lane***
***SR 167 – 8th Street E Vic. to 15th Street SW Vic. Northbound HOT Lane***


# SR 167: Pacific Vic

15 minute Traffic Count, 6/23/06, 9:21 AM - 9:36 AM

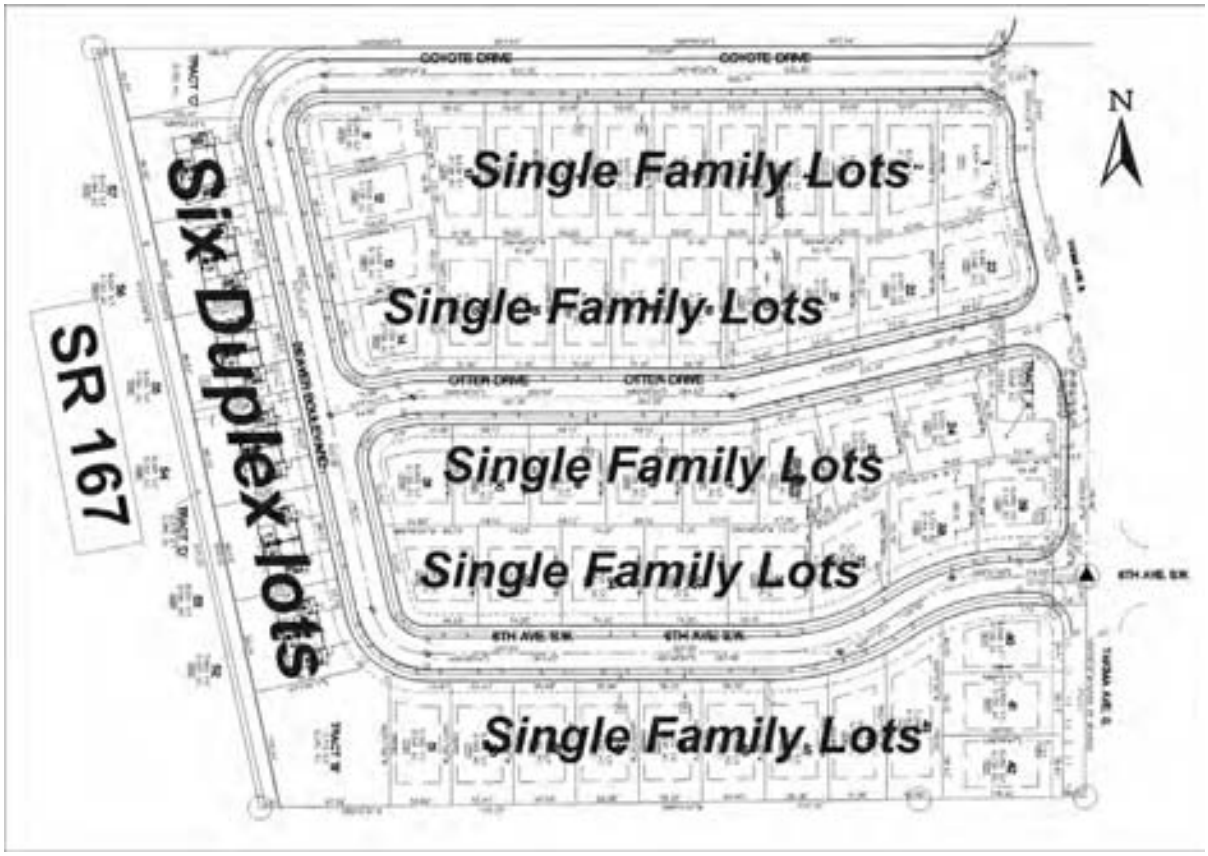
| NB: | SB: |
|---|---|
| Cars - 591 | Cars - 556 |
| Med Trucks - 40 | Med Trucks - 32 |
| Heavy Trucks - 65 | Heavy Trucks - 73 |

Leq - 66.2 dB(A)

Notes:
For information on the housing development that is highlighted in yellow hatch marks, call Stu & Robbin Clifford, 253/852-5007, or 253/350-5993.

Map prepared on June 24, 2008, by Tim Sexton for use in the supplement to the SR 167 Issue Report to be prepared by Michael Minor & Associates.

## APPENDIX D BEAVER MEADOWS REVELOPMENT LOT PLANS



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## APPENDIX E TNM FILES ON CD