



Everett Link Extension

Draft Environmental Impact Statement

NOISE AND VIBRATION TECHNICAL REPORT

Appendix G.8

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Attachments

- Attachment A Noise Measurement Site Photographs
- Attachment B Noise Measurement Data
- Attachment C Vibration Measurement Site Photographs
- Attachment D Vibration Measurement Data
- Attachment E Detailed Noise and Vibration Impact Tables

Acronyms

AIR	SR 99/Airport Road
ALD	West Alderwood
ANSI	American National Standards Institute
ASH	Ash Way
BI	Broadway/I-5
CSA	Cross-Spectrum Acoustics
dB	decibel
dBA	A-weighted decibel
EDNA	Environmental Designation for Noise Abatement
EGN	SR 526/Evergreen
EIS	Environmental Impact Statement
EVLE	Everett Link Extension
EVT	Everett Station
FDL	force density level
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
Hz	Hertz
in/sec	inches per second
L _{dn}	day night sound level
L _{eq}	equivalent sound level
L _{max}	maximum noise level
L _n	sound level exceeded n-percent of the time
LRT	light rail transit
LRV	light rail vehicle
LSTM	line source transfer mobility
L _v	vibration level
MAR	Mariner

mph	miles per hour
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology
OMF	operations and maintenance facility
PPV	peak particle velocity
RCNM	Roadway Construction Noise Model
RMS	root mean square
SEL	sound exposure level
SR	State Route
ST3	Sound Transit 3
SWI	SW Everett Industrial Center
TM	transfer mobility
TPSS	traction power substation
U.F.	usage factor
VdB	vibration decibel
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation

1 INTRODUCTION

1.1 Overview

The Central Puget Sound Regional Transit Authority (Sound Transit) is proposing to expand Link light rail transit service northward from the Lynnwood City Center Station to the Everett Station area in Snohomish County, Washington (Figure 1-1). The Everett Link Extension (EVLE) Project would provide fast, reliable light rail service to regional residential and job centers in Snohomish County's growing urban areas. The proposed project is part of the Sound Transit 3 (ST3) Plan of regional transit system investments, funding for which was approved by voters in the region in 2016.

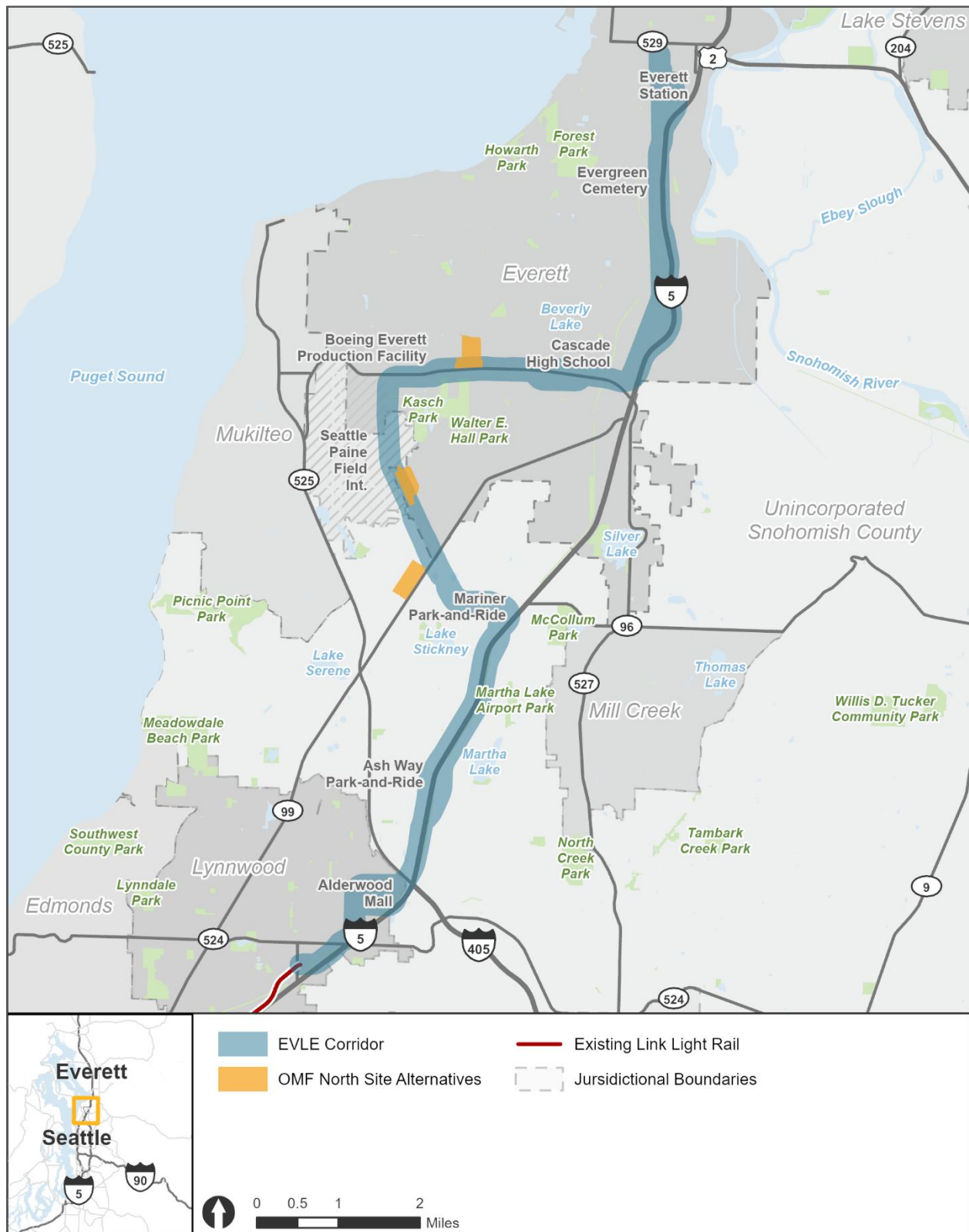
For this analysis, the EVLE Project consists of approximately 16 miles of light rail guideway, seven light rail stations, two parking facilities, and an operations and maintenance facility (OMF North). Sound Transit proposes to begin construction of the project in 2030. The current schedule for opening light rail service from the Lynnwood City Center Station to Everett Station is 2041. A shorter route connecting Lynnwood City Center to the SW Everett Industrial Center Station would open first in 2037 as the initial phase. OMF North would open by 2034, prior to opening of the light rail extension, as the facility is necessary for storing rail cars and supporting service for not only the extension to Everett, but also other parts of the regional system.¹ Parking facilities at the Mariner and Everett Stations would open by 2046.

One station, State Route (SR) 99/Airport Road Station, is currently considered provisional since planning, preliminary engineering, and environmental review are funded, but final design and construction are not. However, for purposes of this evaluation, all seven stations are assumed to be funded and open according to the schedule described above to capture all locations where impacts could occur. The station would be fully constructed and open for service when additional funding is identified.

The initial phase is not discussed in this analysis because it would not have additional potential impacts when compared with the fully built alternatives (i.e., the impacts would be the same in the West Alderwood, Ash Way, Mariner, SR 99/Airport Road, and SW Everett Industrial Center Segments, and for the OMF sites, but the impacts in the SR 526/Evergreen, Broadway/I-5, and Everett Station Segments would not occur until construction on those segments begins). All potential impacts are described in Section 5.

¹ Construction of light rail projects is typically divided into sections, and construction would occur across different parts of the corridor between 2030 and 2046. For more information on the construction approach, see Draft EIS Appendix B.

Figure 1-1 EVLE Project Corridor



For planning and engineering purposes, the project is organized into eight geographic segments, discussed in this document from south to north. Within those segments, a total of 17 alignment alternatives and 18 station location alternatives are under consideration. These alignment and station alternatives are combined into Build Alternatives for analysis as shown in Table 1-1 and Figure 1-2.

Table 1-1 describes the alignment and station alternatives as follows:

- **Segments:** The eight alignment segments and corresponding abbreviations are:
 - West Alderwood (ALD).
 - Ash Way (ASH).
 - Mariner (MAR).
 - SR 99/Airport Road (AIR).
 - SW Everett Industrial Center (SWI).
 - SR 526/Evergreen (EGN).
 - Broadway/I-5 (BI).
 - Everett Station (EVT).
- **Alignment alternatives:** Alignment alternatives in each segment are identified with numbers (e.g., ALD-1).
- **Station alternatives:** Station alternatives in each segment are identified with letters (e.g., ALD-B).²
- **Build Alternatives:** Alignments and stations are combined to create the Build Alternative name (e.g., Station ALD-B is located on Alignment ALD-1, so this pairing is referred to as Alternative ALD-1B). If a preferred Build Alternative has been identified by the Sound Transit Board of Directors, it is indicated with an asterisk.
- **Design options:** A design option is an alternate design for a portion of a Build Alternative. It could be a different route or profile along a portion of an alignment, a different station configuration, or a different parking location. For example, in the West Alderwood Segment the Alderwood Mall Boulevard Design Option is being considered for all three Build Alternatives.

² Letters identifying station alternatives are non-sequential in some segments; missing letters denote alternatives that did not perform as well as alternatives considered in the Draft EIS. For more information on the Alternatives Development process, see Draft EIS Chapter 2.

Table 1-1 Alignment and Station Build Alternatives by Segment

Segment	Alignment Alternatives	Station Alternatives	Build Alternatives (Combined Alignment and Station)	Build Alternative Design Options Also Considered
West Alderwood	ALD-1	ALD-B	ALD-1B	Alderwood Mall Boulevard
	ALD-2	ALD-D	ALD-2D*	Alderwood Mall Boulevard
		ALD-F	ALD-2F	Alderwood Mall Boulevard
Ash Way	ASH-1	ASH-A	ASH-1A	None
	ASH-2	ASH-D	ASH-2D	None
Mariner	MAR-1	MAR-B	MAR-1B	Surface Parking
	MAR-2	MAR-D	MAR-2D	Surface Parking
SR 99/ Airport Road	AIR-1	AIR-A	AIR-1A	None
	AIR-2	AIR-B	AIR-2B	None
SW Everett Industrial Center	SWI-1	SWI-A	SWI-1A*	Lower
		SWI-B	SWI-1B	None
		SWI-C	SWI-1C	None
SR 526/ Evergreen	EGN-1	EGN-A	EGN-1A	None
	EGN-2	EGN-B	EGN-2B	North Side of SR 526
	EGN-3	EGN-E	EGN-3E	North Side of SR 526
Broadway/I-5	BI-1	None	BI-1*	None
	BI-2	None	BI-2	None
Everett Station	EVT-1	EVT-A	EVT-1A	None
	EVT-2	EVT-C	EVT-2C*	None
	EVT-3	EVT-D	EVT-3D*	None

* Denotes preferred alternative

There are also three OMF North site alternatives under consideration as shown in Table 1-2 and Figure 1-2.

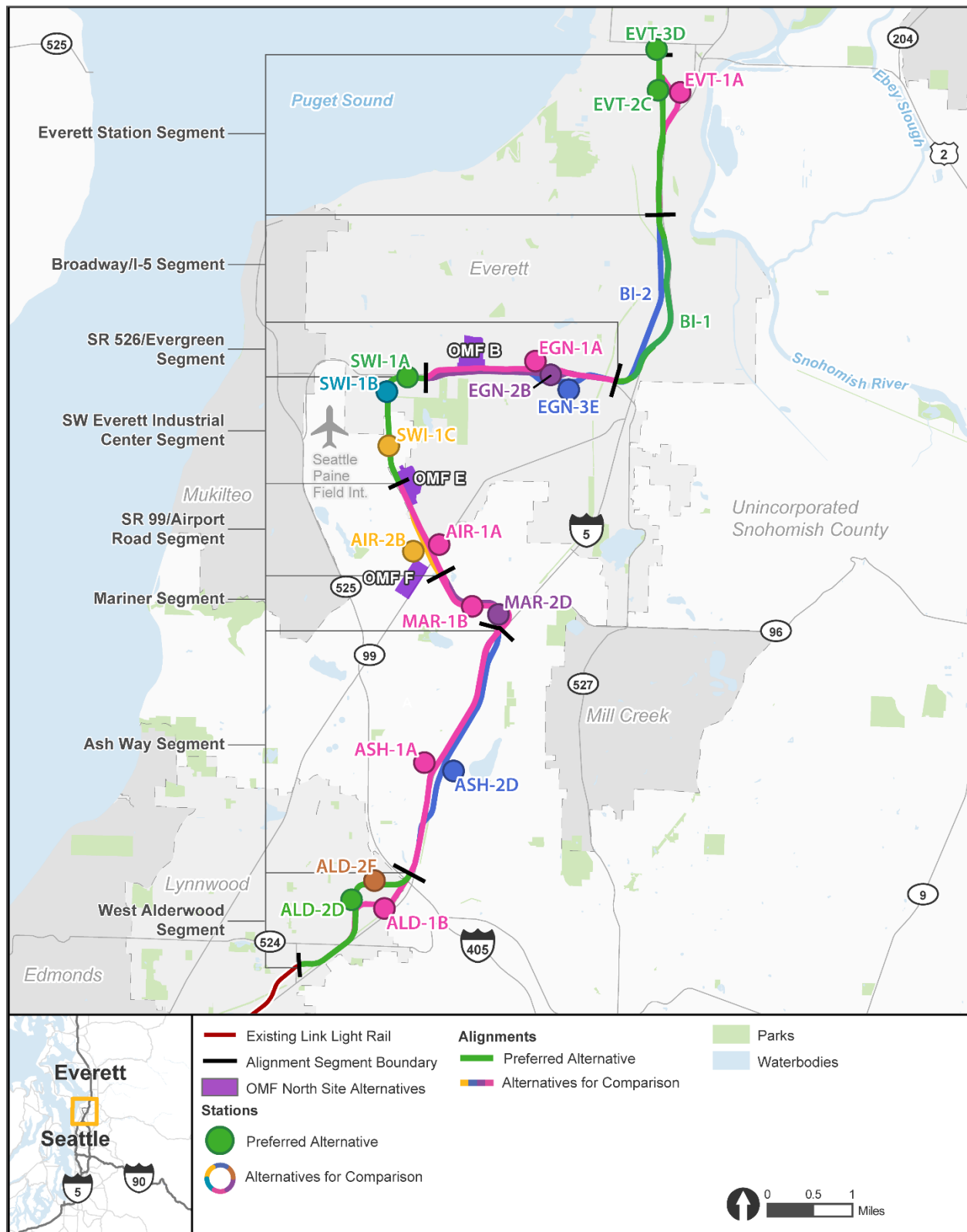
Table 1-2 OMF North Site Alternatives

Build Alternative	Build Alternative Design Options Also Considered
OMF Site F	Lead Tracks to West Side of Airport Road
OMF Site E	None
OMF Site B	Lead Tracks to South Side of SR 526

Analysis of the Build Alternatives was based on the conceptual design drawings included in Draft Environmental Impact Statement (EIS) Appendix F.

The No Build Alternative describes the environment, including the transportation system, as it would exist in 2046 without the proposed project. The No Build Alternative uses 2046 as the year of analysis to align with the target date for completion of all EVLE Project components and the full buildout of the light rail capital projects included in the ST3 Plan.

Figure 1-2 EVLE Project Alternatives



1.2 Potential Design Refinements

In addition to the alternatives described above, the Draft EIS provides a qualitative evaluation of potential design refinements that could reduce overall project cost if applied to the alignment and station alternatives (for more information, see Draft EIS Chapter 2). The potential design refinements identified to date that could be considered in each segment, along with potential changes in impacts, are described in Draft EIS Chapter 4. Potential changes in noise impacts are also described in Section 5.1.1.3 below. No changes in vibration impacts have been identified at this time. If Sound Transit decides to include these refinements as part of the project prior to the Final EIS, they would be reflected in the conceptual design plans and evaluated in the Final EIS.

1.3 Purpose of Report

The purpose of this report is to document noise and vibration in the EVLE Project vicinity and evaluate potential impacts and mitigation measures associated with the proposed alternatives. This report covers both noise and vibration in the study area.

2 NOISE AND VIBRATION BASICS

2.1 Noise Basics

Sound is defined as small changes in air pressure above and below the standard atmospheric pressure, and noise is usually considered to be unwanted sound. The three parameters that define noise include:

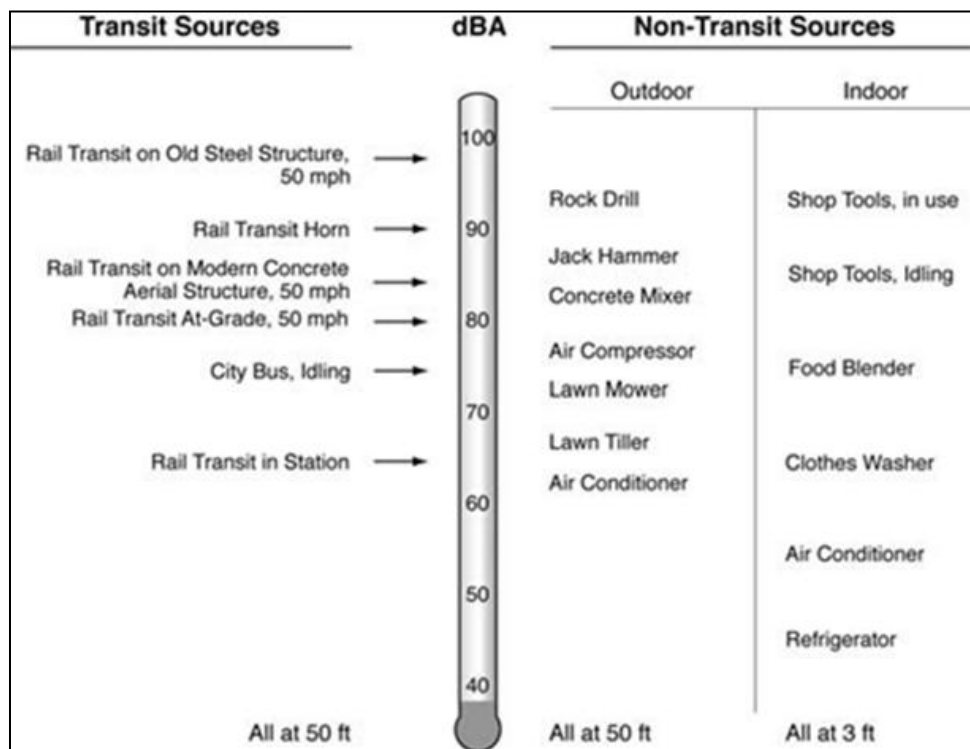
- **Level:** The level of sound is the magnitude of air pressure change above and below atmospheric pressure and is expressed in decibels (dB). Typical sounds fall within a range between 0 dB (the approximate lower limit of human hearing) and 120 dB (the highest sound level generally experienced in the environment). A 3-dB change in sound level is perceived as a barely noticeable change outdoors, and a 10-dB change in sound level is perceived as a doubling (or halving) of loudness.
- **Frequency:** The frequency (pitch or tone) of sound is the rate of air pressure change and is expressed in cycles per second, or Hertz (Hz). Human ears can detect a wide range of frequencies from around 20 Hz to 20,000 Hz; however, human hearing is not as sensitive at high and low frequencies, and the A weighting system, which measures what humans hear in a more meaningful way by reducing the sound levels of higher and lower frequency sounds, is used to provide a measure (dBA) that correlates with human response to noise. Figure 2-1 shows typical maximum A-weighted sound levels for transit and non-transit sources. The A-weighted sound level has been widely adopted by acousticians as the most appropriate descriptor for environmental noise.
- **Time Pattern:** Because environmental noise is constantly changing, it is common to condense all of this information into a single number, called the “equivalent” sound level (Leq). The Leq represents the changing sound level over a period of time, typically 1 hour or 24 hours in transit noise assessments. For assessing the noise impact of rail projects at residential land uses, the day-night sound level (Ldn) is the noise descriptor commonly used, and it has been adopted by many agencies as the best way to describe how people

respond to noise in their environment. Ldn is a 24-hour cumulative A-weighted noise level that includes all noises that occur during a day, with a 10-dB penalty for nighttime noise (10 pm to 7 am). This nighttime penalty means that any noise events at night are equivalent to 10 similar events during the day.

Typical Ldn values for various transit operations and environments are shown on Figure 2-2.

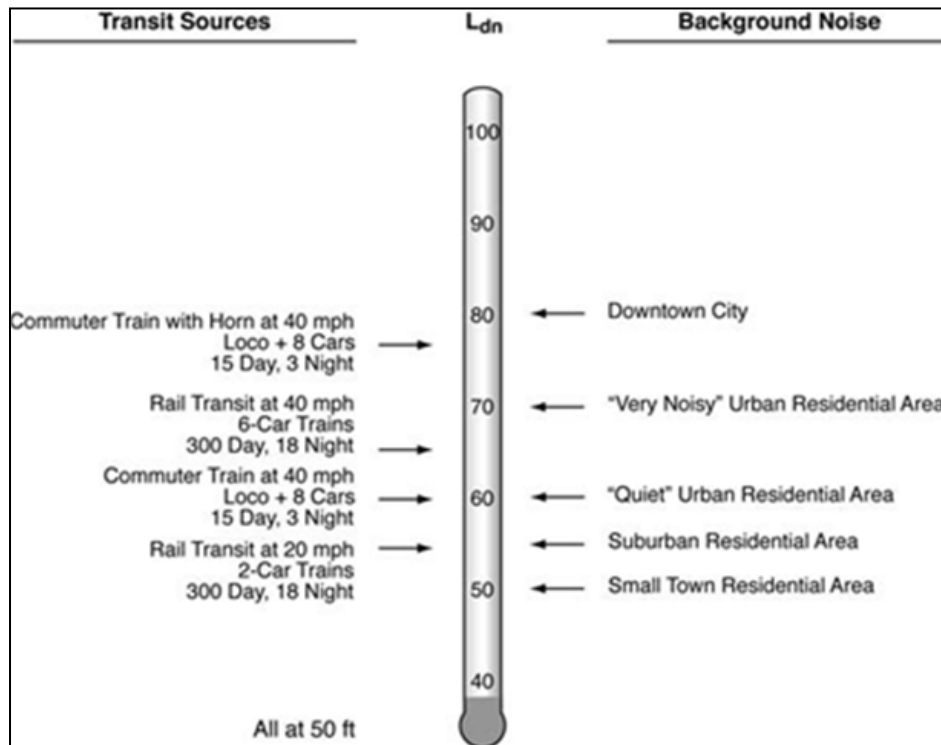
In addition to the Leq and Ldn, there are other metrics used to describe noise. The loudest 1-second of noise over a measurement period, or maximum A-weighted sound level (Lmax), is used in many local and state ordinances for noise emitted from private land uses and for construction noise impact evaluations. Environmental noise can also be viewed on a statistical basis using percentile sound levels (Ln), which refer to the sound level exceeded n-percent of the time.

Figure 2-1 Typical A-Weighted Sound Levels



SOURCE: FTA (2018).

Figure 2-2 Typical Ldn Noise Exposure Levels



SOURCE: FTA (2018).

2.2 Vibration Basics

Ground-borne vibration from trains refers to the fluctuating or oscillatory motion experienced by persons on the ground and in buildings near railroad tracks. Vibration can be described in terms of displacement, velocity, or acceleration. Displacement is the easiest descriptor to understand. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. Velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed. Although displacement is easier to understand, the response of humans, buildings, and equipment to vibration is more accurately described using velocity.

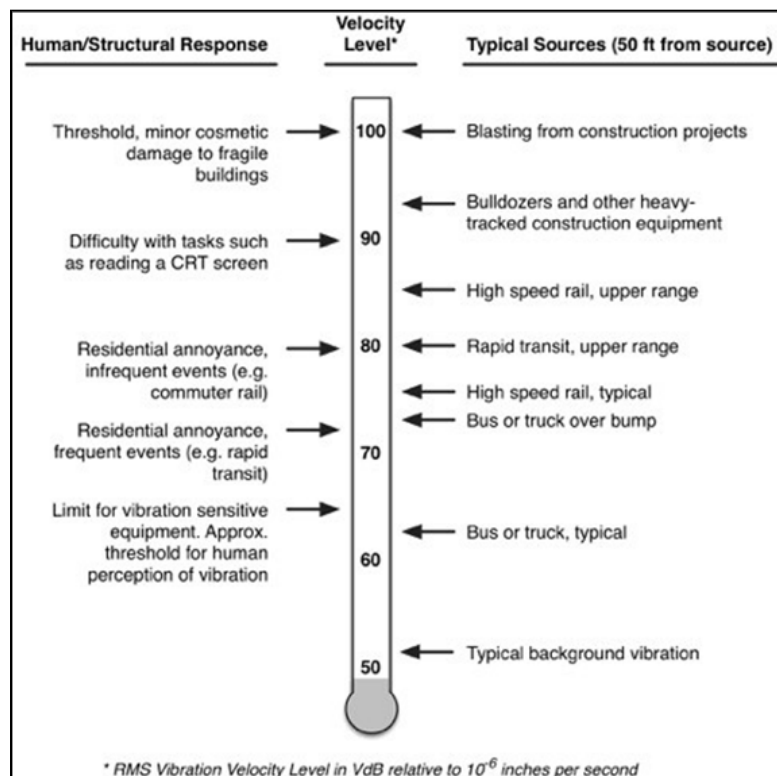
Two methods are used for quantifying vibration. The peak particle velocity (PPV) is defined as the maximum instantaneous positive or negative peak of the vibration signal. PPV often is used in monitoring of blasting vibration, since it is related to the stresses experienced by buildings. Although PPV is appropriate for evaluating the potential for building damage, it is not suitable for evaluating human response. It takes some time for the human body to respond to vibration impulses. In a sense, the human body responds to an average of the vibration amplitude. Because the net average of a vibration signal is zero, the root mean square (RMS) amplitude is used to describe the "smoothed" vibration amplitude.

PPV and RMS velocities are normally described in inches per second in the U.S. and in meters per second in the rest of the world. Decibel notation is in common use for vibration and has been adopted by the Federal Transit Administration (FTA) in their guidance. Decibel notation compresses the range of numbers required to describe vibration. Vibration levels in this report are referenced to 1×10^{-6} inches per second (in/sec). The abbreviation "VdB" is used in this

document for vibration decibels to reduce the potential for confusion with sound decibels. Common vibration sources and human and structural response to ground-borne vibration are illustrated in Figure 2-3. Typical vibration levels can range from below 50 VdB to 100 VdB (0.000316 in/sec to 0.1 in/sec). The human threshold of perception is approximately 65 VdB.

Ground-borne vibration can lead to ground-borne noise, which is a low-volume, low-frequency rumble inside buildings that occurs when ground vibration causes the flexible walls of the buildings to resonate and generate noise. Ground-borne noise is normally not a consideration when trains are elevated or at grade. In these situations, the airborne noise usually overwhelms ground-borne noise, so that the airborne noise level is the major consideration. However, ground-borne noise becomes an important consideration where there are sections of the corridor in a tunnel or where sensitive interior spaces are well-isolated from the airborne noise. In these situations, the airborne noise path is impeded, and ground-borne noise dominates inside buildings. In rare situations, ground-borne noise may also need to be considered where the airborne noise from a project is substantially mitigated by a sound wall.

Figure 2-3 Typical Levels of Ground-Borne Vibration



SOURCE: FTA (2018).

3 REGULATORY CONTEXT AND METHODOLOGY

3.1 Applicable Laws, Regulations, and Guidelines

This section summarizes the noise and vibration criteria used to evaluate the operations and construction of the project. Criteria from the FTA, Federal Highway Administration (FHWA), Washington State Department of Transportation (WSDOT) and the Washington Administrative Code (WAC) noise regulations, which have been adopted via ordinance by the Cities of Everett and Lynnwood and by Snohomish County, are included and discussed as required for this environmental analysis.

3.1.1 FTA Operational Noise Impact Criteria

The FTA operational noise impact criteria are based on well-documented research on community response to noise and are based on both the existing level of noise and the change in noise exposure due to a project. The FTA noise criteria compare the project noise with the existing noise (not the No Build noise). This is because comparison of a noise projection with an existing noise condition is more accurate than comparison of a projection with another noise projection. Because background noise may increase by the time the project is operational, this approach of using existing noise conditions is conservative.

The FTA noise criteria are based on the land use category of the sensitive receptor. The descriptors and criteria for assessing noise impact vary according to land use categories adjacent to the track. For Category 2, land uses where people live and sleep (e.g., residential neighborhoods, hospitals, and hotels), the Ldn is the assessment parameter. For other land use types (Category 1 or 3) where there are noise-sensitive uses (e.g., outdoor concert areas, schools, and libraries), the Leq for the loudest hour of train activity during hours of noise sensitivity is the assessment parameter. Table 3-1 summarizes the three land use categories.

Table 3-1 Land Use Categories and Metrics for Transit Noise Impact Criteria

Land Use Category	Land Use Type	Noise Metric (dBA)	Description of Land Use Category
1	High Sensitivity	Outdoor Leq(h) ^a	Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheaters and concert pavilions, and National Historic Landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category.
2	Residential	Outdoor Ldn	This category is applicable to all residential land use and buildings where people normally sleep, such as hotels and hospitals.
3	Institutional	Outdoor Leq(h) ^a	This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries,

Land Use Category	Land Use Type	Noise Metric (dBA)	Description of Land Use Category
			monuments, museums, campgrounds, and recreational facilities are also included in this category.

SOURCE: FTA (2018).

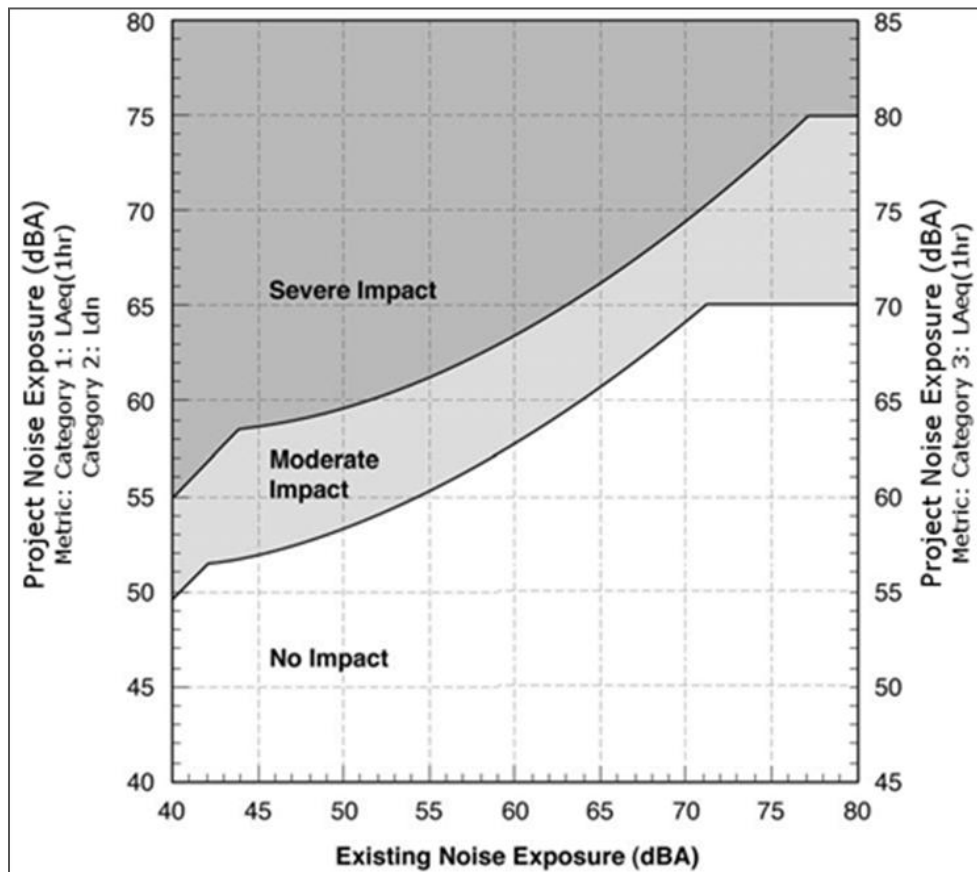
NOTES:

- a) Leq (1hr) for the loudest hour of project-related activity during hours of noise sensitivity.

The noise impact criteria are defined by the two curves in Figure 3-1, which allow increasing project noise as existing noise levels increase, up to a point at which impact is determined based on project noise alone. The FTA noise impact criteria include three levels of impact, as shown on Figure 3-1. The three levels of impact include:

- **No Impact:** In this range, the project is considered to have no impact since, on average, the introduction of the project would result in an insignificant increase in the number of people highly annoyed by the new project noise.
- **Moderate Impact:** Project-generated noise in this range is considered to cause impact at the threshold of measurable annoyance. Moderate impacts serve as an alert to project planners for potential adverse impacts and complaints from the community. Mitigation should be considered at this level of impact based on project specifics and details concerning the affected properties.
- **Severe Impact:** Project-generated noise in this range is likely to cause a high level of community annoyance. Noise mitigation should be applied for severe impacts where feasible.

Figure 3-1 FTA Noise Impact Criteria



SOURCE: FTA (2018).

Although the curves in Figure 3-1 are defined in terms of the project noise exposure and the existing noise exposure, the change in noise – when project-generated noise is added to existing noise levels – is the basis for the criteria. As the existing level of ambient noise increases, the allowable level of transit noise increases, but the total amount that community noise exposure is allowed to increase is reduced. This accounts for the unexpected result that a project noise exposure that is lower than the existing noise exposure can still cause an effect.

3.1.2 FTA Operational Vibration Impact Criteria

The operational vibration impact criteria used for the project are based on the information contained in Section 6 of the *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018; referred to as the FTA guidance manual). The criteria for a general vibration assessment are based on land use and train frequency, as shown in Table 3-2. Some buildings, such as concert halls, recording studios, and theaters, can have a higher sensitivity to vibration (or ground-borne noise) but do not fit into the three vibration categories listed in Table 3-2. Because of the sensitivity of these buildings, special attention is paid to these buildings during the environmental assessment of a project. Table 3-3 shows the FTA criteria for acceptable levels of vibration for several types of special buildings.

Table 3-2 Ground-Borne Vibration and Noise Impact Criteria for General Assessment

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Frequent Events ^a	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Occasional Events ^b	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Infrequent Events ^c	Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals) for Frequent Events ^a	Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals) for Occasional Events ^b	Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals) for Infrequent Events ^c
Category 1: Buildings where vibration would interfere with interior operations	65 ^d	65 ^d	65 ^d	N/A ^e	N/A ^e	N/A ^e
Category 2: Residences and buildings where people normally sleep	72	75	80	35	38	43
Category 3: Institutional land uses with primarily daytime use	75	78	83	40	43	48

SOURCE: FTA (2018).

NOTES:

- "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
- "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
- "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
- This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
- Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

Table 3-3 Ground-Borne Vibration and Noise Impact Criteria for Special Buildings

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Frequent Events ^a	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Occasional or Infrequent Events ^b	Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals) for Frequent Events ^a	Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals) for Occasional or Infrequent Events ^b
Concert Halls	65	65	25	25
TV Studios	65	65	25	25
Recording Studios	65	65	25	25
Auditoriums	72	80	30	38
Theaters	72	80	35	43

SOURCE: FTA (2018).

NOTES:

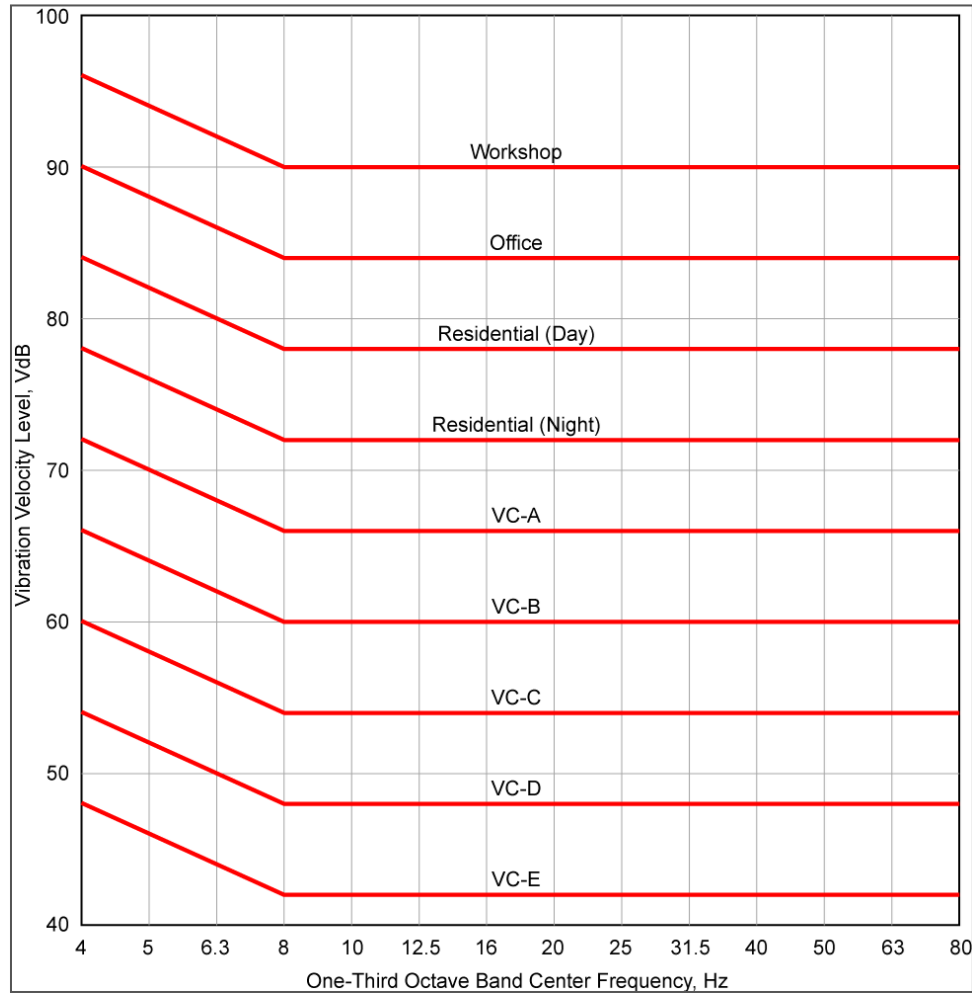
- a) "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
- b) "Occasional or Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail system.
If the building will rarely be occupied when the trains are operating, there is no need to consider impact. As an example, consider locating a commuter rail line next to a concert hall. If no commuter trains will operate after 7 pm, it should be rare that the trains interfere with the use of the hall.

Table 3-2 and Table 3-3 also include additional criteria for ground-borne noise, which is a low-frequency noise that is radiated from the motion of room surfaces, such as walls and ceilings in buildings due to ground-borne vibration. Ground-borne noise is defined in terms of dBA, which emphasizes middle and high frequencies, which are more audible to human ears. The criteria for ground-borne noise are much lower than for airborne noise to account for the low-frequency character of ground-borne noise; however, because airborne noise typically masks ground-borne noise for above ground (at-grade or elevated) transit systems, ground-borne noise is only assessed for operations in tunnels, where airborne noise is not a factor, or at locations such as recording studios, which are well insulated from airborne noise.

The criteria for a detailed vibration assessment are shown in Figure 3-2, and descriptions of the curves are shown in Table 3-4. The curves in Figure 3-2 are applied to the projected vibration spectrum for the project. If the vibration level at any one frequency exceeds the criteria, there would be an impact. Conversely, if the entire proposed vibration spectrum of the project is below the curve, there would be no impact.

For the project, the detailed vibration assessment criteria were used to assess operational ground-borne vibration, except at special buildings where the general vibration assessment criteria were used.

Figure 3-2 FTA Detailed Vibration Impact Criteria



SOURCE: FTA (2018).

Table 3-4 Interpretation of Vibration Criteria for Detailed Analysis

Criterion Curve (See Figure 3-2)	Max. Level (VdB) ^a	Description of Use
Workshop	90	Vibration that is distinctly felt. Appropriate for workshops and similar areas not as sensitive to vibration.
Office	84	Vibration that can be felt. Appropriate for offices and other areas not as sensitive to vibration.
Residential Day	78	Vibration that is barely felt. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration is not felt, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.

Criterion Curve (See Figure 3-2)	Max. Level (VdB) ^a	Description of Use
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X) and inspection and lithography equipment to 3-micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1-micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capabilities.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.

SOURCE: FTA (2018).

NOTES:

- a) As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.

3.1.3 FTA Construction Noise Impact Criteria

FTA has developed methods for evaluating construction noise levels. These methods are not standardized criteria, but they include noise impact guidelines for sensitive land uses that describe levels having the potential to result in a negative community reaction. Table 3-5 shows the FTA noise assessment criteria for construction. The last column applies to construction activities that extend over 30 days near any given receiver. The day-night sound level (L_{dn}) is used to assess impacts in residential areas, and 24-hour Leq is used in commercial and industrial areas. The 8-hour Leq and the 30-day average L_{dn} noise exposure from construction noise calculations use the noise emission levels of the construction equipment, their location, and operating hours. The construction noise limits are normally assessed at the noise-sensitive receiver property line.

Table 3-5 FTA Construction Noise Criteria

Land Use	8-Hour Leq, dBA Day	8-Hour Leq, dBA Night	Noise Exposure, dBA 30-Day Average
Residential	80	70	75
Commercial	85	85	80
Industrial	90	90	85

SOURCE: FTA (2018).

3.1.4 FTA Construction Vibration Impact Criteria

In addition to the vibration criteria for human annoyance and interference with equipment and spaces described above, there are also vibration criteria for damage from construction activities. Typical transit operations do not have the potential for damage, so only certain construction activities are assessed for generating vibration with the potential for building damage.

The thresholds for damage to structures are typically several orders of magnitude above the thresholds for human response to vibration. Table 3-6 shows the FTA criteria for vibration damage to structures. This is based on the structure and construction type (and not a designation as historic). Table 3-6 includes criteria in both VdB and PPV.

Table 3-6 FTA Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Approximate Level ^a (VdB)
I. Reinforced-concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

SOURCE: FTA (2018).

NOTES:

a) RMS velocity in VdB re 1 micro-inch/second.

3.1.5 Traffic Noise Criteria

The FTA guidance manual (FTA 2018, Section 4.1) provides performance standards or thresholds for project elements, including light rail operations and associated ancillary and support elements, such as park-and-ride lots and operations and maintenance facilities. The FTA criteria should be used to consider highway elements of a transit project if:

1. FTA is the lead agency.
2. The main purpose of the project is transit-related and not highway-related, and alternatives considered do not include reconstructing or widening an existing highway or altering existing noise barriers along a highway.
3. No federal-aid highway funds are used for the project.

All three of the FTA transit-only project criteria listed above were met by the EVLE Project, and FTA methods were used to assess traffic noise impacts, where appropriate. The project would not move any highway lanes. Where removing or modifying existing noise barriers or berms would be required, FHWA standards and regulations will be used as design and coordination with WSDOT advance.

3.1.6 Local Ordinances

WAC noise regulations, which have been adopted via ordinance by the Cities of Everett and Lynnwood and by Snohomish County, are taken from Chapter 173-60, Maximum Environmental Noise Levels (WAC 2000). The noise control ordinances provide three different Environmental Designations for Noise Abatement (EDNAs) based on zoning, which are defined as residential, commercial, and industrial. The ordinances define the maximum allowable noise level from one

EDNA to another EDNA. These noise levels apply to construction and stationary land uses like the OMF North with noises originating from outside public roadways and rights-of-way. The WAC noise standards are not applied to light rail transit (LRT) operations. For example, the noise caused by an industrial use must be less than 60 dBA at the closest residential property line, 65 dBA at the closest commercial use, and 70 dBA at the closest industrial use. Table 3-7 shows the property line noise standards provided in the WAC.

Table 3-7 Washington State Noise Control Regulation

Source of Noise	Maximum Allowable Sound Level (dBA) ^a Residential Receiver	Maximum Allowable Sound Level (dBA) ^a Commercial Receiver	Maximum Allowable Sound Level (dBA) ^a Industrial Receiver
Residential	55	57	60
Commercial	57	60	65
Industrial	60	65	70

SOURCE: WAC (2000).

NOTES:

- a) Between 10 pm and 7 am, the levels given above are reduced by 10 dBA for residential receiving property.

In addition to the property-line noise standards listed in Table 3-7, there are exemptions for short-term noise exceedance, including those outlined in Table 3-8, that are based on the minutes per hour that the noise limit is exceeded.

Table 3-8 Washington State Exemptions for Short-Term Noise Exceedances

Minutes per Hour	Ln Value	Adjustment to Maximum Sound Level
15	L ₂₅	+5 dBA
5	L _{8.3}	+10 dBA
1.5	L _{1.5}	+15 dBA

SOURCE: WAC (2000).

Construction noise is exempt from the WAC noise limits, except at residential land uses during nighttime hours (10 pm to 7 am). If construction is performed during nighttime hours, the contractor must still meet the WAC noise level requirements presented in Table 3-7 or obtain a noise variance from the governing jurisdiction.

Maximum permissible sound levels for haul trucks on public roadways 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 (Chapter 173-62, WAC).

Sounds created by backup alarms are exempt, except between 10 pm and 7 am when “beep-beep” backup alarms are essentially prohibited by the WAC in urban areas. During these hours, smart backup alarms (which automatically adjust the alarm level based on the background level) would be used, or the alarms would be switched off and replaced with spotters. This condition is included because, just like noise from construction activities, noise from backup beepers would exceed the WAC nighttime criteria, even with the allowable exceedance, at large distances from the construction site.

3.2 Methodology

National Environmental Policy Act (NEPA) regulations require that an EIS disclose impacts (i.e., effects) of a proposed action on the environment. NEPA requires an EIS to evaluate and disclose the “reasonably foreseeable environmental effects of the proposed agency action” (42 USC Section 4332). Reasonably foreseeable environmental effects are those that are sufficiently likely to occur during operation (long-term) or construction (short-term). Reasonably foreseeable environmental effects do not include effects that are speculative in nature or remote in time or place, or that are the result of a lengthy causal chain. For this analysis, reasonably foreseeable effects include all effects that are considered likely to result from the project over its operational lifetime within the study area of each resource.

The study area for noise and vibration encompasses the area within 350 feet of the project limits for the Build Alternatives per Sound Transit’s standard practice, which is the same distance used in the FTA guidance manual for screening for noise. The project limits include permanent project improvements and areas needed for project construction.

Noise and vibration from LRT operations and construction were modeled using the methods described in the FTA guidance manual. Operational noise generating activities include LRT movements on the EVLE guideway, stations, parking facilities, and traction power substations (TPSS). The only activity that would generate significant vibration would be LRT operations on the guideway.

Within the OMF, noise-generating activities would include vehicles moving within the facility, vehicle washing and drying, a TPSS, and vehicles moving on the lead tracks into service in the morning and back to the facility in the late evening. The only activity that would generate vibration would be light rail vehicles (LRVs) moving on the lead tracks into service in the morning and back to the facility in the late evening.

3.2.1 Operational Noise Methodology

3.2.1.1 LRT Noise Assessment Methodology

The projection of wayside noise levels from light rail operations at sensitive receptors was determined using the model specified in the FTA guidance manual along with current design data for the proposed project and information from the 2019 Reference Noise and Vibration Levels for Link Light Rail Projects document (Sound Transit 2019) with the following assumptions:

- LRT train speeds would range from 20 miles per hour (mph) to 55 mph for revenue operations. LRT train speeds are based on modeled speeds that reflect train operating characteristics, track geometry, and passenger station locations. Design speeds are either the same or higher than operating speeds, which ensures a slightly conservative assessment of operational noise.
- The LRT trains would consist of four LRT rail cars during all hours of operation.
- The operating hours and headways south of Mariner Station in 2041 would be as follows:
 - Early morning operations (5:00 a.m. to 6:00 a.m.): 5-minute headways.
 - Morning peak operations (6:00 a.m. to 8:30 a.m.): 3-minute headways.
 - Midday operations (8:30 a.m. to 3:00 p.m.): 5-minute headways.

- Afternoon peak operations (3:00 p.m. to 6:30 p.m.): 3-minute headways.
- Evening operations (6:30 p.m. to 10:00 p.m.): 5-minute headways.
- Evening to late night operations (10:00 p.m. to 1:00 a.m.): 7.5-minute headways.
- The operating hours and headways north of Mariner Station in 2041 would be as follows:
 - Early morning operations (5:00 a.m. to 6:00 a.m.): 10-minute headways
 - Morning peak operations (6:00 a.m. to 8:30 a.m.): 6-minute headways
 - Midday operations (8:30 a.m. to 3:00 p.m.): 10-minute headways
 - Afternoon peak operations (3:00 p.m. to 6:30 p.m.): 6-minute headways
 - Evening operations (6:30 p.m. to 10:00 p.m.): 10-minute headways
 - Evening to late night operations (10:00 p.m. to 1:00 a.m.): 15-minute headways
- The sound exposure level (SEL) at 50 feet for a four-car LRT train operating on ballast and tie track at 50 mph is assumed to be 88 dBA.
- The SEL at 50 feet for a four-car LRT train operating on direct fixation tracks on a concrete structure is increased by 4 dB relative to ballast and tie tracks.
- Locations of elevated structures, crossovers, and embedded track were identified based on the conceptual design drawings.
- Wheel impacts at track crossovers and turnouts are assumed to cause localized noise increases of 5 dB up to a distance of 300 feet and no increase beyond 300 feet.
- Because all of the TPSS equipment would be fully contained within structures, no noise assessment was conducted for TPSS facilities.

3.2.1.2 OMF Site Noise Assessment Methodology

The OMF North noise assessment methodology was identical for each of the three site alternatives. The reference noise levels were taken from the FTA guidance manual and the Sound Transit reference noise and vibration level report (Sound Transit 2019). The assessment assumes that the majority of the operations activities occur at night, when the LRVs are not in revenue service. The noise assessment includes the following assumptions:

- 152 LRVs would be based at the facility; 38 four-car LRVs would depart before 7 a.m. and return after midnight.
- The FTA reference noise level for an OMF is 118 dBA SEL at 50 feet from the center of the facility for 20 vehicles departing or arriving in one hour.
- Maintenance activities would take place inside the shop building and would not generate substantial noise levels.
- Wheel squeal is possible on curves with a radius of less than 600 to 1,000 feet depending on the speed and type of trackway. Wheel squeal is not included in the noise model because Sound Transit has committed to reducing any potential wheel squeal by installing wayside lubricators on all curves in noise-sensitive areas with a radius of less than 600 feet and by preparing all curves for wayside lubricators that have a radius of between 600 and 1,000 feet.

- The slow speeds within the OMF North site alternatives would reduce any impact noise associated with crossovers within the facility. Crossovers connecting to the mainline tracks would have higher speed operations and the potential for additional noise from vehicles traveling over them.
- Limited testing of LRV train-mounted bells or horns would occur during the daytime.

3.2.1.3 Traffic Noise Assessment Methodology

FTA provides guidance for evaluating noise for rail transit projects that would involve changes to existing highway noise barriers. Where noise barriers would be relocated as a part of the proposed project, a highway noise analysis following WSDOT procedures will be applied (and mitigation developed to address impacts as needed), based on the FTA guidance manual, as design and coordination with WSDOT advance. WSDOT follows FHWA procedures outlined in the Code of Federal Regulations (23 CFR Part 772).

For the park-and-ride facilities in the Mariner Segment and Everett Station Segment, there are no noise sensitive receivers within the FTA screening distances; therefore, no assessment of noise at those locations was conducted. There are no other locations requiring an FTA assessment of traffic noise.

3.2.2 Noise Measurement Procedures and Equipment Methodology

The noise measurements were conducted in June and September 2024 and consisted of long-term (24-hour) and short-term (1-hour) monitoring of the A-weighted sound level. All the measurement sites were located in or near noise-sensitive areas and were selected to represent a range of existing noise conditions near the Build Alternatives. Long-term noise measurements were conducted at 13 locations and a short-term measurement was conducted at one location near the alternatives. The noise measurement locations are shown in Figure 4-1 through Figure 4-12, photographs of the measurement sites are included in Attachment A, and detailed noise measurement data are presented in Attachment B. Summary information regarding the noise measurements for the alternatives is presented below in Section 4.2.

At each of the measurement sites, the A-weighted sound levels were continuously monitored during the measurement periods. The noise measurements were performed with Nti Audio model XL2 noise monitors that conform to American National Standards Institute (ANSI) Standard S1.4 for Type 1 (Precision) sound level meters. Calibrations, traceable to the U.S. National Institute of Standards and Technology (NIST), were carried out in the field before and after each set of measurements using an acoustical calibrator.

In all cases, the measurement microphone was protected by a windscreen and supported on a tripod at a height of 4 to 6 feet above the ground and was positioned to characterize the exposure of the site to the dominant noise sources in the area. For example, microphones were located at the approximate setback lines of the receptors from adjacent roads and were positioned to avoid acoustic shielding by landscaping, fences, or other obstructions.

3.2.3 Operational Vibration Assessment Methodology

The projection of ground-borne vibration from train operations was carried out using the model specified in the FTA guidance manual, supplemented by LRT vibration measurement data provided by Sound Transit, with the following assumptions:

- LRT train speeds would range from 20 mph to 55 mph for revenue operations. LRT train speeds are based on modeled speed that reflect train operating characteristics, track geometry, and passenger station locations.
- The LRT trains would consist of four LRT rail cars during all hours of operation.
- The operating hours and headways south of Mariner Station in 2041 would be as follows:
 - Early morning operations (5:00 a.m. to 6:00 a.m.): 5-minute headways.
 - Morning peak operations (6:00 a.m. to 8:30 a.m.): 3-minute headways.
 - Midday operations (8:30 a.m. to 3:00 p.m.): 5-minute headways.
 - Afternoon peak operations (3:00 p.m. to 6:30 p.m.): 3-minute headways.
 - Evening operations (6:30 p.m. to 10:00 p.m.): 5-minute headways.
 - Evening to late night operations (10:00 p.m. to 1:00 a.m.): 7.5-minute headways.
- The operating hours and headways north of Mariner Station in 2041 would be as follows:
 - Early morning operations (5:00 a.m. to 6:00 a.m.): 10-minute headways.
 - Morning peak operations (6:00 a.m. to 8:30 a.m.): 6-minute headways.
 - Midday operations (8:30 a.m. to 3:00 p.m.): 10-minute headways.
 - Afternoon peak operations (3:00 p.m. to 6:30 p.m.): 6-minute headways.
 - Evening operations (6:30 p.m. to 10:00 p.m.): 10-minute headways.
 - Evening to late night operations (10:00 p.m. to 1:00 a.m.): 15-minute headways.
- Locations of elevated structures, crossovers, and embedded track were identified based on the conceptual design drawings.
- Wheel impacts at track crossovers and turnouts are assumed to cause localized vibration increases of up to 10 VdB for nearby sensitive receptors due to the gaps in the track rails at these locations.
- Elevated structures reduce the ground-borne vibration levels by up to 10 VdB at nearby sensitive receptors compared to at-grade track.
- Vibration source (force density) levels were based on test data provided in the Sound Transit reference noise and vibration level report for both ballast and tie tracks and direct fixation tracks. The vehicle force density includes a 3 VdB safety factor.
- Vibration propagation tests were conducted at representative sites along the corridor near sensitive receptors, as described in Section 4.3. The results of these tests were combined with the LRT vehicle vibration source level measurement data to provide projections of vibration levels from the project.

The assumed vehicle vibration characteristics are represented by the force density levels (FDL) spectra at 25 mph in Figure 3-3 for both ballast and tie tracks and direct fixation tracks. The force density is the vehicle input force, by frequency, which is measured for vehicles operating on different track structures. The results were combined with the ground vibration propagation test results (represented by transfer mobility spectra shown in Attachment D) to project vibration levels as a function of distance. The formula for calculating the future vibration levels is as follows:

$$L_v = FDL + LSTM$$

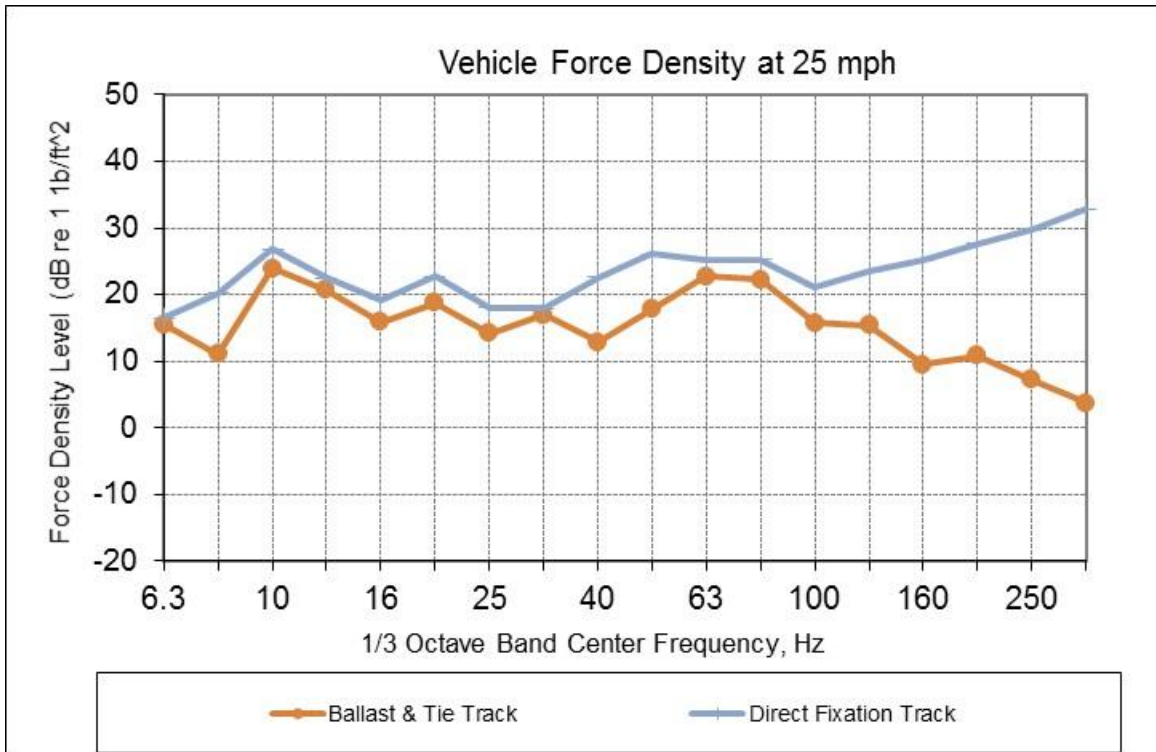
Where:

L_v = projected train vibration level,

FDL = vehicle force density, and

LSTM = line source transfer mobility at a given site.

Figure 3-3 Vehicle Force Density Levels at 25 mph



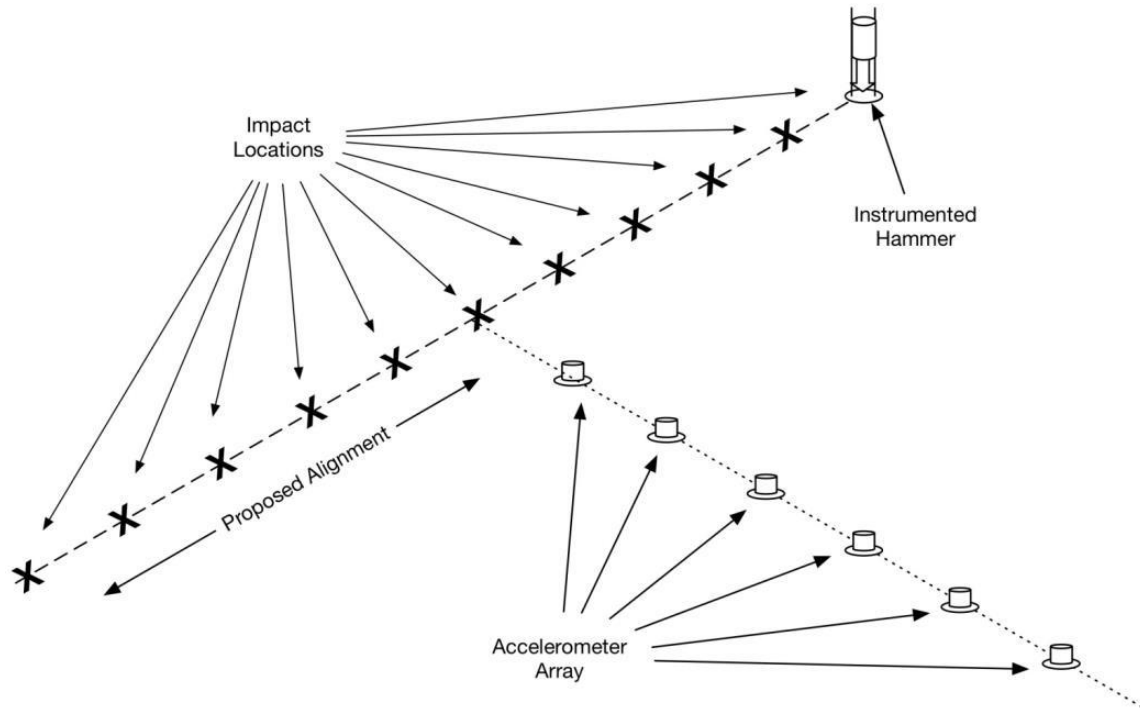
3.2.4 Vibration Measurement Procedures Methodology

Vibration propagation measurements were conducted during June and September 2024 to determine the vibration response characteristics of the ground near vibration-sensitive locations located near the proposed mainline track options. A custom-built instrumented hammer was used to impart an impulsive force to the ground to determine the ground response. The magnitude of the force was calculated based on the acceleration and mass of the falling hammer. The resulting vibration signals were measured using high-sensitivity accelerometers (PCB Model 393C and 393B05) mounted in a vertical direction on pavement or on steel spikes driven into the ground. The signals from the hammer and accelerometers were recorded using Data Translation DT9837A digital acquisition hardware. Data Translation's QuickDAQ software, running on a laptop computer, was used to review the measurement data.

The vibration propagation test procedure is shown schematically in Figure 3-4. The instrumented hammer was used to generate impulses at specific locations spaced 15 feet apart along a line on or parallel to the proposed alignment. A line of accelerometers was placed

perpendicular to the line of impacts as shown in the figure. The relationship between the input force and the resulting vibration measured by the accelerometers, called the transfer mobility (TM), was calculated using proprietary software in the Cross-Spectrum Acoustics (CSA) laboratory. The transfer mobility represents the vibration propagation characteristics of the ground at the measurement site and along the mainline track options.

Figure 3-4 Vibration Propagation Measurement Schematic



3.2.5 Construction Noise Assessment Methodology

Construction noise and impacts were assessed using a combination of the methods and construction source data contained in the FTA guidance manual and the FHWA Roadway Construction Noise Model (RCNM) from the FHWA *Construction Noise Handbook* (FHWA 2006). Typical noise levels generated by representative pieces of equipment are listed in Table 3-9. The noise exposure at a receiver location may be calculated using decibel addition of all operating construction equipment using the following equation:

$$Leq(n) = L_{max} + 10 \times \log(U.F.) - 20 \times \log(D/50) - A_{shielding}$$

where:

$Leq(n)$ = noise exposure at a receiver resulting from the operation of a single piece of equipment over n hours,

L_{max} = noise emission level of the particular piece of equipment at the reference distance of 50 feet (taken from Table 3-9),

$A_{shielding}$ = shielding provided by barriers, building, or terrain,

D = distance from the receiver to the piece of equipment in feet, and

U.F. = usage factor that accounts for the fraction of time that the equipment is in use over the specified time period. For Leq (1) assume a U.F. equal to 100%, and for 8 hours or more use the values in Table 3-9.

The combination of noise from several pieces of equipment operating during the same time period is obtained from decibel addition of the Leq of each single piece of equipment calculated using the above equations.

Table 3-9 Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level (dBA) 50 feet	Usage Factor, (U.F.) %
Air Compressor	80	40
Backhoe	80	40
Ballast Equalizer	82	50
Ballast Tamper	83	50
Compactor	82	20
Concrete Mixer	85	40
Concrete Pump	82	20
Crane, Derrick	88	16
Crane, Mobile	83	16
Dozer	85	16
Generator	82	50
Grader	85	40
Impact Wrench	85	50
Jack Hammer	88	20
Loader	80	40
Paver	85	50
Pile Driver (Impact)	101	20
Pile Driver (Vibratory)	95	20
Pneumatic Tool	85	50
Pump	77	50
Rail Saw	90	20
Rock Drill	85	20
Roller	85	20
Saw	76	20
Scarifier	83	20
Scraper	85	40
Shovel	82	40
Spike Driver	77	20
Tie Cutter	84	20
Tie Handler	80	20

Equipment	Typical Noise Level (dBA) 50 feet	Usage Factor, (U.F.) %
Tie Inserter	85	20
Truck	84	40

SOURCE: FTA (2018) and FHWA (2006).

3.2.6 Construction Vibration Assessment Methodology

Construction vibration was assessed for areas where there is potential for impact from construction activities. Such activities include blasting, pile driving, demolition, and drilling or excavation in close proximity to sensitive structures. Typical vibration levels generated by representative pieces of equipment are listed in Table 3-10. For damage assessment, the following equation is used:

$$PPV_{\text{equip}} = PPV_{\text{ref}} \times [(25/D)]^{1.5}$$

where:

PPV_{equip} = the peak particle velocity in in/sec of the equipment adjusted for distance,

PPV_{ref} = the reference vibration level in in/sec at 25 feet from Table 3-10, and

D = the distance from the equipment to the receiver in feet.

For annoyance assessment, the following equation is used:

$$Lv(D) = Lv(25 \text{ ft}) - 30 \times \log(D/25)$$

where:

$Lv(D)$ = RMS vibration level at distance D,

$Lv(25 \text{ ft})$ = RMS vibration level at 25 feet from Table 3-10, and

D = the distance from the equipment to the receiver in feet.

Table 3-10 Construction Equipment Vibration Source Levels

Equipment		PPV at 25 feet (in/sec)	Approximate Level 1 at 25 feet (VdB) ^a
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (vibratory)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory roller		0.210	94
Hoe ram		0.089	87
Large bulldozer		0.089	87

Equipment	PPV at 25 feet (in/sec)	Approximate Level 1 at 25 feet (VdB) ^a
Caisson drilling	0.089	87
Loaded trucks	0.076	86
Jackhammer	0.035	79
Small bulldozer	0.003	58

SOURCE: FTA (2018).

NOTES:

a) RMS velocity in decibels (VdB) re 1 micro-inch/second

4 AFFECTED ENVIRONMENT

The affected noise and vibration environment in the vicinity of the EVLE alternatives was investigated based on a review of aerial photographs, geographic information system (GIS) data on current land use, site and topographic features, future land use identified per comprehensive plans, a windshield survey of the study area to determine specific site conditions (e.g., structures), and noise measurements conducted during June and September 2024. Land uses in the study area are a combination of residential, institutional, commercial, and industrial. Investigations identified noise-sensitive and vibration-sensitive receivers in the study area. Sensitive receptors located near the proposed alternatives were found to be single-family and multi-family residences, hotels, schools, and places of worship.

A summary of noise- and vibration-sensitive land uses adjacent to the EVLE alternatives that are existing or reasonably foreseeable based on local land use planning is provided below, followed by descriptions of the existing noise and vibration conditions in the study area.

4.1 Noise and Vibration Sensitive Land Uses

4.1.1 West Alderwood Segment

The land use adjacent to the West Alderwood Segment alternatives is a mixture of commercial and residential properties. The noise and vibration sensitive land use includes Hilton Garden Inn Seattle/Lynnwood, La Quinta Inn by Wyndham Lynnwood, Courtyard by Marriott Seattle North, Alderwood Community Church, Devre Bisrat St. Gabriel in Lynnwood, MMJ Training Institute, and multi-family homes.

4.1.2 Ash Way Segment

The land use adjacent to the Ash Way Segment alternatives is a mixture of industrial, commercial, and residential properties. The noise and vibration sensitive land use is a mix of single- and multi-family homes. There are no institutional noise or vibration receivers in this segment.

4.1.3 Mariner Segment

The land use adjacent to the Mariner Segment alternatives is a mixture of industrial, commercial, and residential properties. The noise and vibration sensitive land use includes

Motel 6 Everett, WA – South, Seattle Korean Seventh-Day Adventist Church, and a mix of single- and multi-family homes.

4.1.4 SR 99/Airport Road Segment and OMF Sites F and E

The land use adjacent to the SR 99/Airport Road Segment alternatives and OMF Sites F and E is a mixture of industrial, commercial, and residential properties. The noise and vibration sensitive land use includes Kingdom Hall of Jehovah’s Witnesses and a mix of single- and multi-family homes.

4.1.5 SW Everett Industrial Center Segment and OMF Site E

The land use adjacent to the SW Everett Industrial Center Segment alternatives and OMF Site E is a mixture of industrial, commercial, and residential properties. The noise and vibration sensitive land use includes Sno-Isle TECH Skills Center and single-family homes.

4.1.6 SR 526/Evergreen Segment and OMF Site B

The land use adjacent to the SR 526/Evergreen Segment alternatives and OMF Site B is a mixture of industrial, commercial, and residential properties. The noise and vibration sensitive land use includes Bible Baptist Church, Everett KinderCare, Cascade High School, South Everett Community Church, Head Start & Early Head Start, Sunrise Inn Everett, Hope Slavic Baptist Church, Cascade View Presbyterian Church, Church of Bethel, and a mix of single- and multi-family homes.

4.1.7 Broadway/I-5 Segment

The land use adjacent to the Broadway/I-5 Segment alternatives is a mixture of commercial and residential properties. The noise and vibration sensitive land use includes WoodSpring Suites Seattle Everett, Montessori Schools of Snohomish County, Extended Stay America – Seattle – Everett – North, Lowell Elementary School, and a mix of single- and multi-family homes.

4.1.8 Everett Station Segment

The land use adjacent to the Everett Station Segment alternatives is a mixture of industrial, commercial, and residential properties. The noise and vibration sensitive land use includes Evergreen Funeral Home & Cemetery, Everett Gospel Mission, Travelodge by Wyndham Everett City Center, and a mix of single- and multi-family homes.

4.2 Existing Noise Conditions

Existing noise in the project area is predominantly associated with: traffic on I-5, SR 526, Airport Road and other major roadways; local roadway traffic; aircraft overflights; and local community activities such as people talking or dogs barking. The existing ambient sound levels vary by location, depending on the proximity to I-5, SR 526, or Airport Road, and are generally typical of a suburban environment near a busy interstate and arterial roads. Existing ambient noise levels were characterized through direct measurements at selected sites in the area near the EVLE alternatives during June and September 2024. The measurement sites below were chosen to

be representative of areas with similar existing noise levels, such as locations between two exits on I-5, where the traffic volumes and noise levels would be the same.

4.2.1 West Alderwood Segment

Table 4-1 summarizes the results of the existing noise measurements conducted for the West Alderwood Segment, and Figure 4-1 shows the locations of the four noise measurements in this segment. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the West Alderwood Segment.

Site LT-28: 20007 44th Avenue. The Ldn measured at this location was 68 dBA, and the measured peak hour Leq was 64 dBA. This location is representative of the residential and institutional noise sensitive land use along the alignment between 44th Avenue and 40th Avenue. The ambient noise levels were dominated by traffic on I-5 and local traffic.

Site LT-27: Hilton Garden Inn. The Ldn measured at this location was 76 dBA, and the measured peak hour Leq was 72 dBA. This location is representative of the residential land use along the alignment between 40th Avenue and 188th Street SW. The ambient noise levels were dominated by traffic on I-5 and local traffic.

Site LT-26: The Woods at Alderwood. The Ldn measured at this location was 63 dBA, and the measured peak hour Leq was 62 dBA. This location is representative of the residential land use along 184th Street SW. The ambient noise levels were dominated by local traffic.

Site ST-5: Alderwood Community Church. The hourly Leq measured at this location was 68 dBA, and the calculated Ldn was 66 dBA. This location is representative of the institutional land use (which falls into FTA Category 3 and uses a 1-hour Leq) along the alignment between 196th Street and 188th Street. The ambient noise levels were dominated by traffic on I-5.

Table 4-1 Summary of Existing Ambient Noise Measurements Results – West Alderwood Segment

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-28	20007 44th Avenue	6/4/2024	10:00	24	68	64
LT-27	Hilton Garden Inn Seattle/Lynwood	6/4/2024	8:00	24	76	72
LT-26	The Woods at Alderwood	6/4/2024	11:00	24	63	62
ST-5	Alderwood Community Church	6/6/2024	17:01	1	66	68

Figure 4-1 Existing Noise and Vibration Measurement Locations – West Alderwood Segment



4.2.2 Ash Way Segment

Table 4-2 summarizes the results of the existing noise measurements conducted for the Ash Way Segment, and Figure 4-2 and Figure 4-3 show the locations of the eight noise measurements for this segment. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the Ash Way Segment.

Site LT-25: 2212 180th Street. The Ldn measured at this location was 76 dBA, and the measured peak hour Leq was 73 dBA. This location is representative of the single-family homes west of I-5 between Maple Road and 178th Street. The ambient noise levels were dominated by traffic on I-5.

Site LT-24: 17623 176th Place. The Ldn measured at this location was 74 dBA, and the measured peak hour Leq was 68 dBA. This location is representative of the residences west of I-5 between 178th Street and 172nd Street. The ambient noise levels were dominated by traffic on I-5.

Site LT-23: 17014 18th Place. The Ldn measured at this location was 66 dBA, and the measured peak hour Leq was 63 dBA. This location is representative of the residences east of I-5 along 18th Place and 17th Avenue. The ambient noise levels were dominated by traffic on I-5.

Site LT-22: 16921 20th Avenue. The Ldn measured at this location was 70 dBA, and the measured peak hour Leq was 66 dBA. This location is representative of the single-family residences west of I-5 between 172nd Street and 164th Street. This measurement and the associated residences are behind a noise barrier along I-5. The ambient noise levels were dominated by traffic on I-5.

Site LT-21: 1215 Darben Place. The Ldn measured at this location was 71 dBA, and the measured peak hour Leq was 67 dBA. This location is representative of the residences east of I-5 between 164th Street and 148th Street. The ambient noise levels were dominated by traffic on I-5.

Site LT-20: 15408 14th Avenue. The Ldn measured at this location was 75 dBA, and the measured peak hour Leq was 70 dBA. This location is representative of the residences west of I-5 between 164th Street and 150th Street. The ambient noise levels were dominated by traffic on I-5.

Site LT-19: 902 141st Lane Unit B. The Ldn measured at this location was 72 dBA, and the measured peak hour Leq was 68 dBA. This location is representative of the residences west of I-5 between 150th Street and 137th Street. This measurement and the associated residences are behind a noise barrier along I-5. The ambient noise levels were dominated by traffic on I-5.

Site LT-18: 725 142nd Street. The Ldn measured at this location was 67 dBA, and the measured peak hour Leq was 63 dBA. This location is representative of the residences east of I-5 between 148th Street and Meridian Avenue. The ambient noise levels were dominated by traffic on I-5.

Table 4-2 Summary of Existing Ambient Noise Measurements Results – Ash Way Segment

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-25	2212 180th Street	6/5/2024	10:00	24	76	73
LT-24	17623 176th Place	6/5/2024	11:00	24	74	68
LT-23	17014 18th Place	6/6/2024	12:00	24	66	63
LT-22	16921 20th Avenue	6/6/2024	11:00	24	70	66
LT-21	1215 Darben Place	9/9/2024	11:00	24	71	67
LT-20	15408 14th Avenue	6/26/2024	13:00	24	75	70
LT-19	902 141st Lane Unit B	6/6/2024	9:00	24	72	68
LT-18	725 142nd Street	9/10/2024	11:00	24	67	63

Figure 4-2 Existing Noise and Vibration Measurement Locations – Ash Way Segment (South)

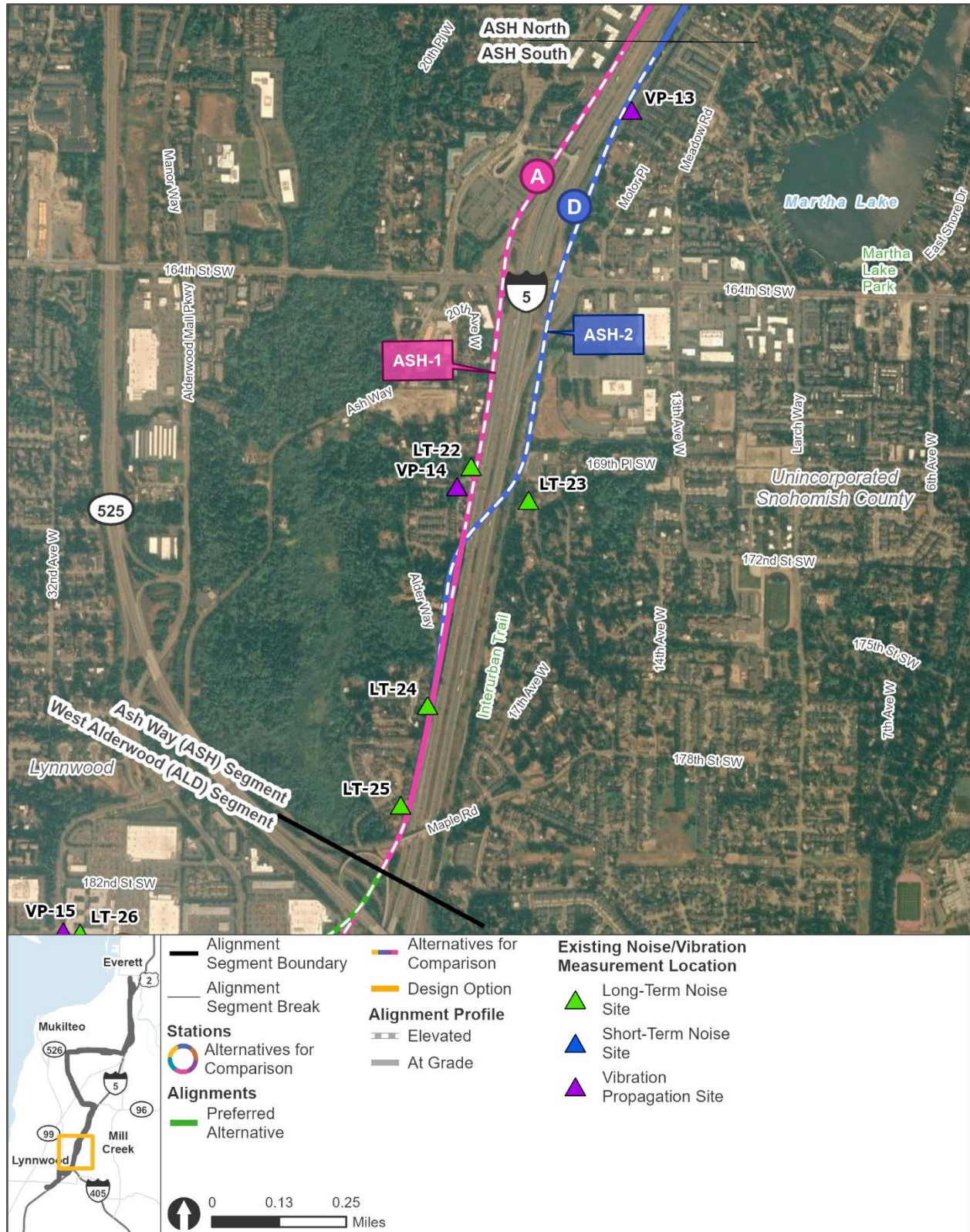
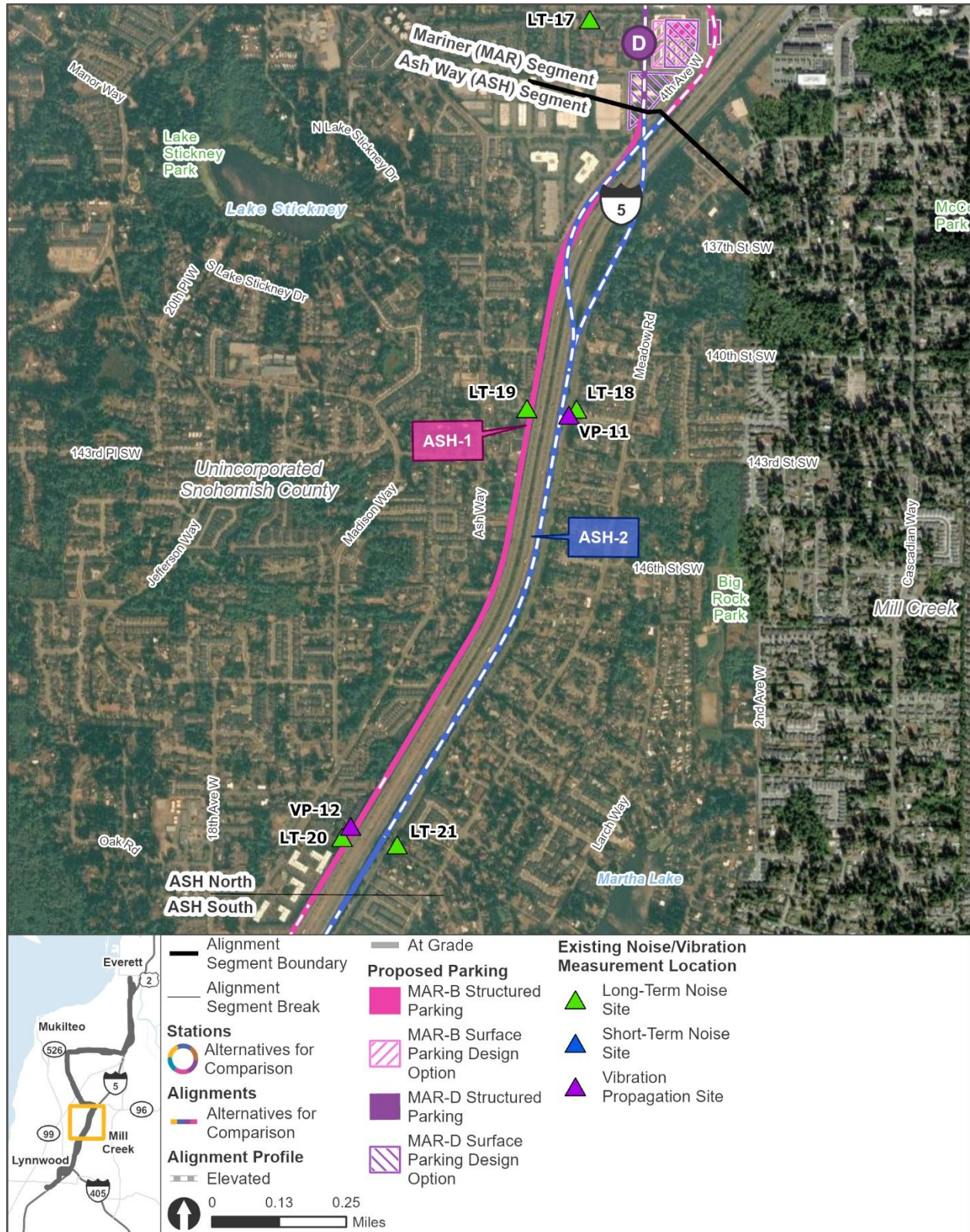


Figure 4-3 Existing Noise and Vibration Measurement Locations – Ash Way Segment (North)



4.2.3 Mariner Segment

Table 4-3 summarizes the results of the existing noise measurements conducted for the Mariner Segment, and Figure 4-4 shows the locations of the three noise measurements for this segment. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the Mariner Segment.

Site LT-17: 13031 8th Avenue. The Ldn measured at this location was 57 dBA, and the measured peak hour Leq was 52 dBA. This location is representative of the noise at Hangar 128 Apartments and Motel 6 Everett, WA - South. The ambient noise levels were dominated by local traffic.

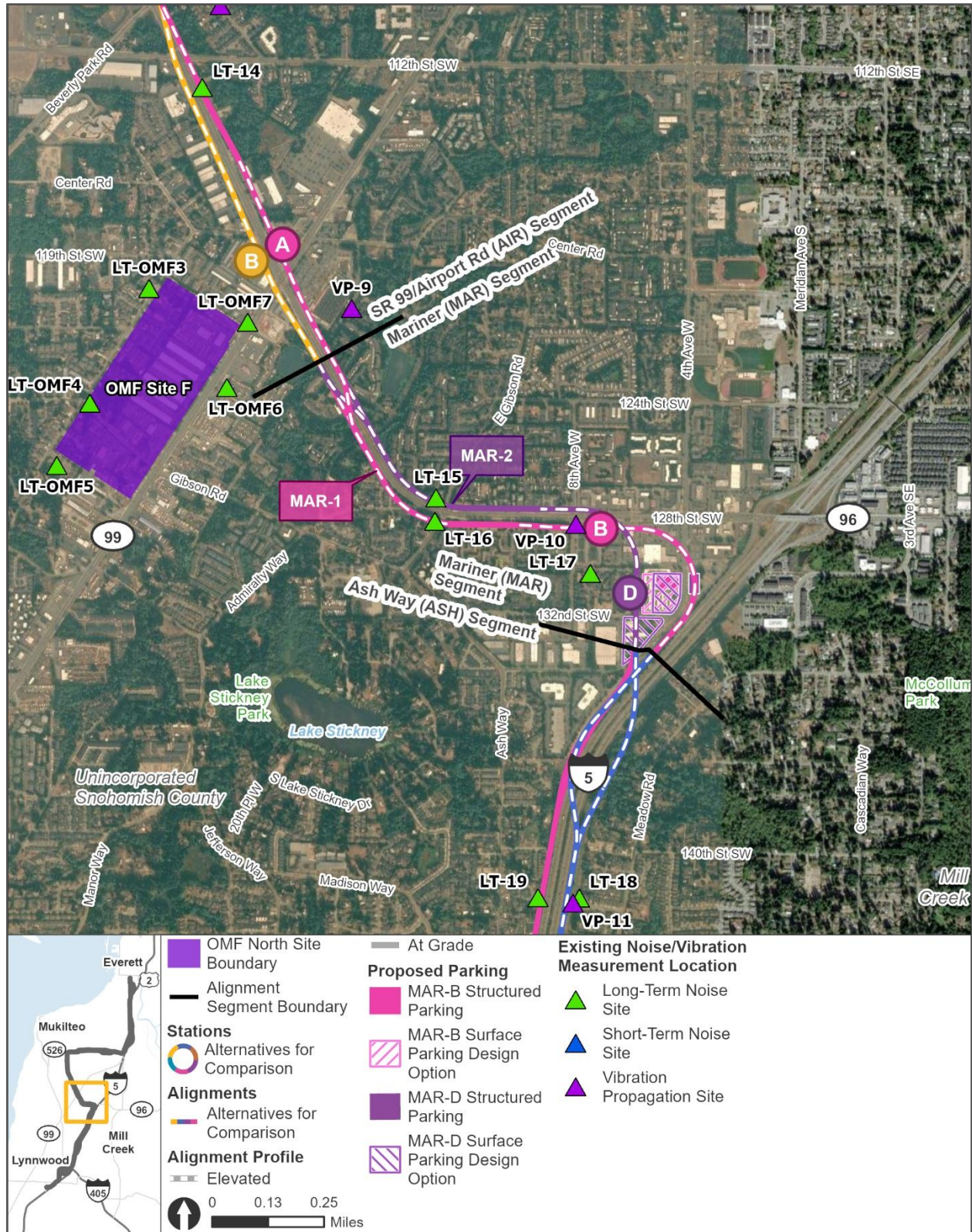
Site LT-16: 12804 Gibson Road. The Ldn measured at this location was 67 dBA, and the measured peak hour Leq was 64 dBA. This location is representative of the noise south of Airport Road between 8th Avenue and SR 99. The ambient noise levels were dominated by traffic on Airport Road/128th Street.

Site LT-15: 12724 Gibson Road. The Ldn measured at this location was 66 dBA, and the measured peak hour Leq was 61 dBA. This location is representative of the noise north of Airport Road between 8th Avenue and SR 99. The ambient noise levels were dominated by traffic on Airport Road/128th Street. This noise measurement is shared with the SR 99/Airport Road Segment.

Table 4-3 Summary of Existing Ambient Noise Measurements Results – Mariner Segment

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-17	13031 8th Avenue	9/9/2024	11:00	24	57	52
LT-16	12804 Gibson Road	9/10/2024	11:00	24	67	64
LT-15	12724 Gibson Road	6/5/2024	16:00	24	66	61

Figure 4-4 Existing Noise and Vibration Measurement Locations – Mariner Segment



4.2.4 SR 99/Airport Road Segment and OMF Sites F and E

Table 4-4 summarizes the results of the existing noise measurements conducted for the SR 99/Airport Road Segment and OMF Sites F and E, and Figure 4-5 shows the locations of the nine noise measurements for this segment and OMF Sites F and E. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the SR 99/Airport Road Segment and around OMF Sites F and E.

Site LT-15: 12724 Gibson Road. The Ldn measured at this location was 66 dBA, and the measured peak hour Leq was 61 dBA. This location is representative of the noise north of Airport Road between 8th Avenue and SR 99. The ambient noise levels were dominated by traffic on Airport Road/128th Street. This noise measurement is shared with the Mariner Segment.

Site LT-14: 11303 Airport Road. The Ldn measured at this location was 67 dBA, and the measured peak hour Leq was 63 dBA. This location is representative of the noise sensitive land use along Airport Road between SR 99 and 100th Street. The ambient noise levels were dominated by traffic on Airport Road. This noise site is shared with the SW Everett Industrial Center Segment.

Site LT-OMF7: 12118 Highway 99. The Ldn measured at this location was 77 dBA, and the measured peak hour Leq was 75 dBA. This location is representative of the noise sensitive land use north of OMF Site F along Alexander Road and Center Road between 120th Place and Airport Road. The ambient noise levels were dominated by local traffic.

Site LT-OMF6: Lakeside RV Park. The Ldn measured at this location was 66 dBA, and the measured peak hour Leq was 64 dBA. This location is representative of the noise sensitive land use east of OMF Site F along SR 99 between Gibson Road and Airport Road. The ambient noise levels were dominated by traffic on SR 99.

Site LT-OMF5: 2612 126th Place. The Ldn measured at this location was 55 dBA, and the measured peak hour Leq was 56 dBA. This location is representative of the noise sensitive land use south of OMF Site F between Alexander Road and SR 99. The ambient noise levels were dominated by local traffic.

Site LT-OMF4: 12413 Alexander Road. The Ldn measured at this location was 62 dBA, and the measured peak hour Leq was 59 dBA. This location is representative of the noise sensitive land use west of OMF Site F along Alexander Road between 126th Place and Stallings Road. The ambient noise levels were dominated by local traffic.

Site LT-OMF3: 12014 Alexander Road. The Ldn measured at this location was 64 dBA, and the measured peak hour Leq was 63 dBA. This location is representative of the noise sensitive land use west of OMF Site F along Alexander Road between Stallings Road and 119th Street. The ambient noise levels were dominated by local traffic.

Site LT-OMF2: 10629 21st Place. The Ldn measured at this location was 53 dBA, and the measured peak hour Leq was 49 dBA. This location is representative of the noise sensitive land use east of OMF Site E between Holly Drive and 101st Place. The ambient noise levels were dominated by local traffic.

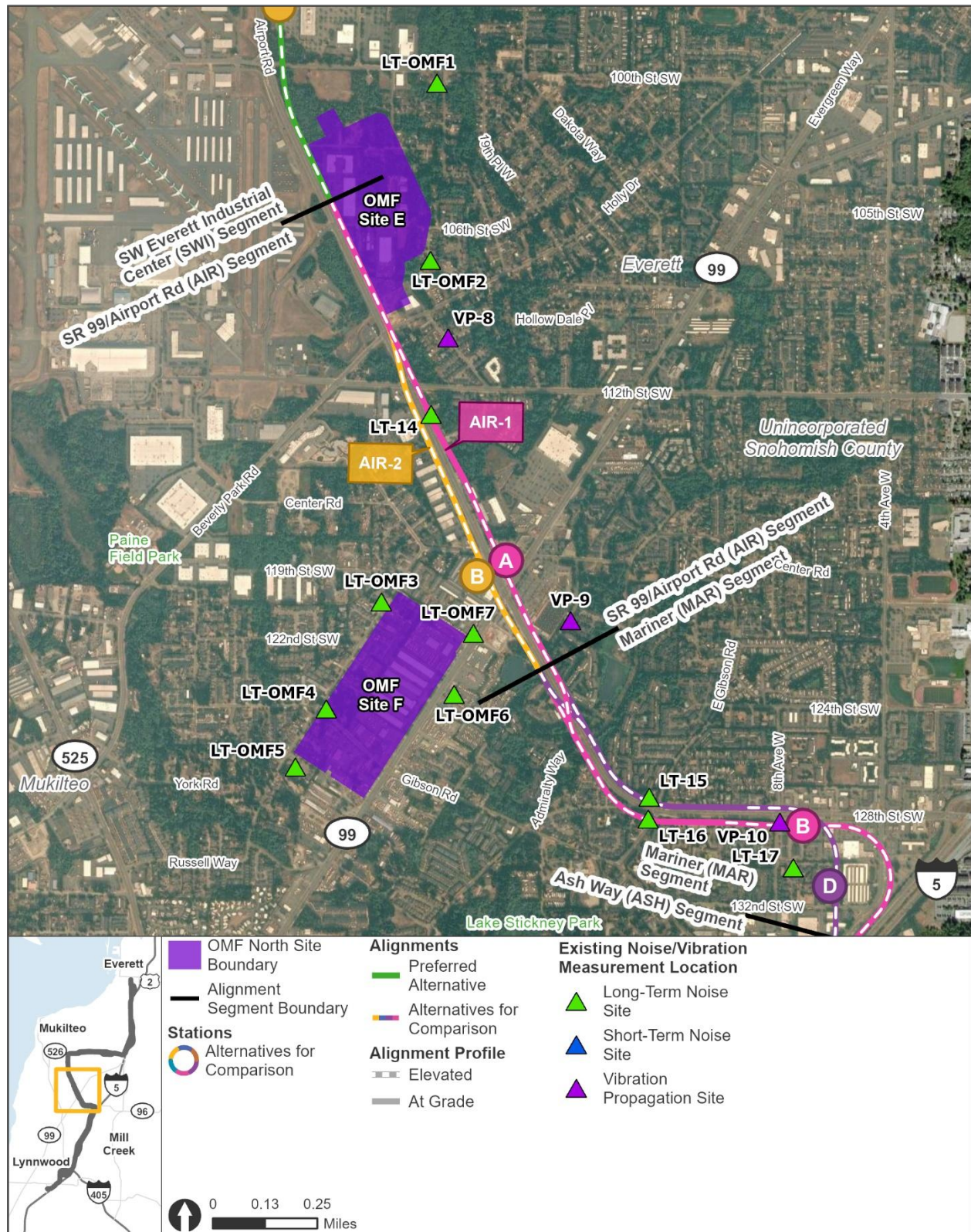
Site LT-OMF1: 2106 100th Street. The Ldn measured at this location was 63 dBA, and the measured peak hour Leq was 67 dBA. This location is representative of the noise sensitive land use east of OMF Site E between 101st Place and 100th Street. The ambient noise levels were

dominated by local traffic. This noise site is shared with the SW Everett Industrial Center Segment.

Table 4-4 Summary of Existing Ambient Noise Measurements Results – SR 99/Airport Road Segment and OMF Sites F and E

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-15	12724 Gibson Road	6/5/2024	16:00	24	66	61
LT-14	11303 Airport Road	6/26/2024	9:00	24	67	63
LT-OMF7	12118 Highway 99	9/10/2024	10:00	24	77	75
LT-OMF6	Lakeside RV Park	9/10/2024	15:00	24	66	64
LT-OMF5	2612 126th Place	9/9/2024	11:00	24	55	56
LT-OMF4	12413 Alexander Road	9/10/2024	10:00	24	62	59
LT-OMF3	12014 Alexander Road	9/10/2024	12:00	24	64	63
LT-OMF2	10629 21st Place	9/10/2024	12:00	24	53	49
LT-OMF1	2106 100th Street	6/24/2024	10:00	24	63	67

Figure 4-5 Existing Noise and Vibration Measurement Locations – SR 99/Airport Road Segment and OMF Sites F and E



4.2.5 SW Everett Industrial Center Segment and OMF Site E

Table 4-5 summarizes the results of the existing noise measurements conducted for the SW Everett Industrial Center Segment and OMF Site E, and Figure 4-6 shows the locations of the three noise measurements for this segment. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the SW Everett Industrial Center Segment and around OMF Site E.

Site LT-14: 11303 Airport Road. The Ldn measured at this location was 67 dBA, and the measured peak hour Leq was 63 dBA. This location is representative of the noise sensitive land use along Airport Road between SR 99 and 100th Street. The ambient noise levels were dominated by traffic on Airport Road. This noise site is shared with the SR 99/Airport Road Segment.

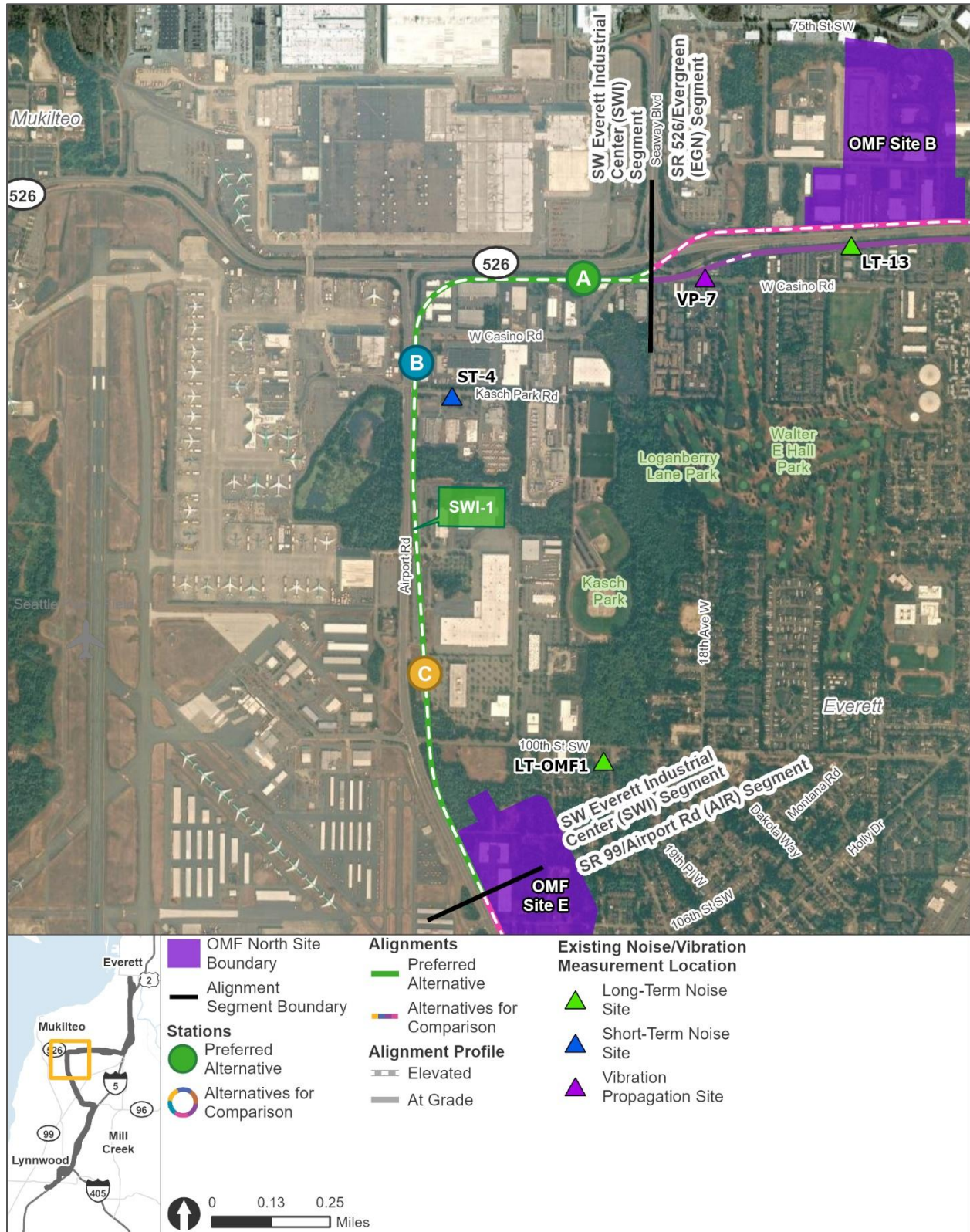
Site LT-OMF1: 2106 100th Street. The Ldn measured at this location was 63 dBA, and the measured peak hour Leq was 67 dBA. This location is representative of the noise sensitive land use east of OMF Site E between 101st Place and 100th Street. The ambient noise levels were dominated by local traffic. This noise site is shared with the SR 99/Airport Road Segment.

Site ST-4: 8925 Airport Road. The hourly Leq measured at this location was 70 dBA, and the calculated Ldn was 68 dBA. This location is representative of the noise at Sno-Isle TECH Skills Center. The ambient noise levels were dominated by traffic on Kasch Park Road.

Table 4-5 Summary of Existing Ambient Noise Measurements Results – SW Everett Industrial Center Segment and OMF Site E

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-14	11303 Airport Road	6/26/2024	9:00	24	67	63
LT-OMF1	2106 100th Street	6/24/2024	10:00	24	63	67
ST-4	8925 Airport Road	6/6/2024	16:20	24	68	70

Figure 4-6 Existing Noise and Vibration Measurement Locations – SW Everett Industrial Center Segment and OMF Site E



4.2.6 SR 526/Evergreen Segment and OMF Site B

Table 4-6 summarizes the results of the existing noise measurements conducted for the SR 526/Evergreen Segment and OMF Site B, and Figure 4-7 and Figure 4-8 show the locations of the nine noise measurements for this segment. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the SR 526/Evergreen Segment and around OMF Site B.

Site LT-13: 1305 W Casino Road. The Ldn measured at this location was 79 dBA, and the measured peak hour Leq was 75 dBA. This location is representative of the noise sensitive land use south of SR 526 between Seaway Boulevard and 7th Avenue. The ambient noise levels were dominated by traffic on SR 526.

Site LT-12: Ridgeline Apartments. The Ldn measured at this location was 64 dBA, and the measured peak hour Leq was 61 dBA. This location is representative of the noise sensitive land use along Casino Road between Seaway Boulevard and Evergreen Way. The ambient noise levels were dominated by traffic on SR 526 and Casino Road.

Site LT-11: 8121 E Glen Drive. The Ldn measured at this location was 69 dBA, and the measured peak hour Leq was 61 dBA. This location is representative of the noise sensitive land use north of SR 526 between Hardeson Road and Evergreen Way. The ambient noise levels were dominated by traffic on SR 526.

Site LT-10: 809 84th Street. The Ldn measured at this location was 61 dBA, and the measured peak hour Leq was 59 dBA. This location is representative of the noise sensitive land use in the SR 526/Evergreen Segment between Holly Drive and 84th Street. The ambient noise levels were dominated by traffic on SR 526. This noise measurement and the associated noise sensitive land uses are behind a noise barrier along SR 526.

Site LT-9: 1301 Pinkerton Avenue. The Ldn measured at this location was 63 dBA, and the measured peak hour Leq was 59 dBA. This location is representative of the noise sensitive land use north of SR 526 between Xavier Way and Commercial Avenue. The ambient noise levels were dominated by traffic on SR 526. This noise measurement and the associated noise sensitive land uses are behind a noise barrier along SR 526.

Site LT-8: 1606 Puget Drive. The Ldn measured at this location was 67 dBA, and the measured peak hour Leq was 59 dBA. This location is representative of the noise sensitive land use along SR 526 between the Interurban Trail and Everett Mall Way. The ambient noise levels were dominated by traffic on SR 526. This noise measurement is shared with the Broadway/I-5 Segment.

Site LT-OMF10: 7701 Hardeson Road. The Ldn measured at this location was 66 dBA, and the measured peak hour Leq was 63 dBA. This location is representative of the noise sensitive land use northeast of OMF Site B. The ambient noise levels were dominated by traffic on Hardeson Road.

Site ST-6: 44 E Casino Road. The hourly Leq measured at this location was 61 dBA, and the calculated Ldn was 59 dBA. This location is representative of the noise at Head Start & Early Head Start. The ambient noise levels were dominated by traffic on Casino Road.

Site ST-3: 8925 Airport Road. The hourly Leq measured at this location was 69 dBA, and the calculated Ldn was 67 dBA. This location is representative of the noise at Cascade High School

and the residences east of Casino Road between SR 526 and Xavier Way. The ambient noise levels were dominated by traffic on Casino Road.

Table 4-6 Summary of Existing Ambient Noise Measurements Results – SR 526/Evergreen Segment and OMF Site B

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-13	1305 W Casino Road	6/4/2024	16:00	24	79	75
LT-12	Ridgeline Apartments	9/11/2024	12:00	24	64	61
LT-11	8121 E Glen Drive	6/5/2024	9:00	24	69	61
LT-10	809 84th Street	6/4/2024	15:00	24	61	59
LT-9	1301 Pinkerton Avenue	9/9/2024	10:00	24	63	59
LT-8	1606 Puget Drive	6/6/2024	16:00	24	67	59
LT-OMF10	7701 Hardeson Road	9/10/2024	15:00	24	66	63
ST-6	44 E Casino Road	6/25/2024	8:48	1	59	61
ST-3	Interurban Trail and Casino Road	9/12/2024	7:36	1	67	69

Figure 4-7 Existing Noise and Vibration Measurement Locations – SR 526/Evergreen Segment (West) and OMF Site B

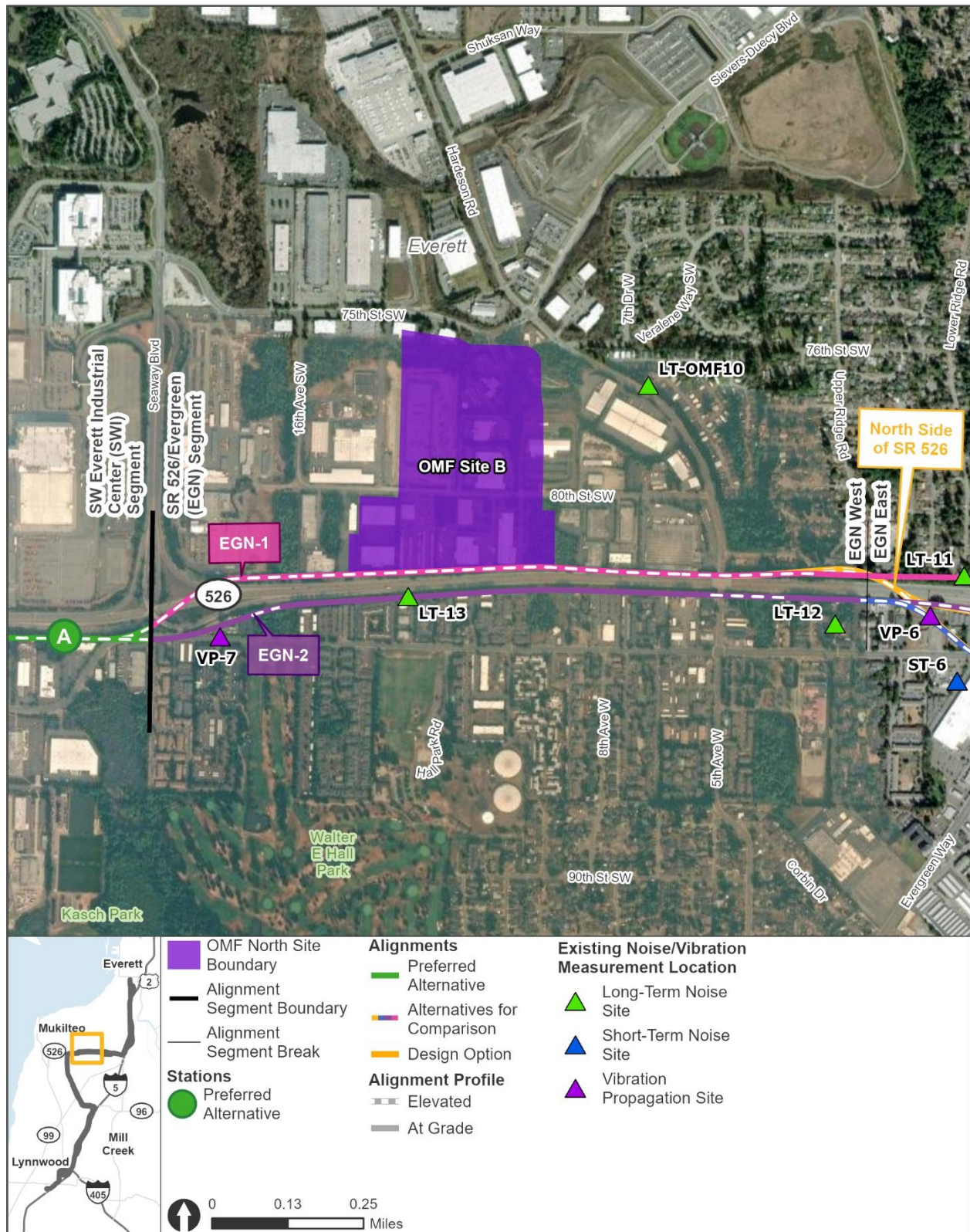


Figure 4-8 Existing Noise and Vibration Measurement Locations – SR 526/Evergreen Segment (East)



4.2.7 Broadway/I-5 Segment

Table 4-7 summarizes the results of the existing noise measurements conducted for the Broadway/I-5 Segment, and Figure 4-9 and Figure 4-10 show the locations of the seven noise measurements for this segment. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the Broadway/I-5 Segment.

Site LT-8: 1606 Puget Drive. The Ldn measured at this location was 67 dBA, and the measured peak hour Leq was 59 dBA. This location is representative of the noise sensitive land use along SR 526 between the Interurban Trail and Everett Mall Way. The ambient noise levels were dominated by traffic on SR 526. This noise measurement is shared with the SR 526/Evergreen Segment.

Site LT-7: 8016 Broadway. The Ldn measured at this location was 70 dBA, and the measured peak hour Leq was 66 dBA. This location is representative of the noise sensitive land use along Broadway west of I-5 between Beverly Boulevard and 78th Place. The ambient noise levels were dominated by traffic on Broadway.

Site LT-6: 2221 73rd Street. The Ldn measured at this location was 69 dBA, and the measured peak hour Leq was 66 dBA. This location is representative of the noise sensitive land use along Broadway between the Snohomish County Public Utility District (SnoPUD) utilities easement and Madison Street. The ambient noise levels were dominated by traffic on Broadway.

Site LT-5: 6907 Columbia Court. The Ldn measured at this location was 71 dBA, and the measured peak hour Leq was 67 dBA. This location is representative of the noise sensitive land use along I-5 between the 78th Place and Lexington Avenue. The ambient noise levels were dominated by traffic on I-5. The noise measurement and associated receivers are behind a noise barrier along I-5.

Site LT-4: 6002 Broadway. The Ldn measured at this location was 67 dBA, and the measured peak hour Leq was 63 dBA. This location is representative of the noise sensitive land use along I-5 and Broadway between Lexington Avenue and Fairfax Avenue. The ambient noise levels were dominated by traffic on I-5. The noise measurement and associated receivers are behind a noise barrier along I-5.

Site LT-3: 5119 View Drive. The Ldn measured at this location was 72 dBA, and the measured peak hour Leq was 68 dBA. This location is representative of the noise sensitive land use along I-5 and Broadway north of Fairfax Avenue to the end of the segment where there is no noise wall along I-5. The ambient noise levels were dominated by traffic on I-5.

Site LT-2: 5515 Broadway. The Ldn measured at this location was 65 dBA, and the measured peak hour Leq was 61 dBA. This location is representative of the noise sensitive land use along I-5 and Broadway north of Fairfax Avenue to the end of the segment where there is a noise wall along I-5. The ambient noise levels were dominated by traffic on I-5. The noise measurement and associated receivers are behind a noise barrier along I-5.

**Table 4-7 Summary of Existing Ambient Noise Measurements Results –
Broadway/I-5 Segment**

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-8	1606 Puget Drive	6/6/2024	16:00	24	67	59
LT-7	8016 Broadway	6/25/2024	11:00	24	70	66
LT-6	2221 73rd Street	6/24/2024	10:00	24	69	66
LT-5	6907 Columbia Court	6/24/2024	14:00	24	71	67
LT-4	6002 Broadway	6/26/2024	10:00	24	67	63
LT-3	5119 View Drive	6/24/2024	9:00	24	72	68
LT-2	5515 Broadway	6/25/2024	11:00	24	65	61



Figure 4-10 Existing Noise and Vibration Measurement Locations – Broadway/I-5 Segment (North)



4.2.8 Everett Station Segment

Table 4-8 summarizes the results of the existing noise measurements conducted for the Everett Station Segment, and Figure 4-11 and Figure 4-12 show the locations of the four noise measurements for this segment. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the Everett Station Segment.

Site LT-1: 4729 View Drive. The Ldn measured at this location was 72 dBA, and the measured peak hour Leq was 67 dBA. This location is representative of the noise sensitive land use along I-5 and Broadway between the segment start to 46th Street. The ambient noise levels were dominated by traffic on I-5.

Site LT-30: 3223 Lombard Avenue. The Ldn measured at this location was 51 dBA, and the measured peak hour Leq was 51 dBA. This location is representative of the noise sensitive land use along Broadway north of 34th Street. The ambient noise levels were dominated by local traffic.

Site ST-2: Evergreen Funeral Home. The hourly Leq measured at this location was 74 dBA, and the calculated Ldn was 72 dBA. This location is representative of the noise at the Evergreen Funeral Home & Cemetery. The ambient noise levels were dominated by traffic on I-5.

Site ST-1: 3711 Smith Avenue. The hourly Leq measured at this location was 73 dBA, and the calculated Ldn was 71 dBA. This location is representative of the noise at the Everett Gospel Mission. The ambient noise levels were dominated by traffic on I-5.

Table 4-8 Summary of Existing Ambient Noise Measurements Results – Everett Station Segment

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hrs)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1 hr Leq
LT-1	4729 View Drive	6/24/2024	9:00	24	72	67
LT-30	3223 Lombard Avenue	9/9/2024	13:00	24	51	51
ST-2	Evergreen Funeral Home	6/7/2024	7:30	1	72	74
ST-1	3711 Smith Avenue	6/7/2024	8:45	1	71	73

Figure 4-11 Existing Noise and Vibration Measurement Locations – Everett Station Segment (South)



Figure 4-12 Existing Noise and Vibration Measurement Locations – Everett Station Segment (North)



4.3 Existing Vibration Conditions

Vibration-sensitive land use for the project alternatives is the same as the noise-sensitive land use described above. Existing vibration sources along the project alignments are primarily auto, bus, and truck traffic on local streets. However, vibrations from street traffic are not generally perceptible at receivers in the study area unless streets have significant bumps, potholes, or other uneven surfaces. Furthermore, the FTA vibration impact criteria are not ambient-based; that is, future project vibrations are not compared with existing vibrations to assess impact. Therefore, the vibration measurements for the project focused on characterizing the soil conditions along the mainline track rather than on characterizing the existing vibration levels as described below.

4.3.1 West Alderwood Segment

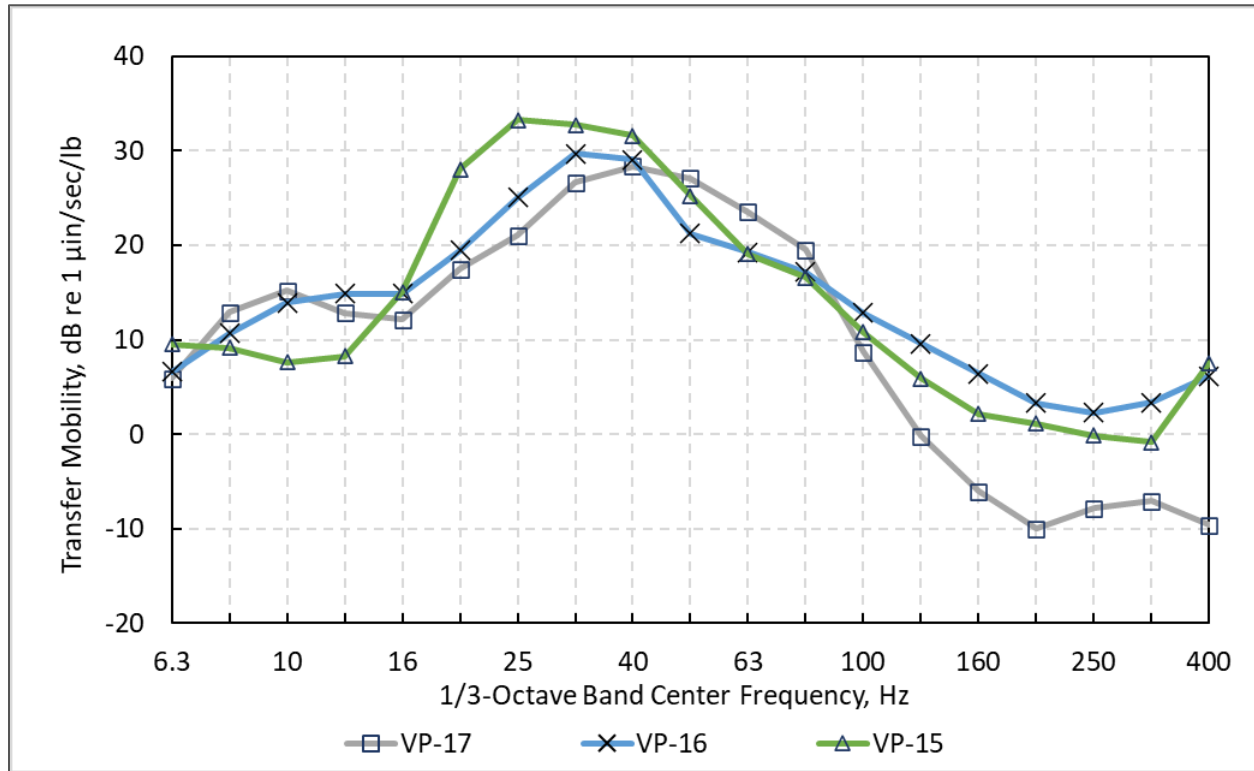
Three vibration propagation test sites were selected for the 2024 measurements for the West Alderwood Segment. The locations of the sites are shown on Figure 4-1, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-13 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the West Alderwood Segment.

Site VP-17: Alderwood Mall Boulevard. The vibration propagation measurement at this location was conducted in the alley close to 20007 44th Avenue off Alderwood Mall Boulevard. This site was used to represent the vibration sensitive land use between 44th Avenue and 196th Street.

Site VP-16: Alderwood Community Church. The vibration propagation measurement at this location was conducted in the Alderwood Community Church parking lot. This site was used to represent the vibration sensitive land use between 196th Street and 188th Street.

Site VP-15: The Woods at Alderwood. The vibration propagation measurement at this location was conducted at the corner of 33rd Avenue and 184th Street. This site was used to represent the vibration sensitive land use between 188th Street and Maple Road.

Figure 4-13 West Alderwood Segment Vibration Measurement Results at 100 Feet



4.3.2 Ash Way Segment

Four vibration propagation test sites were selected for the 2024 measurements for the Ash Way Segment. The locations of the sites are shown on Figure 4-2 and Figure 4-3, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-14 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the Ash Way Segment.

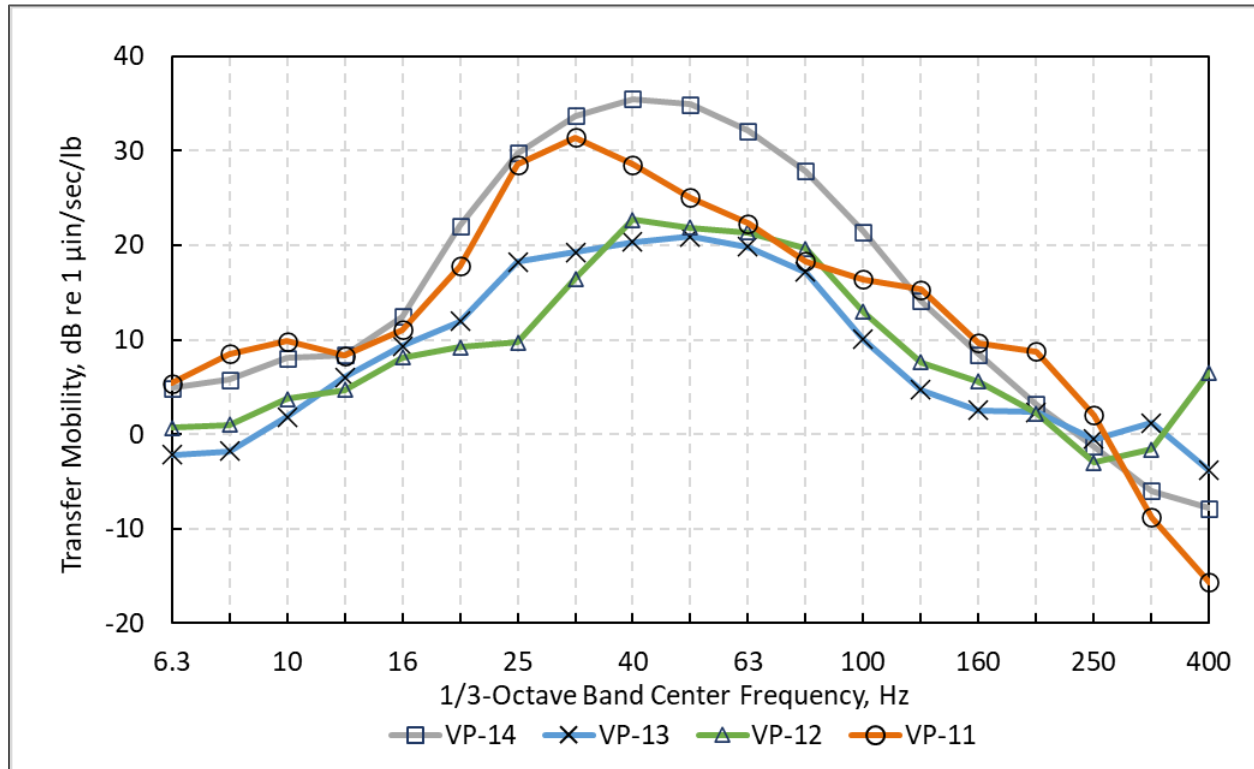
Site VP-14: 170th Street and 20th Avenue. The vibration propagation measurement at this location was conducted on the corner of 170th Street and 20th Avenue. This site was used to represent the vibration between Maple Road and 164th Street.

Site VP-13: Interurban Trail. The vibration propagation measurement at this location was conducted at the entrance to the Interurban Trail along 14th Avenue. This site was used to represent the vibration east of I-5 between 164th Street and 148th Street.

Site VP-12: 153rd Place SW and 14th Avenue W. The vibration propagation measurement at this location was conducted at the corner of 153rd Place and 14th Avenue. This site was used to represent the vibration west of I-5 between 164th Street and 11th Place.

Site VP-11: Interurban Trail. The vibration propagation measurement at this location was conducted at the entrance of the Interurban Trail off 142nd Street. This site was used to represent the vibration on both sides of I-5 between 148th Street and 134th Street.

Figure 4-14 Ash Way Segment Vibration Measurement Results at 100 Feet



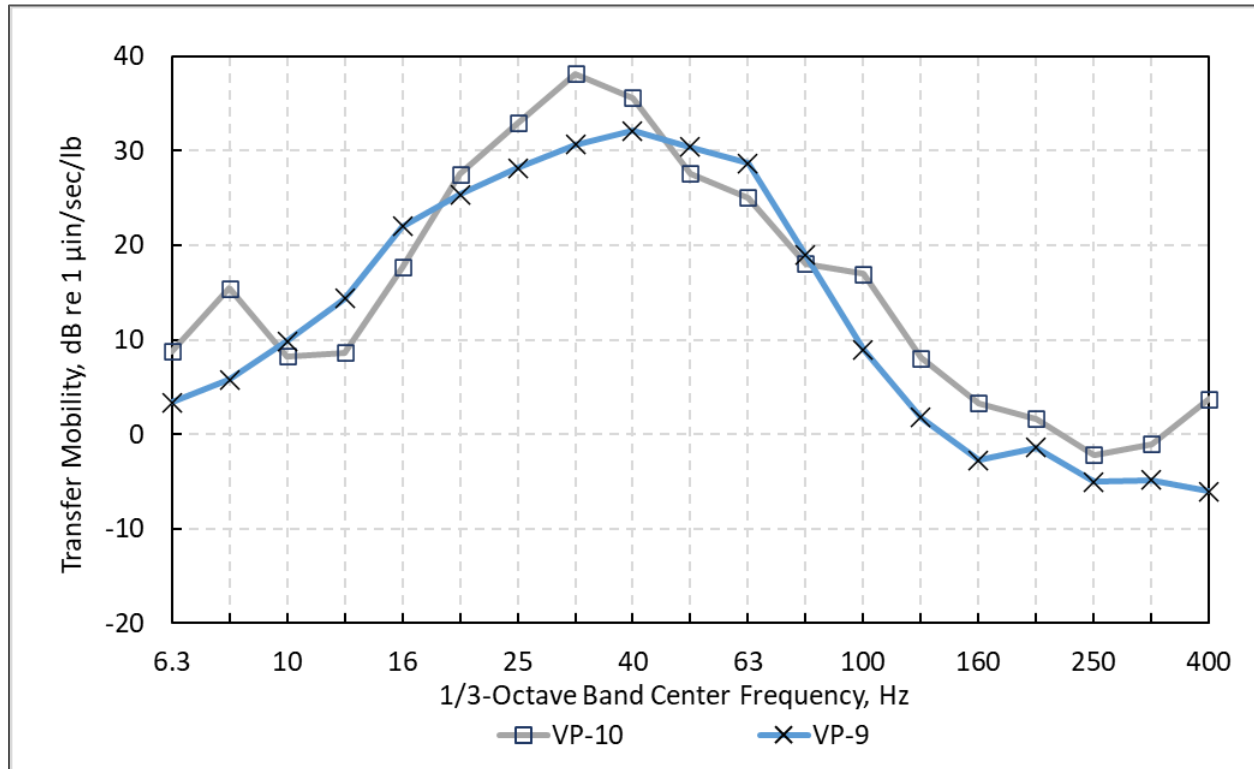
4.3.3 Mariner Segment

Two vibration propagation test sites were selected for the 2024 measurements for the Mariner Segment. The locations of the sites are shown on Figure 4-4, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-15 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the Mariner Segment.

Site VP-10: 128th Street SW and 9th Avenue W. The vibration propagation measurement at this location was conducted on the corner of 128th Street and 9th Avenue. This site was used to represent the vibration along I-5 and 128th Street/Airport Road between 134th Street and Admiralty Way.

Site VP-9: Avondale Road and 121st Street. The vibration propagation measurement at this location was conducted at the corner of Avondale Road and 121st Street. This site was used to represent the vibration along Airport Road between Admiralty Way and 112th Street. This measurement is shared with the SR 99/Airport Road Segment.

Figure 4-15 Mariner Segment Vibration Measurement Results at 100 Feet



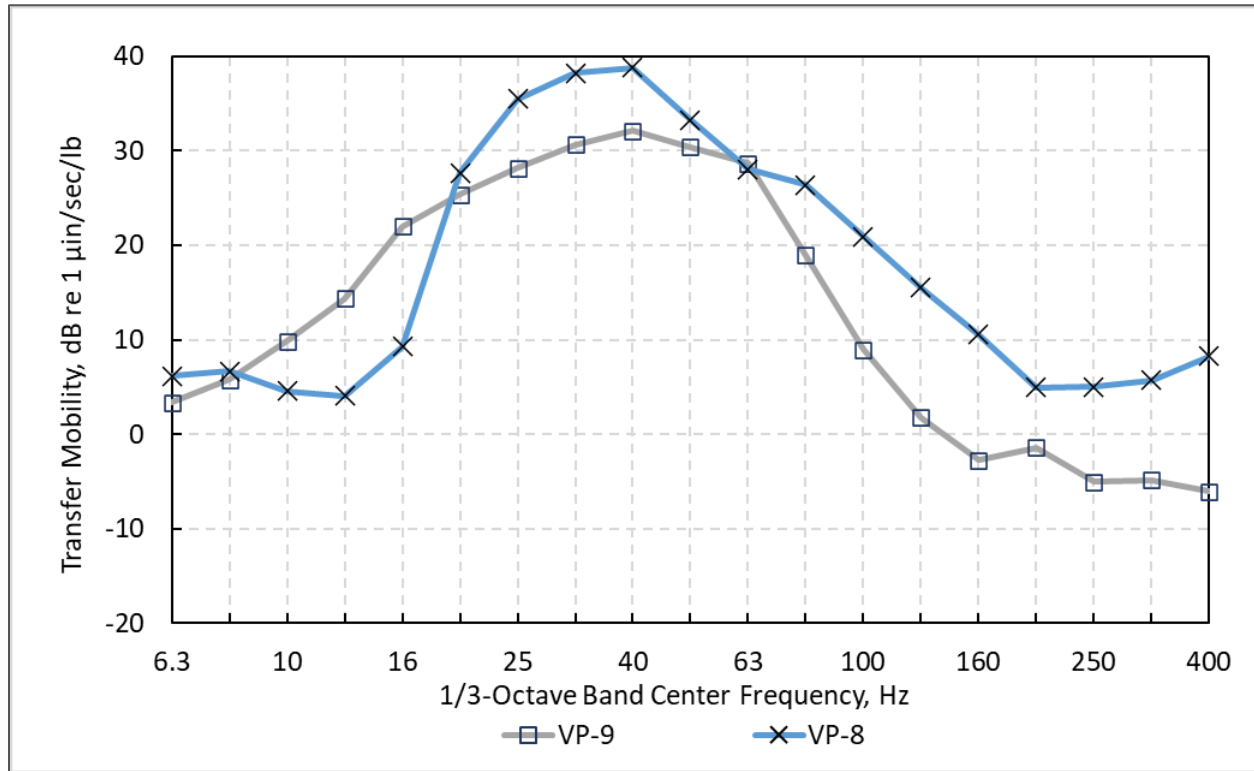
4.3.4 SR 99/Airport Road Segment and OMF Sites F and E

Two vibration propagation test sites were selected for the 2024 measurements for the SR 99/Airport Road Segment and OMF Sites F and E. The locations of the sites are shown on Figure 4-5, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-16 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the SR 99/Airport Road Segment and for OMF Sites F and E.

Site VP-9: Avondale Road and 121st Street. The vibration propagation measurement at this location was conducted at the corner of Avondale Road and 121st Street. This site was used to represent the vibration along Airport Road between Admiralty Way and 112th Street. This measurement is shared with the Mariner Segment.

Site VP-8: Hollow Dale Place and Paine Field Way. The vibration propagation measurement at this location was conducted at the corner of Hollow Dale Place and Paine Field Way. This site was used to represent the vibration along Airport Road between 112th Street and 100th Street. This measurement is shared with the SW Everett Industrial Center Segment.

Figure 4-16 SR 99/Airport Road Segment and OMF Sites F and E Vibration Measurement Results at 100 Feet



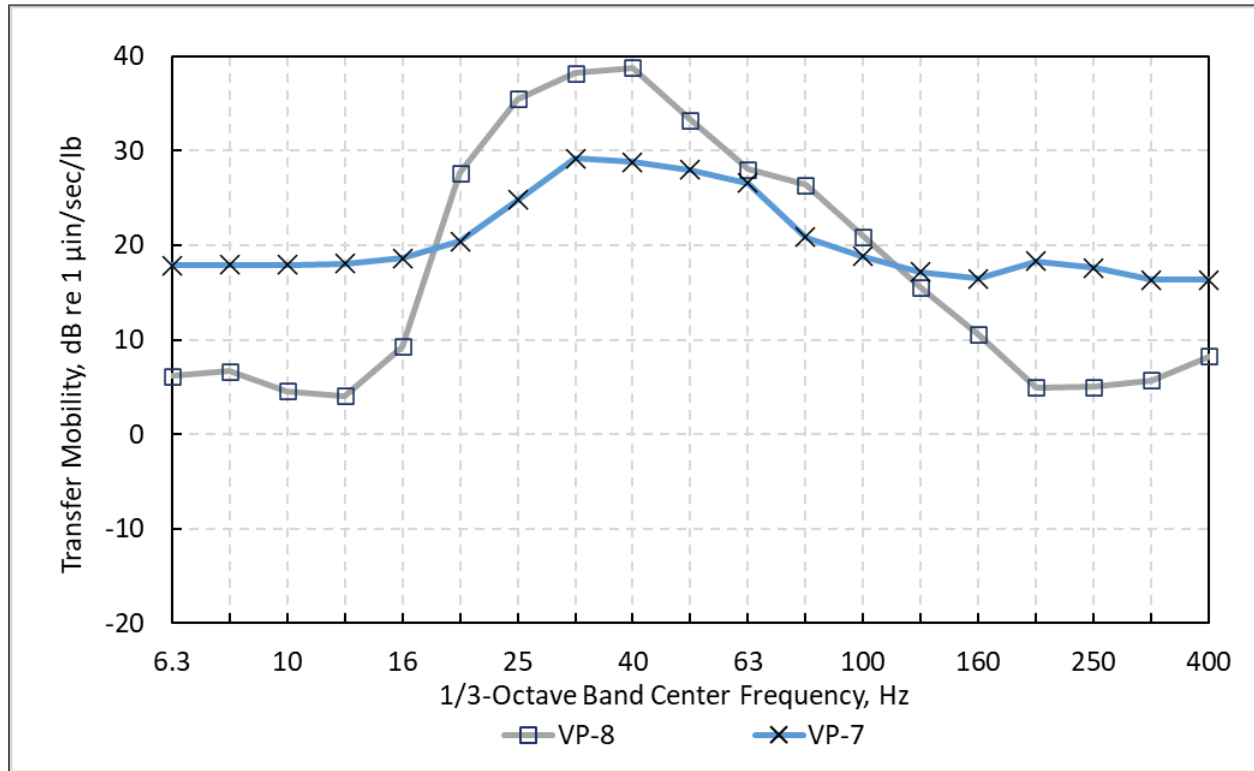
4.3.5 SW Everett Industrial Center Segment and OMF Site E

Two vibration propagation test sites were selected for the 2024 measurements for the SW Everett Industrial Center Segment and OMF Site E. The locations of the sites are shown on Figure 4-5 and Figure 4-6, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-17 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the SW Everett Industrial Center Segment and OMF Site E.

Site VP-8: Hollow Dale Place and Paine Field Way. The vibration propagation measurement at this location was conducted at the corner of Hollow Dale Place and Paine Field Way. This site was used to represent the vibration along Airport Road between 112th Street and 100th Street. This measurement is shared with the SR 99/Airport Road Segment.

Site VP-7: W Casino Road and 18th Avenue W. The vibration propagation measurement at this location was conducted at the corner of Casino Road and 18th Avenue. This site was used to represent the vibration along Airport Road and Casino Road between 100th Street and Hardeson Road. This measurement is shared with the SR 526/Evergreen Segment.

Figure 4-17 SW Everett Industrial Center Segment and OMF Site E Vibration Measurement Results at 100 Feet



4.3.6 SR 526/Evergreen Segment and OMF Site B

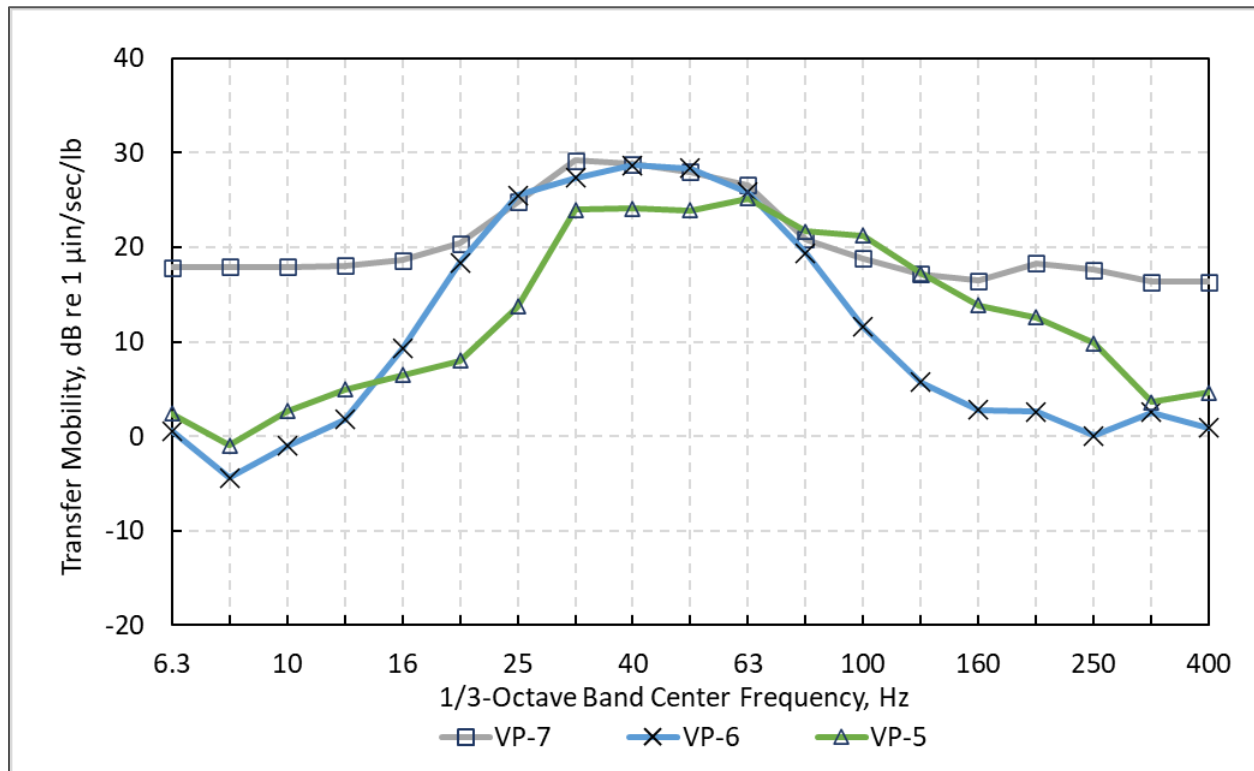
Three vibration propagation test sites were selected for the 2024 measurements for the SR 526/Evergreen Segment and OMF Site B. The locations of the sites are shown on Figure 4-7 and Figure 4-8, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-18 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the SR 526/Evergreen Segment and OMF Site B.

Site VP-7: W Casino Road and 18th Avenue W. The vibration propagation measurement at this location was conducted at the corner of Casino Road and 18th Avenue. This site was used to represent the vibration along Airport Road and Casino Road between 100th Street and Hardeson Road. This measurement is shared with the SW Everett Industrial Center Segment.

Site VP-6: South Everett Community Church. The vibration propagation measurement at this location was conducted in the parking lot of the South Everett Community Church. This site was used to represent the vibration along SR 526 between Hardeson Road and Evergreen Way.

Site VP-5: 85th Street SE and 9th Avenue SE. The vibration propagation measurement at this location was conducted on the corner of 85th Street and 9th Avenue. This site was used to represent the vibration along SR 526 and Broadway between Evergreen Way and 78th Place. This measurement is shared with the Broadway/I-5 Segment.

Figure 4-18 SR 526/Evergreen Segment and OMF Site B Vibration Measurement Results at 100 Feet



4.3.7 Broadway/I-5 Segment

Four vibration propagation test sites were selected for the 2024 measurements for the Broadway/I-5 Segment. The locations of the sites are shown on Figure 4-8, Figure 4-9, and Figure 4-10, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-19 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the Broadway/I-5 Segment.

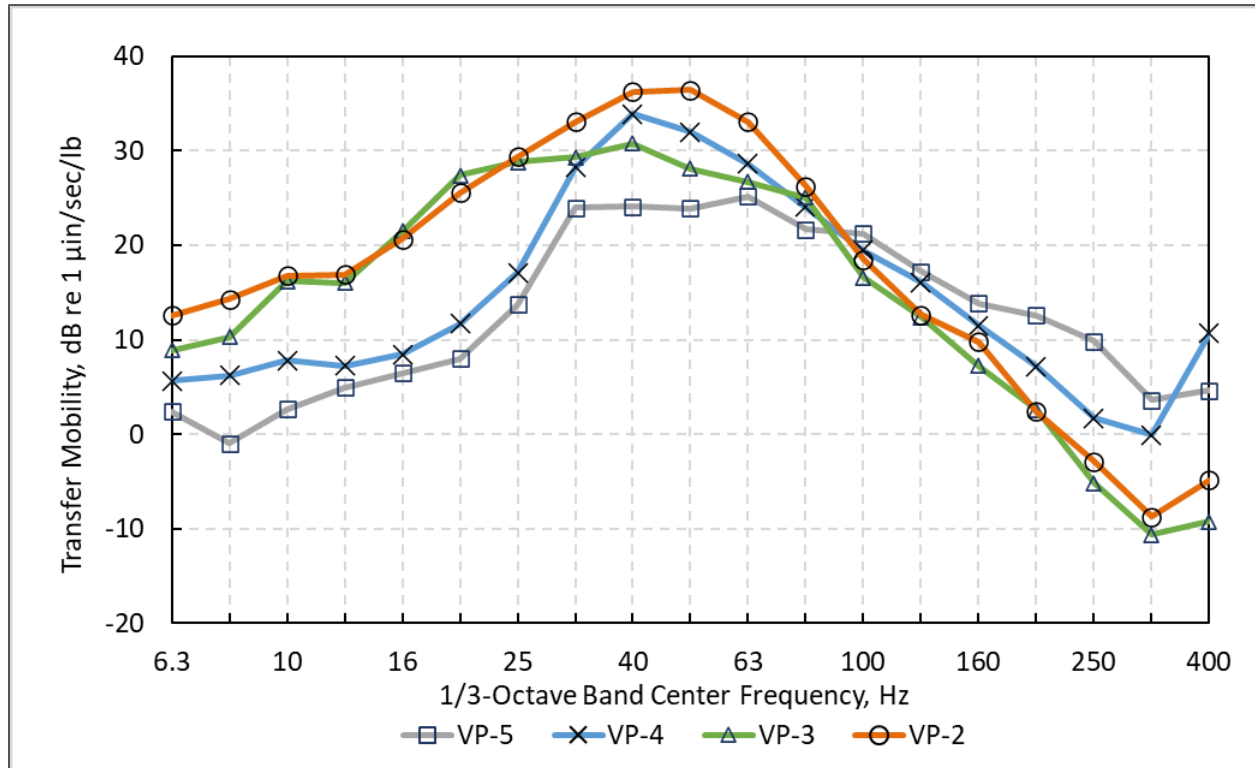
Site VP-5: 85th Street SE and 9th Avenue SE. The vibration propagation measurement at this location was conducted on the corner of 85th Street and 9th Avenue. This site was used to represent the vibration along SR 526 and Broadway between Evergreen Way and 78th Place. This measurement is shared with the SR 526/Evergreen Segment.

Site VP-4: McDougall Street and Monroe Avenue. The vibration propagation measurement at this location was conducted on the corner of McDougall Street and Monroe Avenue. This site was used to represent the vibration along Broadway and I-5 between 78th Place and Madison Street.

Site VP-3: 63rd Street and Commercial Avenue. The vibration propagation measurement at this location was conducted on the corner of 63rd Street and Commercial Avenue. This site was used to represent the vibration along Broadway and I-5 between Madison Street and Fairfax Avenue.

Site VP-2: 47th Street SE and View Drive. The vibration propagation measurement at this location was conducted on the corner of 47th Street and View Drive. This site was used to represent the vibration along Broadway and I-5 between Fairfax Avenue and 41st Street. This measurement is shared with the Everett Station Segment.

Figure 4-19 Broadway/I-5 Segment Vibration Measurement Results at 100 Feet



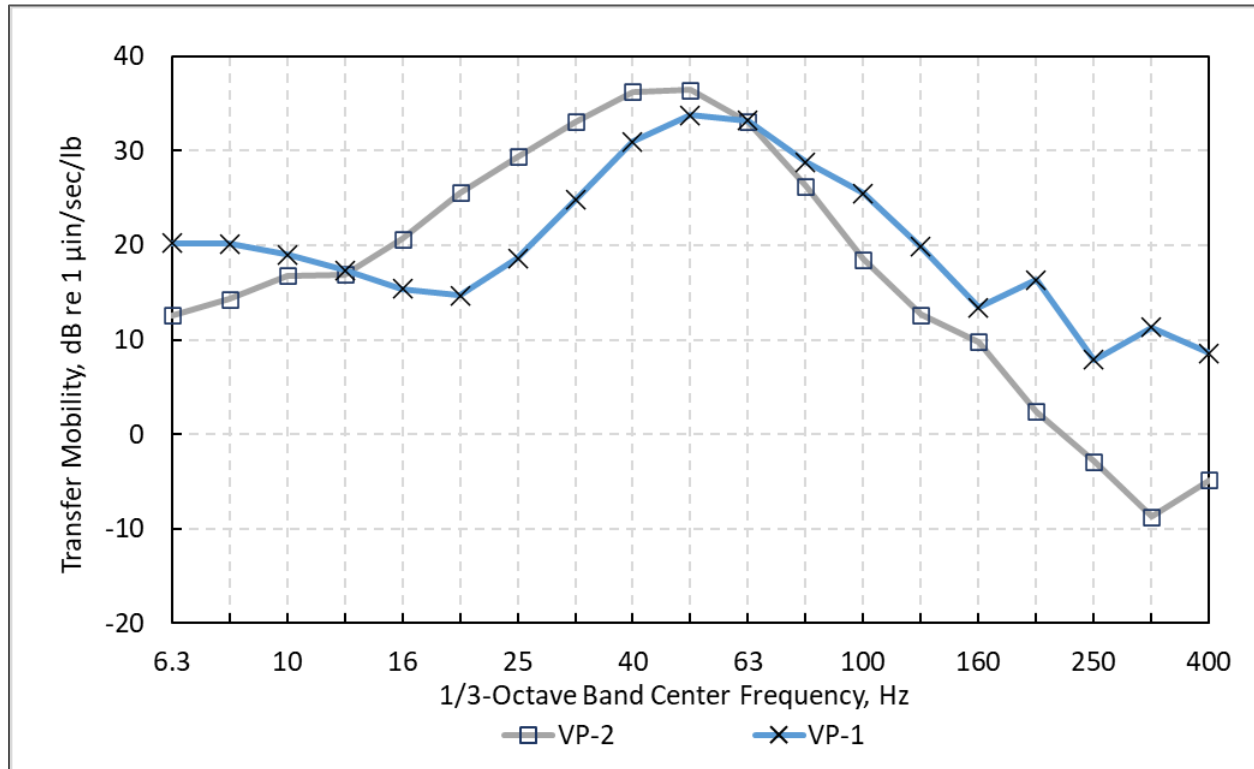
4.3.8 Everett Station Segment

Two vibration propagation test sites were selected for the 2024 measurements for the Everett Station Segment. The locations of the sites are shown on Figure 4-11 and Figure 4-12, site photographs are included in Attachment C, and detailed propagation information is included in Attachment D. Figure 4-20 shows the results of the vibration propagation tests at 100 feet for each of the test sites in the Everett Station Segment.

Site VP-2: 47th Street SE and View Drive. The vibration propagation measurement at this location was conducted on the corner of 47th Street and View Drive. This site was used to represent the vibration along Broadway and I-5 between Fairfax Avenue and 41st Street. This measurement is shared with the Broadway/I-5 Segment.

Site VP-1: 33rd Street and Broadway. The vibration propagation measurement at this location was conducted on the corner of 33rd Street and Broadway. This site was used to represent the vibration along Broadway and I-5 between 41st Street and Everett Station.

Figure 4-20 Everett Station Segment Vibration Measurement Results



5 ENVIRONMENTAL IMPACTS

Detailed noise and vibration impact assessments were performed based on the criteria discussed in Section 3.1 and the prediction methodology described in Section 3.2. The assessment results are presented in this section. The FTA guidance manual is the primary source for the noise methodology. The noise and vibration assessments included the following steps:

- Noise- and vibration-sensitive land uses were identified using aerial photography, GIS data, and field surveys. See Section 4.1.
- Existing noise levels along the corridor were measured at sensitive receptors. See Section 4.2.
- Vibration-propagation characteristics of the soil along the corridor were measured near representative sensitive receptors. See Section 4.3.
- Project noise and vibration levels from transit operations were predicted using project drawings and information on speeds, headways, track type, and vehicle type.
- The noise impact from transit operations was assessed by comparing the project noise with the existing noise (not the No Build Alternative noise) using the FTA noise impact criteria. See Figure 3-1. Each receiver where the noise impact criteria would be exceeded was counted as an impact.

- Project noise levels from the OMF North site alternatives were also compared with the WAC noise criteria for exceedances.
- The vibration impact from transit operations was assessed by comparing the project vibration levels with the FTA vibration impact criteria in Figure 3-2.
- Mitigation was recommended at locations where project noise or vibration levels would likely exceed the impact criteria.
- Existing highway noise barriers would be impacted by Alternatives ASH-2D, EGN-3E, and BI-1. These barriers may be relocated or modified as a part of the project. As part of further developing the engineering plans, these barriers will be designed with input from WSDOT.

5.1 Build Alternatives Noise Impact Assessment

5.1.1 Operational Impacts

In addition to the impacts listed by alternative below, noise and vibration impacts could be associated with transit oriented development near the stations. Any new developments would be required to meet the local noise regulations. Most vehicle traffic and other sources of environmental vibration are below the levels of human perception and would not constitute an impact.

5.1.1.1 Alignment and Station Alternatives

West Alderwood Segment

A summary of the noise impacts for the Build Alternatives in the West Alderwood Segment is presented in Table 5-1, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of likely moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

The noise impacts in the West Alderwood Segment are projected to occur at hotels and multi-family residences and the Alderwood Community Church. These impacts are due to the proximity to the proposed tracks and the presence of elevated structures.

For Alternative ALD-1B and ALD-1B with Alderwood Mall Boulevard Design Option, moderate noise impacts are projected at two hotels and one multi-family building with 347 units, and severe noise impacts are projected at one multi-family building with 239 units. For Alternative ALD-2D and ALD-2B with Alderwood Mall Boulevard Design option, moderate noise impacts are projected at two hotels and two multi-family buildings with 487 units, and severe noise impacts are projected at two multi-family buildings with 449 units. For Alternative ALD-2F and ALD-2F with Alderwood Mall Boulevard Design Option, moderate noise impacts are projected at two hotels and three multi-family buildings with 697 units, and severe noise impacts are projected at one multi-family building with 239 units. A severe impact is projected at the Alderwood Community Church for all the alternatives with the Alderwood Mall Boulevard Design Option.

The noise impact locations in the West Alderwood Segment are shown in Figure 5-1 through Figure 5-10.

Table 5-1 Summary of Noise Impacts – West Alderwood Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
ALD-1B	349	239
ALD-1B with Alderwood Mall Boulevard Design Option	349	240
ALD-2D	489	449
ALD-2D with Alderwood Mall Boulevard Design Option	489	450
ALD-2F	699	239
ALD-2F with Alderwood Mall Boulevard Design Option	699	240

Figure 5-1 Noise Impact Locations – Alternative ALD-1B (1 of 1)

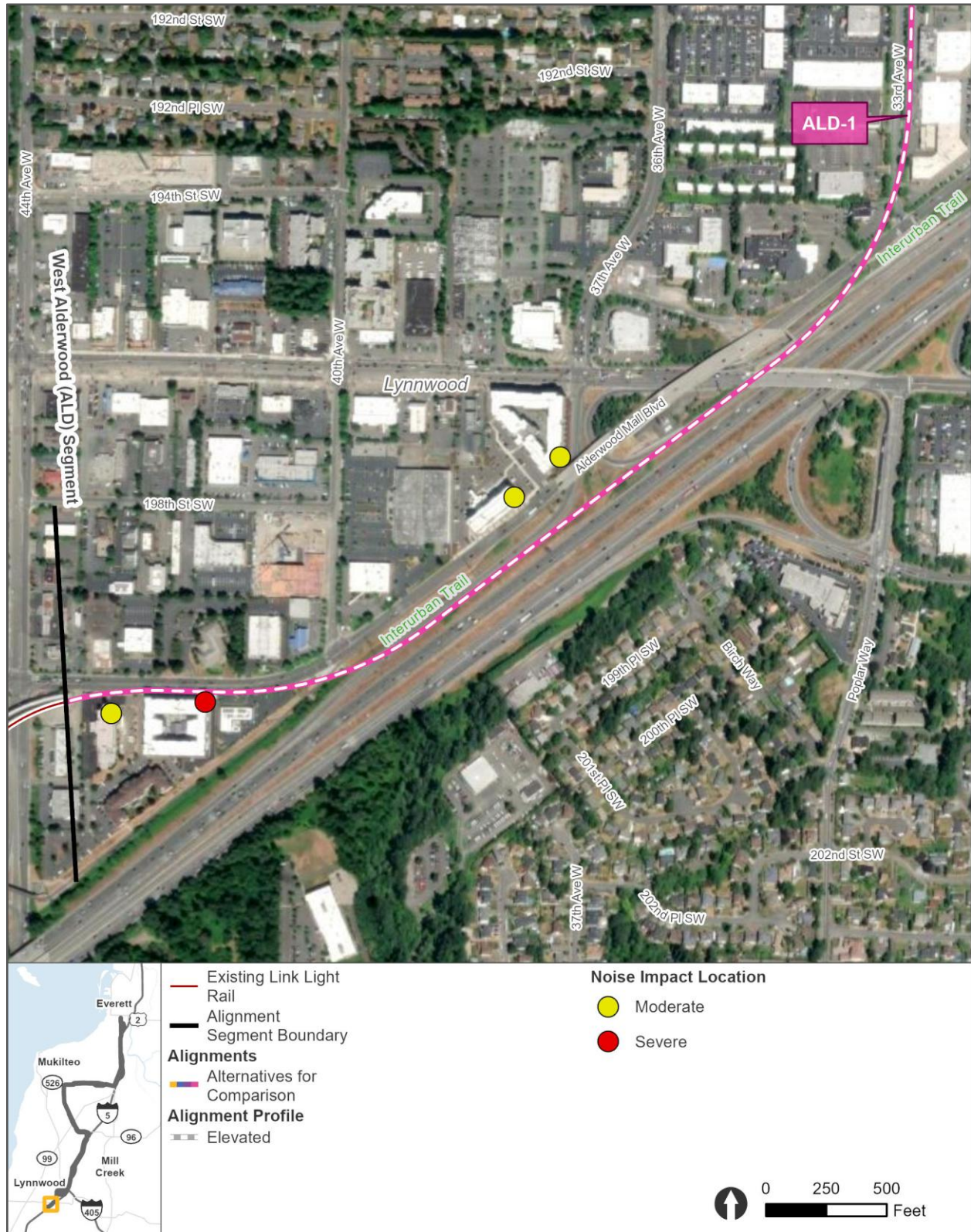


Figure 5-2 Noise Impact Locations – Alternative ALD-1B with Alderwood Mall Boulevard Design Option (1 of 1)



Figure 5-3 Noise Impact Locations – Alternative ALD-2D (1 of 2)



Figure 5-4 Noise Impact Locations – Alternative ALD-2D (2 of 2)



Figure 5-5 Noise Impact Locations – Alternative ALD-2D with Alderwood Mall Boulevard Design Option (1 of 2)



Figure 5-6 Noise Impact Locations – Alternative ALD-2D with Alderwood Mall Boulevard Design Option (2 of 2)



Figure 5-7 Noise Impact Locations – Alternative ALD-2F (1 of 2)



Figure 5-8 Noise Impact Locations – Alternative ALD-2F (2 of 2)



Figure 5-9 Noise Impact Locations – Alternative ALD-2F with Alderwood Mall Boulevard Design Option (1 of 2)



Figure 5-10 Noise Impact Locations – Alternative ALD-2F with Alderwood Mall Boulevard Design Option (2 of 2)



Ash Way Segment

A summary of the noise impacts for the Build Alternatives in the Ash Way Segment is presented below in Table 5-2, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

The noise impacts in the Ash Way Segment are projected to occur at single- and multi-family residences and are due to the proximity to the proposed tracks and the presence of elevated structures. Additionally, the following crossovers contribute to nearby impacts:

- The crossover between 172nd Street and 164th Street for Alternative ASH-1A.
- The crossover between 140th Street and 134th Street for Alternative ASH-1A.
- The crossover between 140th Street and 134th Street for Alternative ASH-2D to connect to Alternative MAR-2D.

For Alternative ASH-1A with a connection to Alternative MAR-1B, moderate noise impacts are projected at 54 single-family residences and 10 multi-family buildings with 280 units, and severe noise impacts are projected at 29 single-family residences and one multi-family building with 30 units. For Alternative ASH-1A with a connection to Alternative MAR-2D, moderate noise impacts are projected at 52 single-family residences and nine multi-family buildings with 278 units, and severe noise impacts are projected at 31 single-family residences and one multi-family building with 30 units.

For Alternative ASH-2D with a connection to Alternative MAR-1B, moderate noise impacts are projected at 55 single-family residences and one multi-family building with two units, and severe noise impacts are projected at six single-family residences. For Alternative ASH-2D with a connection to Alternative MAR-2D, moderate noise impacts are projected at 56 single-family residences and one multi-family building with two units, and severe noise impacts are projected at nine single-family residences.

The noise impact locations in the Ash Way Segment are shown in Figure 5-11 through Figure 5-20.

Table 5-2 Summary of Noise Impacts – Ash Way Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
ASH-1A with connection to MAR-1B	334	59
ASH-1A with connection to MAR-2D	330	61
ASH-2D with connection to MAR-1B	57	6
ASH-2D with connection to MAR-2D	58	9

Figure 5-11 Noise Impact Locations – Alternative ASH-1A (1 of 5)



Figure 5-12 Noise Impact Locations – Alternative ASH-1A (2 of 5)



Figure 5-13 Noise Impact Locations – Alternative ASH-1A (3 of 5)



Figure 5-14 Noise Impact Locations – Alternative ASH-1A (4 of 5)



Figure 5-15 Noise Impact Locations – Alternative ASH-1A (5 of 5)



Figure 5-16 Noise Impact Locations – Alternative ASH-2D (1 of 5)



Figure 5-17 Noise Impact Locations – Alternative ASH-2D (2 of 5)



Figure 5-18 Noise Impact Locations – Alternative ASH-2D (3 of 5)



Figure 5-19 Noise Impact Locations – Alternative ASH-2D (4 of 5)



Figure 5-20 Noise Impact Locations – Alternative ASH-2D (5 of 5)



Mariner Segment

A summary of the noise impacts for the Build Alternatives in the Mariner Segment is presented below in Table 5-3, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

The noise impacts in the Mariner Segment are projected to occur at single- and multi-family residences and the Seattle Korean Seventh-Day Adventist Church. These impacts are due to the proximity to the proposed tracks and the presence of elevated structures. Additionally, the crossovers between 8th Avenue and Gibson Road for both Alternatives MAR-1B and MAR-2D contribute to nearby impacts.

For Alternative MAR-1B with a connection to Alternative AIR-1A, moderate noise impacts are projected at two single-family residences, one hotel, and 13 multi-family buildings with 202 units, and severe noise impacts are projected at two multi-family buildings with 27 units. For Alternative MAR-1B with a connection to Alternative AIR-2B, moderate noise impacts are projected at two single-family residences, one hotel, 11 multi-family buildings with 139 units, and the Seattle Korean Seventh-Day Adventist Church, and severe noise impacts are projected at three multi-family buildings with 57 units.

For Alternative MAR-2D with a connection to Alternative AIR-1A, moderate noise impacts are projected at eight single-family residences and 12 multi-family buildings with 245 units, and severe noise impacts are projected at one single-family residence and two multi-family buildings with 30 units. For Alternative MAR-2D with a connection to Alternative AIR-2B, moderate noise impacts are projected at eight single-family residences and 11 multi-family buildings with 194 units, and severe noise impacts are projected at one single-family residence and three multi-family buildings with 60 units. The number of impacts for each alternative is the same with the Surface Parking Design Option.

The noise impact locations in the Mariner Segment are shown in Figure 5-21 through Figure 5-24.

Table 5-3 Summary of Noise Impacts – Mariner Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
MAR-1B with connection to AIR-1A	205	27
MAR-1B with connection to AIR-2B	143	57
MAR-1B with Surface Parking Design Option and connection to AIR-1A	205	27
MAR-1B with Surface Parking Design Option and connection to AIR-2B	143	57
MAR-2D with connection to AIR-1A	253	31
MAR-2D with connection to AIR-2B	202	61
MAR-2D with Surface Parking Design Option and connection to AIR-1A	253	31
MAR-2D with Surface Parking Design Option and connection to AIR-2B	202	61

Figure 5-21 Noise Impact Locations – Alternative MAR-1B (1 of 2)

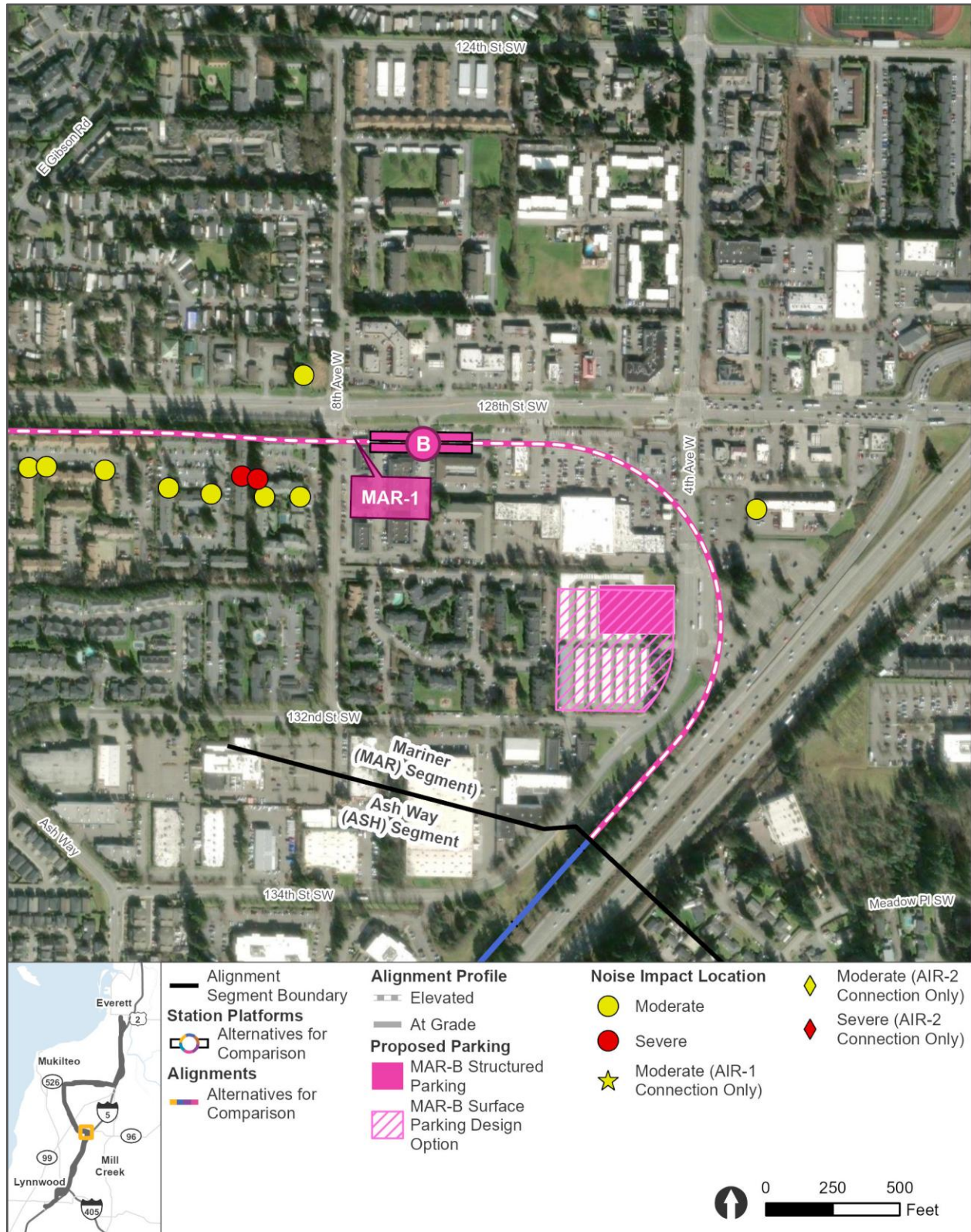


Figure 5-22 Noise Impact Locations – Alternative MAR-1B (2 of 2)



Figure 5-23 Noise Impact Locations – Alternative MAR-2D (1 of 2)

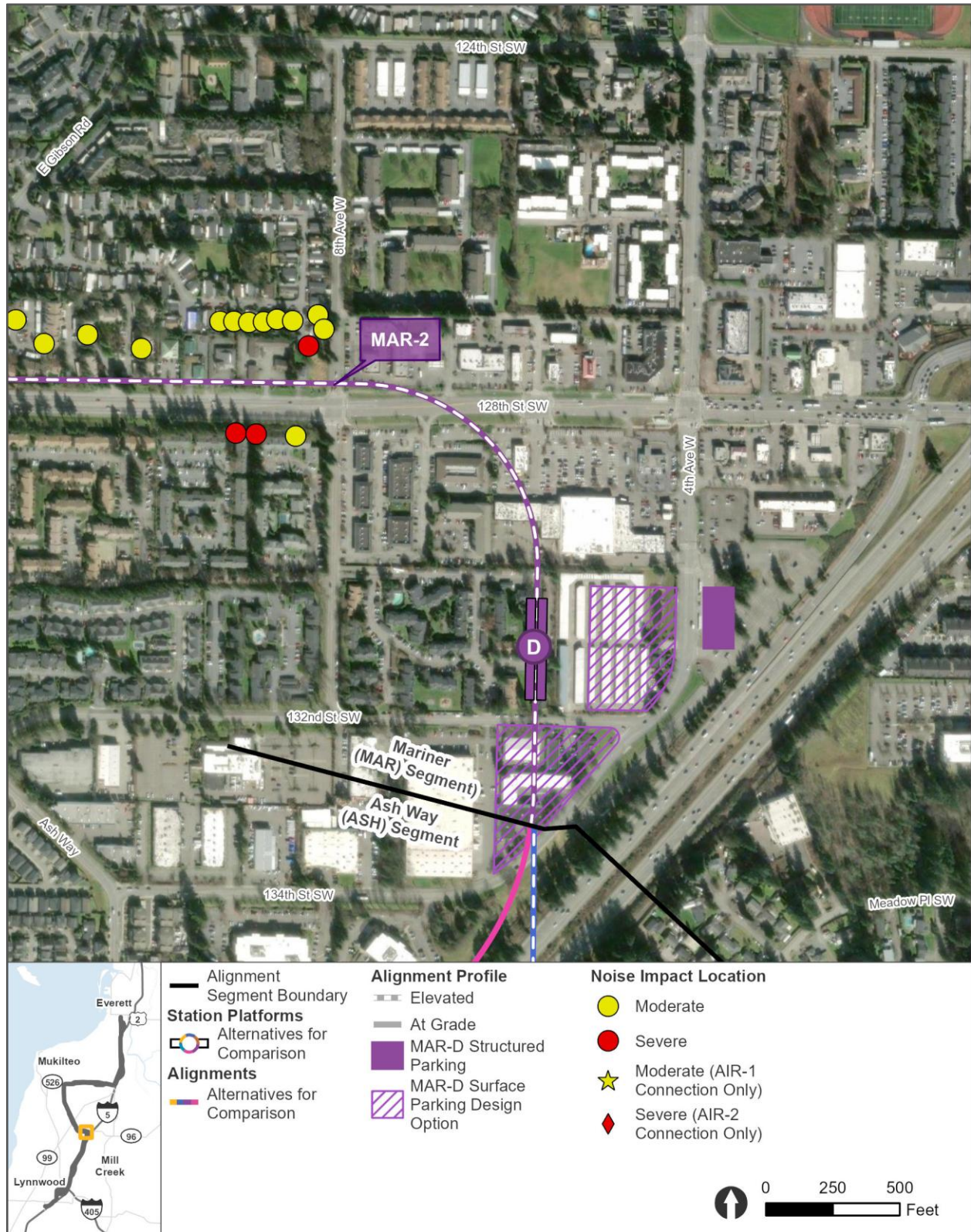
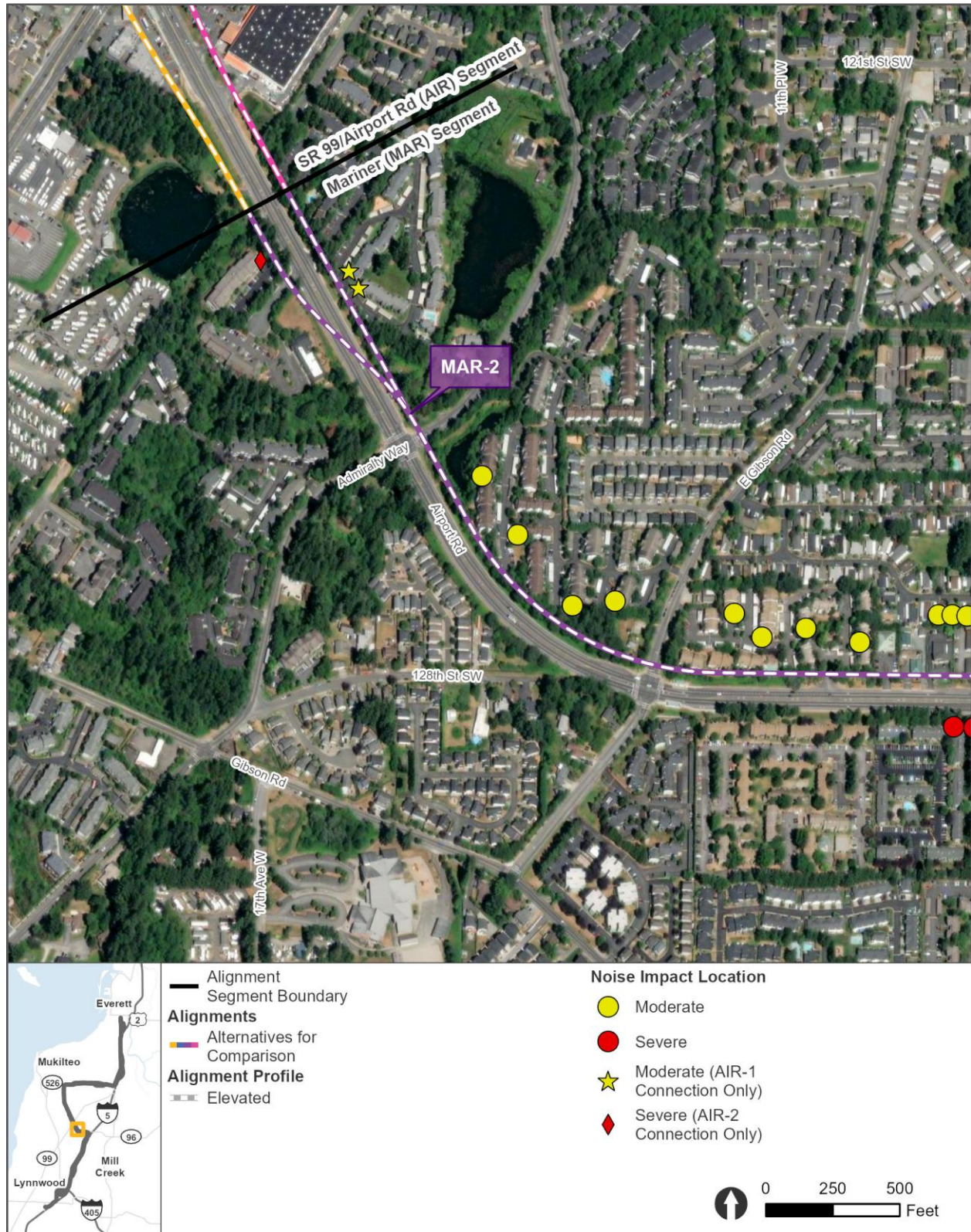


Figure 5-24 Noise Impact Locations – Alternative MAR-2D (2 of 2)



SR 99/Airport Road Segment

A summary of the noise impacts for the Build Alternatives in the SR 99/Airport Road Segment is presented below in Table 5-4, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

The noise impacts in the SR 99/Airport Road Segment are projected to occur at single- and multi-family residences and are due to the proximity to the proposed tracks and the presence of elevated structures. Additionally, the crossover between Evergreen Way and Holly Drive for Alternative AIR2B contributes to nearby impacts.

For Alternative AIR-2B, moderate noise impacts are projected at six single-family residences and two multi-family buildings with 226 units, and severe noise impacts are projected at one hotel.

The noise impact locations in the SR 99/Airport Road Segment are shown in Figure 5-25 and Figure 5-26.

Table 5-4 Summary of Noise Impacts – SR 99/Airport Road Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
AIR-1A	0	0
AIR-2B	232	1

Figure 5-25 Noise Impact Locations – Alternative AIR-2B (1 of 2)



Figure 5-26 Noise Impact Locations – Alternative AIR-2B (2 of 2)



SW Everett Industrial Center Segment

A summary of the noise impacts for the Build Alternatives in the SW Everett Industrial Center Segment is presented below in Table 5-5, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

There are no noise impacts in the SW Everett Industrial Center Segment.

Table 5-5 Summary of Noise Impacts – SW Everett Industrial Center Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
SWI-1A	0	0
SWI-1A with Lower Design Option	0	0
SWI-1B	0	0
SWI-1C	0	0

SR 526/Evergreen Segment

A summary of the noise impacts for the Build Alternatives in the SR 526/Evergreen Segment is presented below in Table 5-6, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

The noise impacts in the SR 526/Evergreen Segment are projected to occur at single- and multi-family residences and Everett KinderCare. These impacts are due to the proximity to the proposed tracks and the presence of elevated structures. Additionally, a crossover for Alternative EGN-2B between 5th Avenue and Evergreen Way contributes to nearby impacts.

For Alternative EGN-1A, moderate noise impacts are projected at 11 single-family residences and three multi-family buildings with 10 units, and severe noise impacts are projected at two single-family residences.

For Alternative EGN-2B, moderate noise impacts are projected at 19 single-family residences, 29 multi-family buildings with 337 units and the South Everett Community Church, and severe noise impacts are projected at three single-family residences and seven multi-family buildings with 45 units. For Alternative EGN-2B with North Side of SR 526 Design Option, moderate noise impacts are projected at 21 single-family residences, three multi-family buildings with 10 units and the South Everett Community Church, and severe noise impacts are projected at two single-family residences.

For Alternative EGN-3E, moderate noise impacts are projected at 22 single-family residences, 28 multi-family buildings with 324 units and the South Everett Community Church, and severe noise impacts are projected at one single-family residence and seven multi-family buildings with 43 units. For Alternative EGN-3E with North Side of SR 526 Design Option, moderate noise impacts are projected at 26 single-family residences, two multi-family buildings with eight units and the South Everett Community Church, and severe noise impacts are projected at two single-family residences and one multi-family building with two units.

The noise impact locations in the SR 526/Evergreen Segment are shown in Figure 5-27 through Figure 5-43.

Table 5-6 Summary of Noise Impacts – SR 526/Evergreen Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
EGN-1A	21	2
EGN-2B	357	48
EGN-2B with North Side of SR 526 Design Option	32	2
EGN-3E	347	44
EGN-3E with North Side of SR 526 Design Option	35	4

Figure 5-27 Noise Impact Locations – Alternative EGN-1A (1 of 3)



Figure 5-28 Noise Impact Locations – Alternative EGN-1A (2 of 3)

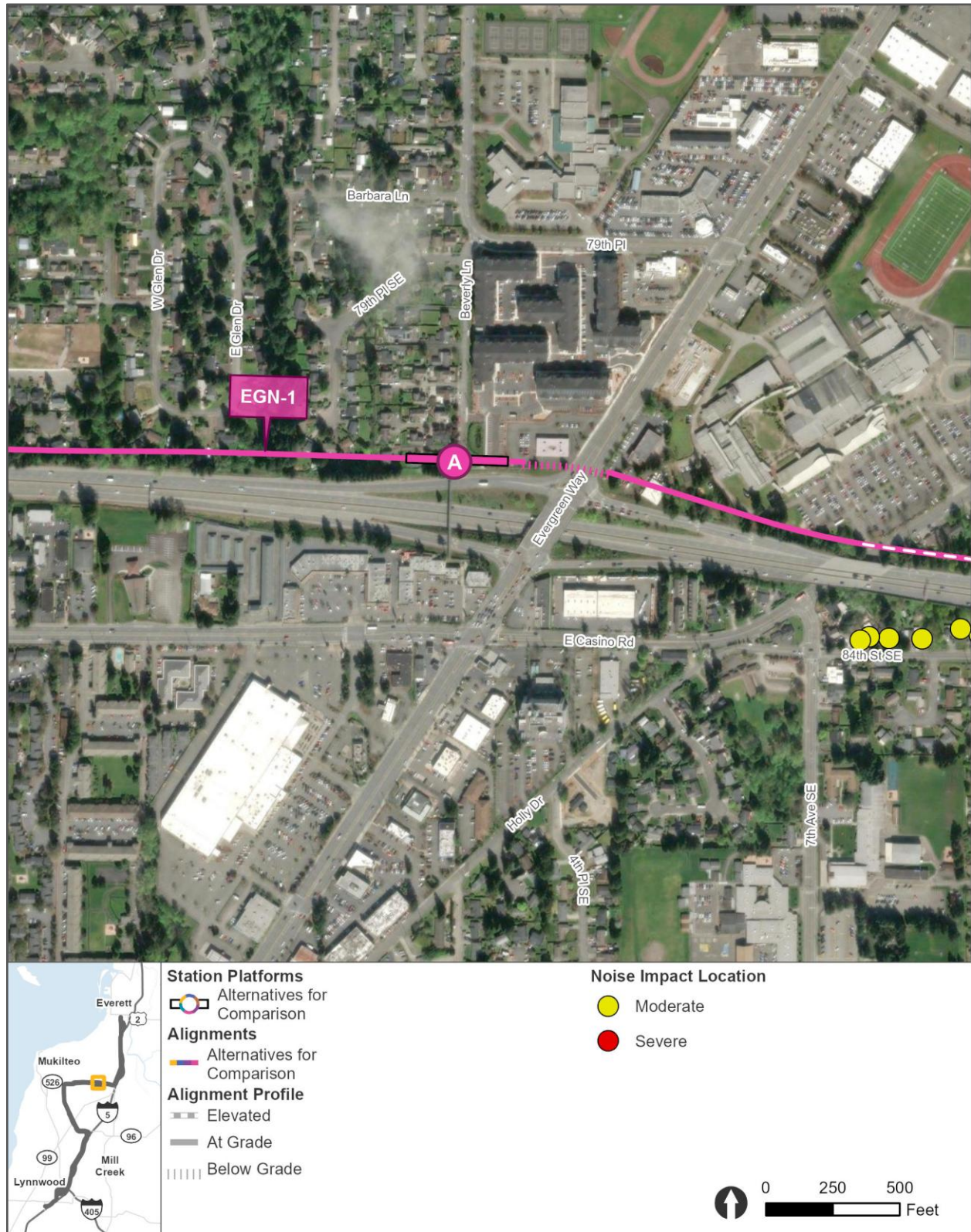


Figure 5-29 Noise Impact Locations – Alternative EGN-1A (3 of 3)

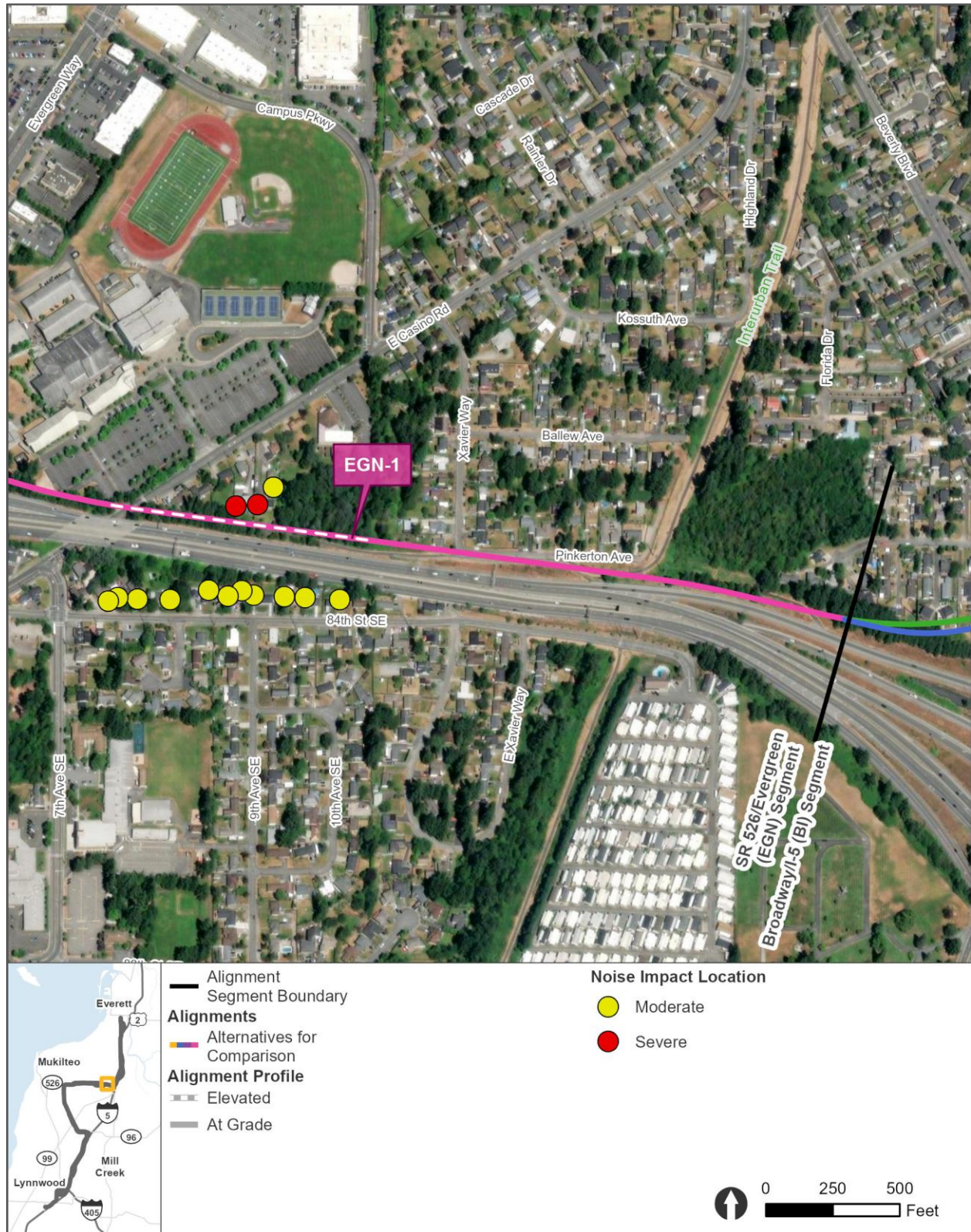


Figure 5-30 Noise Impact Locations – Alternative EGN-2B (1 of 4)



Figure 5-31 Noise Impact Locations – Alternative EGN-2B (2 of 4)



Figure 5-32 Noise Impact Locations – Alternative EGN-2B (3 of 4)



Figure 5-33 Noise Impact Locations – Alternative EGN-2B (4 of 4)

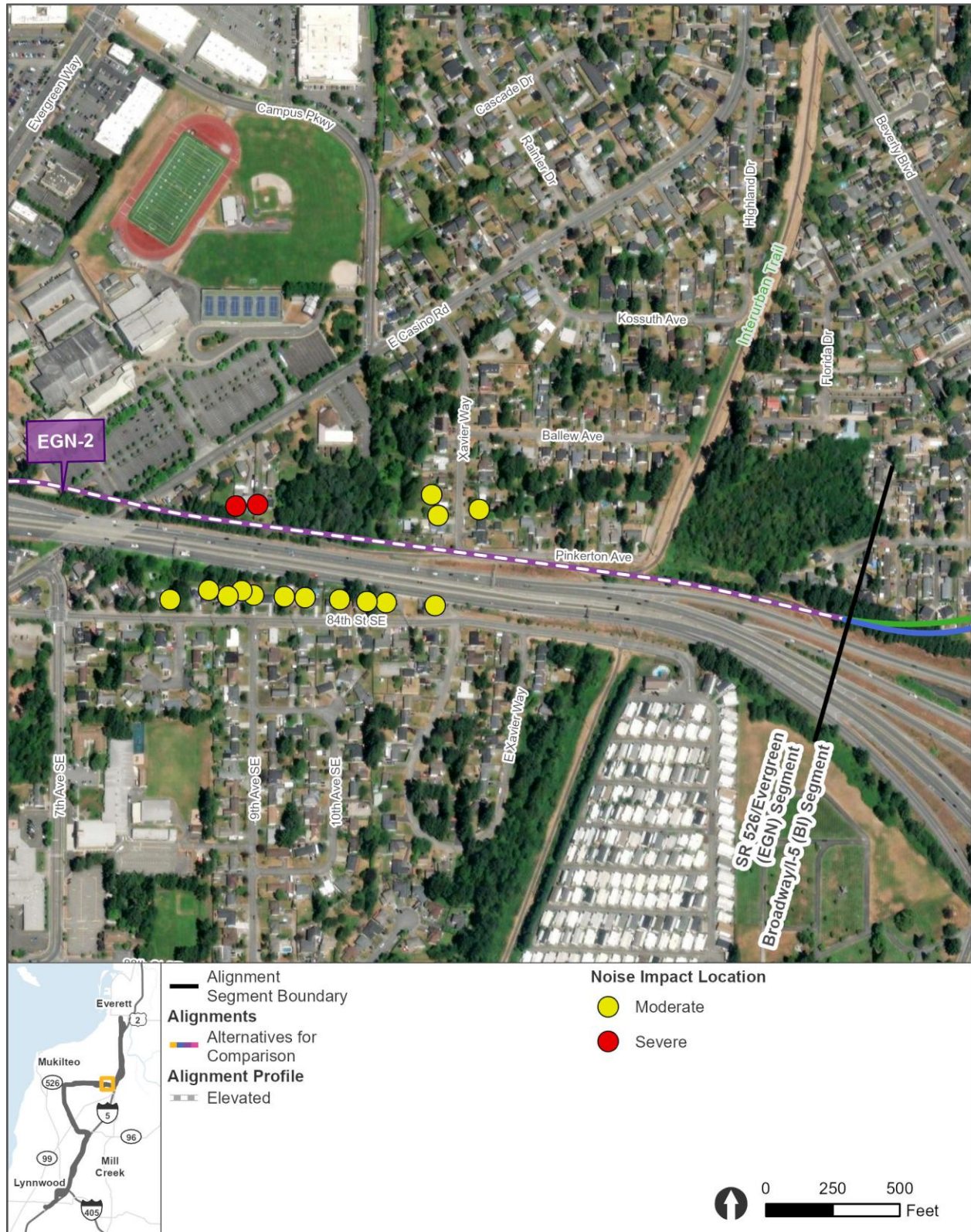


Figure 5-34 Noise Impact Locations – Alternative EGN-2B with North Side of SR 526 Design Option (1 of 3)



Figure 5-35 Noise Impact Locations – Alternative EGN-2B with North Side of SR 526 Design Option (2 of 3)



Figure 5-36 Noise Impact Locations – Alternative EGN-2B with North Side of SR 526 Design Option (3 of 3)

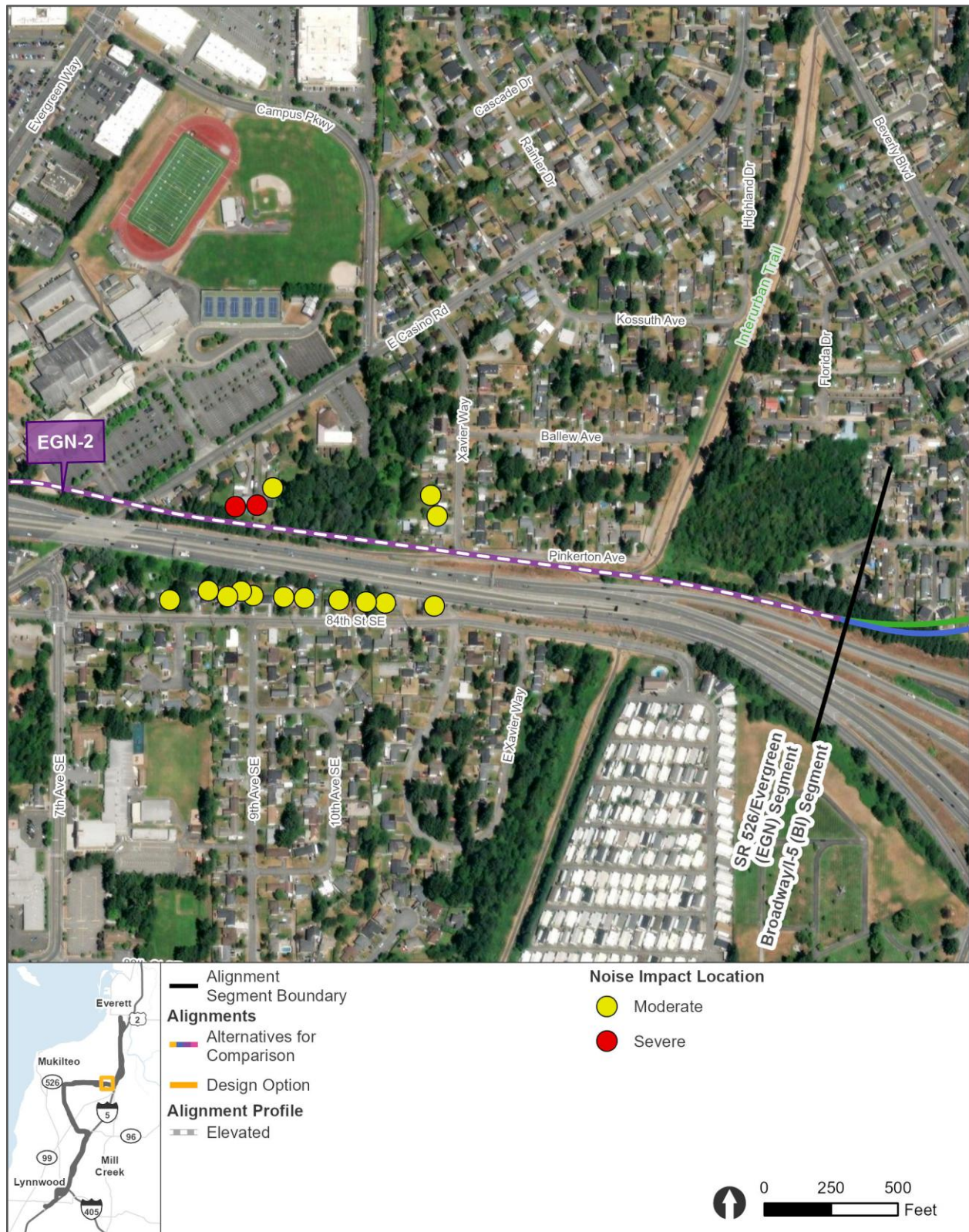


Figure 5-37 Noise Impact Locations – Alternative EGN-3E (1 of 4)



Figure 5-38 Noise Impact Locations – Alternative EGN-3E (2 of 4)



Figure 5-39 Noise Impact Locations – Alternative EGN-3E (3 of 4)



Figure 5-40 Noise Impact Locations – Alternative EGN-3E (4 of 4)

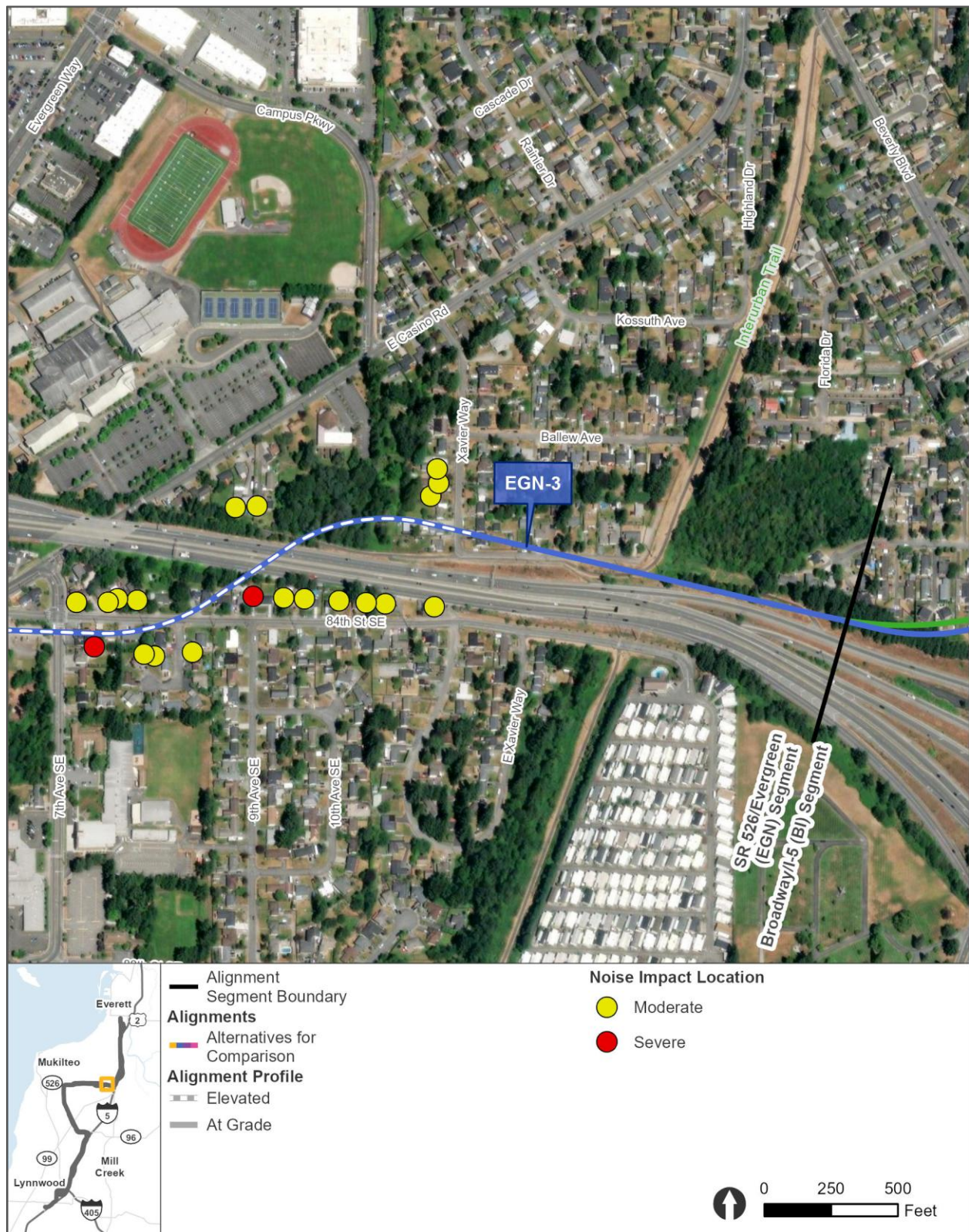


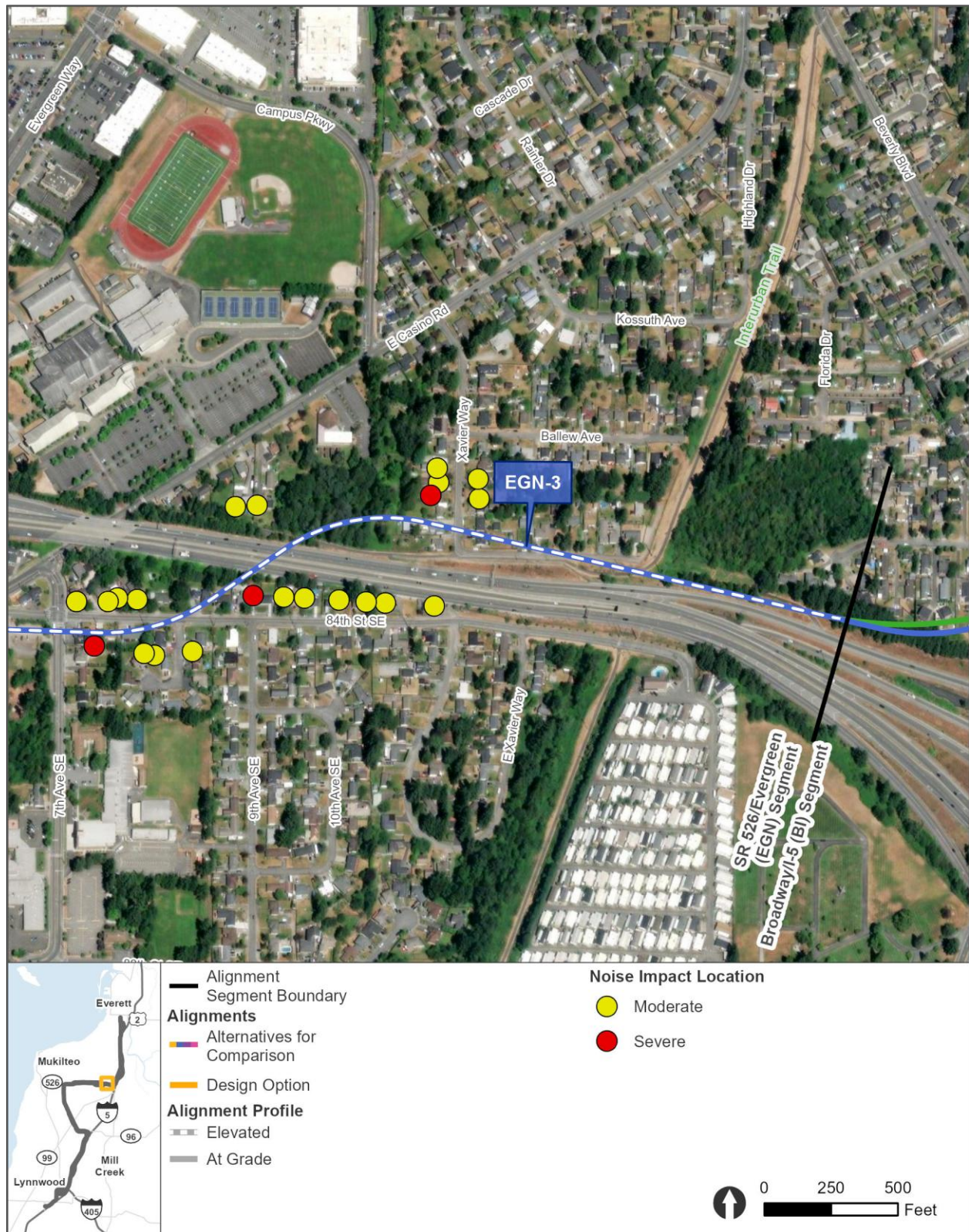
Figure 5-41 Noise Impact Locations – Alternative EGN-3E with North Side of SR 526 Design Option (1 of 3)



Figure 5-42 Noise Impact Locations – Alternative EGN-3E with North Side of SR 526 Design Option (2 of 3)



Figure 5-43 Noise Impact Locations – Alternative EGN-3E with North Side of SR 526 Design Option (3 of 3)



Broadway/I-5 Segment

A summary of the noise impacts for the Build Alternatives in the Broadway/I-5 Segment is presented below in Table 5-7, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

The noise impacts in the Broadway/I-5 Segment are projected to occur at single- and multi-family residences and the Montessori Schools of Snohomish County. These impacts are due to the proximity to the proposed tracks and the presence of elevated structures. Additionally, the crossovers between Madison Street and 61st Street for both Alternatives BI-1 and BI-2 contribute to nearby impacts.

For Alternative BI-1, moderate noise impacts are projected at 15 single-family residences, two hotels, and two multi-family buildings with 12 units, and severe noise impacts are projected at seven single-family residences and the Montessori Schools of Snohomish County. For Alternative BI-2, moderate noise impacts are projected at 66 single-family residences and 11 multi-family buildings with 46 units, and severe noise impacts are projected at 16 single-family residences and six multi-family buildings with 26 units.

The noise impact locations in the Broadway/I-5 Segment are shown in Figure 5-44 through Figure 5-49.

Table 5-7 Summary of Noise Impacts – Broadway/I-5 Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
BI-1	29	8
BI-2	112	42

Figure 5-44 Noise Impact Locations – Alternative BI-1 (1 of 3)



Figure 5-45 Noise Impact Locations – Alternative BI-1 (2 of 3)



Figure 5-46 Noise Impact Locations – Alternative BI-1 (3 of 3)



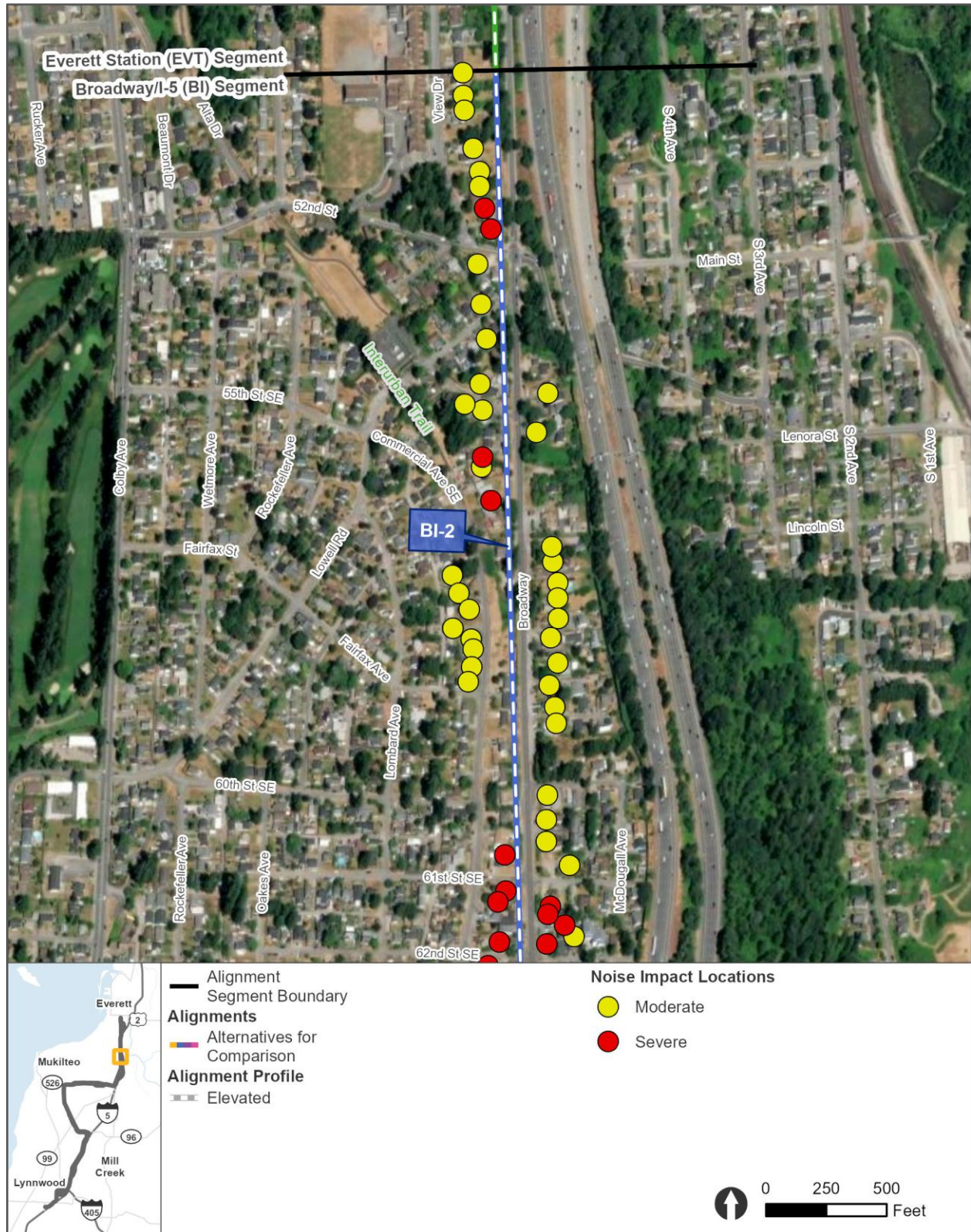
Figure 5-47 Noise Impact Locations – Alternative BI-2 (1 of 3)



Figure 5-48 Noise Impact Locations – Alternative BI-2 (2 of 3)



Figure 5-49 Noise Impact Locations – Alternative BI-2 (3 of 3)



Everett Station Segment

A summary of the noise impacts for the Build Alternatives in the Everett Station Segment is presented below in Table 5-8, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the existing noise levels, the projected noise levels from LRT operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

The noise impacts in the Everett Station Segment are projected to occur at single- and multi-family residences and are due to the proximity to the proposed tracks and the presence of elevated structures. Additionally, the crossovers between 36th Street and Hewitt Avenue for both Alternatives EVT-2C and EVT-3D contribute to nearby impacts.

For Alternative EVT-1A, moderate noise impacts are projected at 11 single-family residences. For Alternative EVT-2C, moderate noise impacts are projected at 11 single-family residences and one multi-family building with 140 units, and severe noise impacts are projected at one multi-family building with 65 units. For Alternative EVT-3D, moderate noise impacts are projected at 11 single-family residences, and severe noise impacts are projected at one hotel and three multi-family buildings with 295 units.

The noise impact locations in the Everett Station Segment are shown in Figure 5-50 through Figure 5-54.

Table 5-8 Summary of Noise Impacts – SR 526/Evergreen Segment

Build Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts
EVT-1A	11	0
EVT-2C	151	65
EVT-3D	11	296

Figure 5-50 Noise Impact Locations – Alternative EVT-1A (1 of 1)



Figure 5-51 Noise Impact Locations – Alternative EVT-2C (1 of 2)



Figure 5-52 Noise Impact Locations – Alternative EVT-2C (2 of 2)



Figure 5-53 Noise Impact Locations – Alternative EVT-3D (1 of 2)



Figure 5-54 Noise Impact Locations – Alternative EVT-3D (2 of 2)



5.1.1.2 OMF North Site Alternatives

A summary of the noise impacts for the OMF North site alternatives is presented below in Table 5-9, with more detailed information for each of the site alternatives in Attachment E. For each site alternative, tables are presented that include the side of the OMF or lead track where the receivers are located, the distances to the nearest portion of the OMF or lead track, the existing noise levels, the projected noise levels from OMF operations, the FTA noise impact criteria, and the number of moderate and severe noise impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

Table 5-9 Summary of Noise Impacts – OMF North Site Alternatives

OMF North Site Alternative	Number of Moderate Noise Impacts	Number of Severe Noise Impacts	WAC Noise Exceedances
OMF Site F	63	0	0
OMF Site F with Lead Tracks to West Side of Airport Road Design Option	125	33	0
OMF Site E	2	0	0
OMF Site B	4	0	0
OMF Site B with Lead Tracks to South Side of SR 526 Design Option	191	0	0

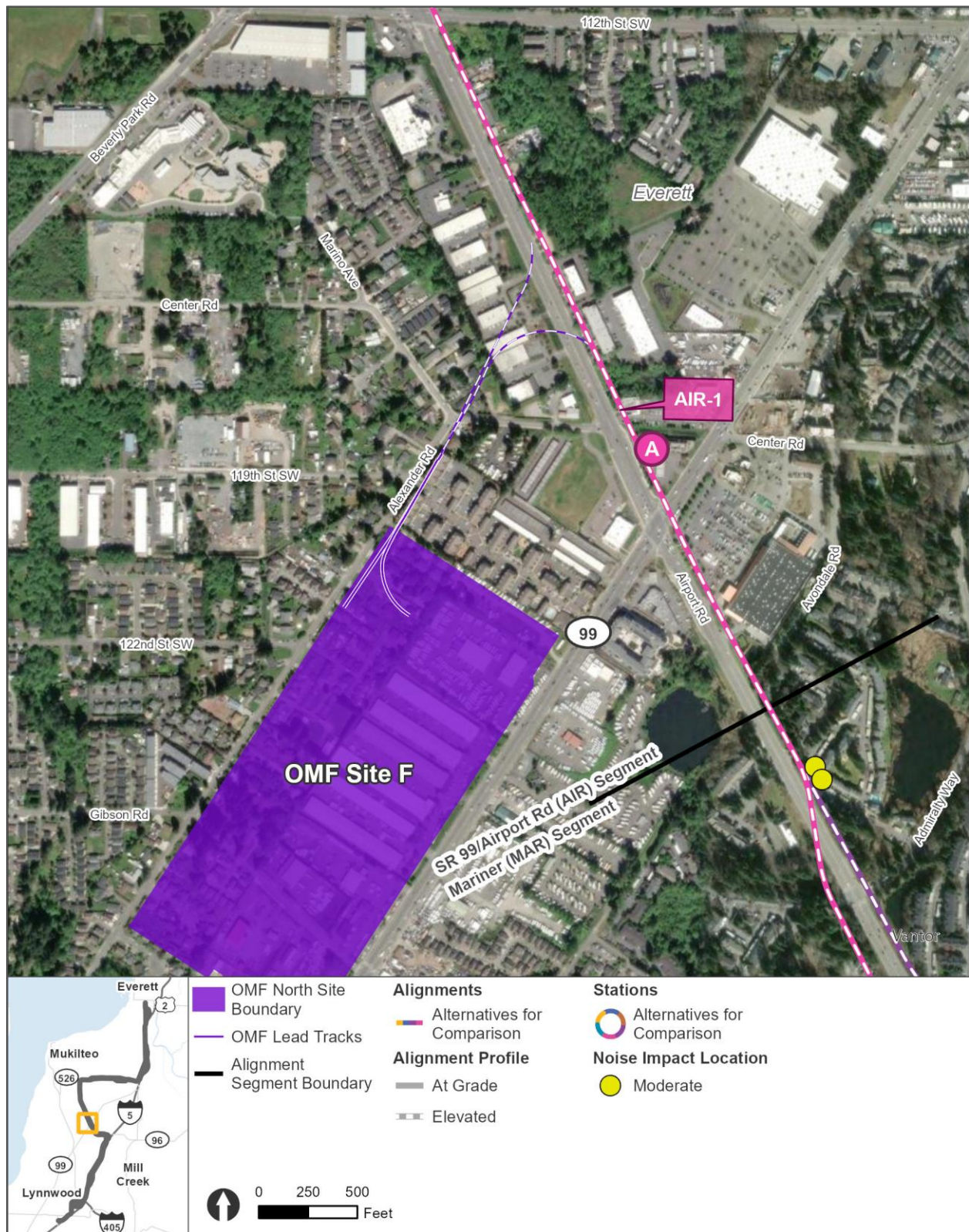
OMF Site F (SR 99)

The FTA moderate noise impacts for OMF Site F are projected to occur at two multi-family residences with 63 units and are due to the proximity to the proposed LRT operations. There would be additional noise due to the OMF site, but the number or severity of impact does not change.

A comparison of the maximum noise levels from facility operations with the WAC thresholds for residential land uses at night is also presented below. Because the majority of the activity at the facility would occur at night, and commercial and industrial uses typically do not have activity at night, only the residential night threshold is assessed. There are no WAC exceedances for OMF Site F.

The noise impact locations are shown in Figure 5-55 for OMF Site F.

Figure 5-55 Noise Impact Locations – OMF Site F



OMF Site F with Lead Tracks to West Side of Airport Road Design Option

The FTA moderate noise impacts for OMF Site F with Lead Tracks to West Side of Airport Road Design Option are projected to occur at the Seattle Korean Seventh-Day Adventist Church, 13 single-family residences, and five multi-family buildings with 111 units, and severe impacts at two single family residences, one hotel, and one multi-family building with 30 units.

The impacts at the Seattle Korean Seventh-Day Adventist Church and between Admiralty Way and Evergreen Way are due to the proximity of the lead tracks, nearby crossovers, and mainline guideway. The noise from the lead tracks and associated crossovers would increase the number of impacts in the area compared to the impacts due to the mainline guideway.

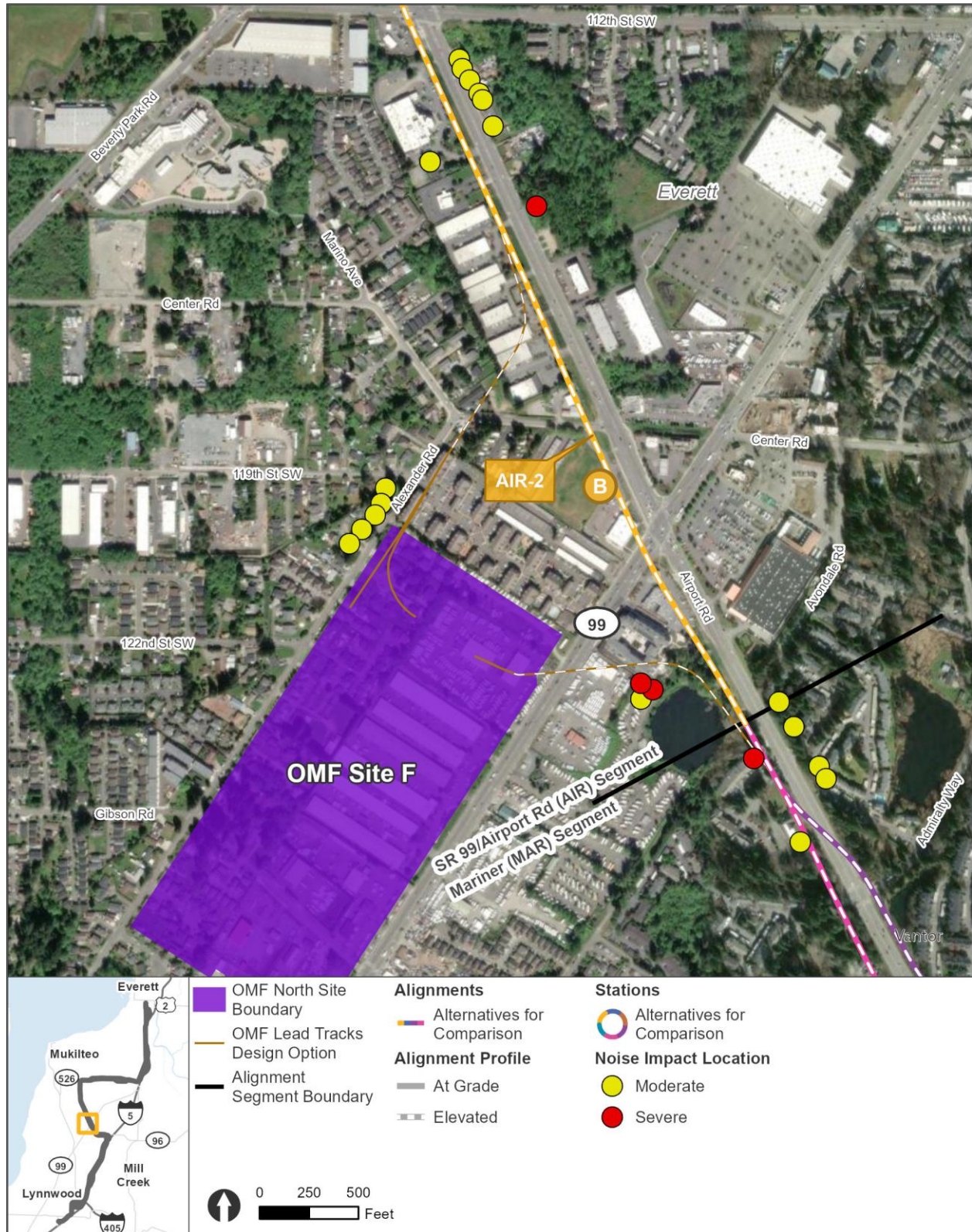
The impacts between Evergreen Way and Holly Drive are due to the lead tracks, nearby crossovers, and LRT operations on the mainline track. The noise from the lead tracks and associated crossovers would increase the noise levels, but the number and severity of impacts would not increase.

The remaining impacts are due to the lead tracks, nearby crossovers, and elevated structures of the OMF. The noise from operations on the mainline guideway does not contribute to these impacts.

A comparison of the maximum noise levels from facility operations with the WAC thresholds for residential land uses at night is also presented below. Because the majority of the activity at the facility would occur at night, and commercial and industrial uses typically do not have activity at night, only the residential night threshold is assessed. There are no WAC exceedances for OMF Site F with Lead Tracks to West Side of Airport Road Design Option.

The noise impact locations are shown in Figure 5-56 for OMF Site F with Lead Tracks to West Side of Airport Road Design Option.

Figure 5-56 Noise Impact Locations – OMF Site F with Lead Tracks to West Side of Airport Road Design Option



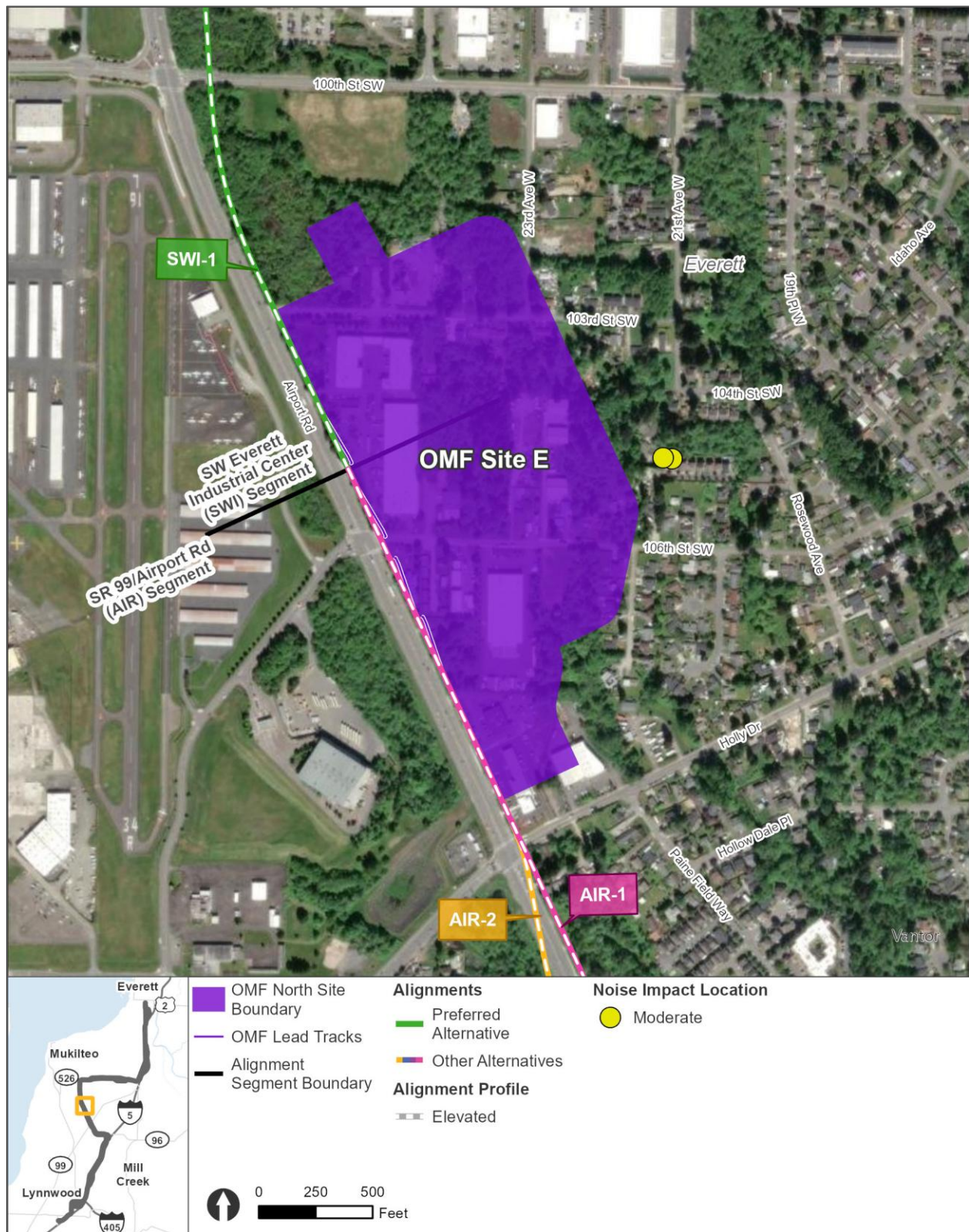
OMF Site E (Airport Road)

The FTA moderate noise impacts for OMF Site E are projected to occur at two single-family residences and are due to the proximity to the proposed OMF.

A comparison of the maximum noise levels from facility operations with the WAC thresholds for residential land uses at night is also presented below. Because the majority of the activity at the facility would occur at night, and commercial and industrial uses typically do not have activity at night, only the residential night threshold is assessed. There are no WAC exceedances for OMF Site E.

The noise impact locations are shown in Figure 5-57 for OMF Site E.

Figure 5-57 Noise Impact Locations – OMF Site E



OMF Site B (SR 526)

The FTA moderate noise impacts for OMF Site B are projected to occur at one multi-family building with four units and are due to the operations of the project on the mainline guideway. There would be additional noise due to the OMF site, but the number or severity of impact does not change.

A comparison of the maximum noise levels from facility operations with the WAC thresholds for residential land uses at night is also presented below. Because the majority of the activity at the facility would occur at night, and commercial and industrial uses typically do not have activity at night, only the residential night threshold is assessed. There are no WAC exceedances for OMF Site B.

The noise impact locations are shown in Figure 5-58 for OMF Site B.

Figure 5-58 Noise Impact Locations – OMF Site B



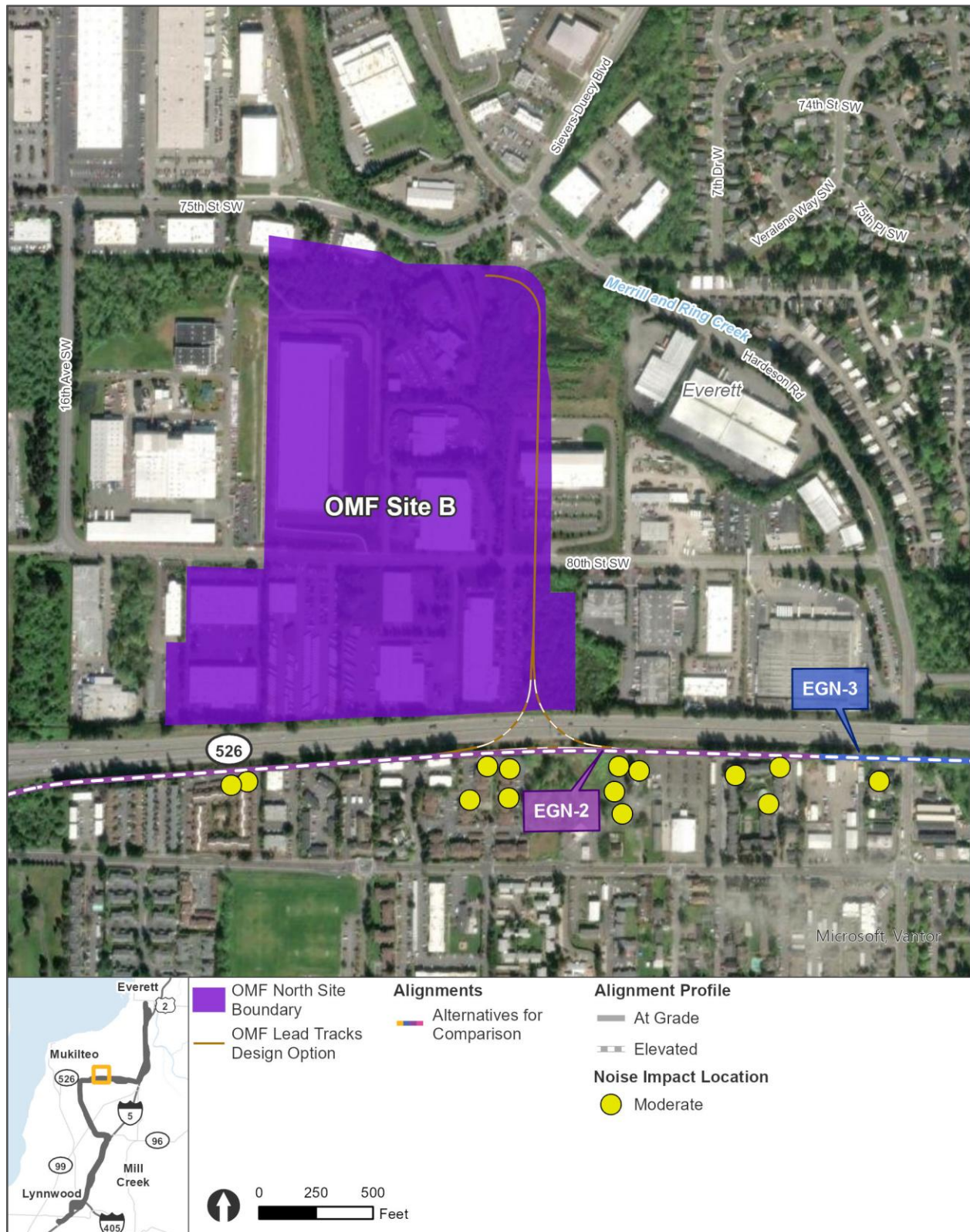
OMF Site B with Lead Tracks to South Side of SR 526 Design Option

The FTA moderate noise impacts for OMF Site B with Lead Tracks to South Side of SR 526 Design Option are projected to occur at 14 multi-family buildings with 191 units and are due to the project operations on the mainline guideway. The OMF and lead tracks would add to the noise, but it would not increase the number or severity of the impacts. The additional acquisitions associated with the lead tracks would reduce the number of impacts in this area compared to the project operations without this OMF alternative.

A comparison of the maximum noise levels from facility operations with the WAC thresholds for residential land uses at night is also presented below. Because the majority of the activity at the facility would occur at night, and commercial and industrial uses typically do not have activity at night, only the residential night threshold is assessed. There are no WAC exceedances for OMF Site B with Lead Tracks to South Side of SR 526 Design Option.

The noise impact locations are shown in Figure 5-59 for OMF Site B with Lead Tracks to South Side of SR 526 Design Option.

Figure 5-59 Noise Impact Locations – OMF Site B with Lead Tracks to South Side of SR 526 Design Option



5.1.1.3 Potential Design Refinements

As mentioned in Section 1.2, Sound Transit is considering potential design refinements in each alignment segment. Potential changes to noise impacts resulting from the potential design refinements are described in Table 5-10. No changes in vibration impacts have been identified at this time.

Table 5-10 Potential Changes to Noise Impacts

Potential Design Refinement	Applicable Alternatives	Potential Changes to Impacts
Cross I-5 further south and shift Station ASH-D and the 164th Street SW crossing further east.	ASH-2D	Would result in a longer stretch of at-grade guideway, which would reduce the curvature of the guideway and related light rail noise.
Move crossover away from residential area and closer to the station.	MAR-2D and MAR-2D with Surface Parking Design Option	Would reduce noise impacts for sensitive residential uses.
Move crossover away from station.	SWI-1A, SWI-1B, EGN-1A, and EGN-3E	Would result in similar noise impacts at the new crossover location.

5.1.2 Construction Noise Impacts

The types of noise levels that would likely be experienced in the project vicinity during construction are, to a degree, unavoidable for this type of project. For most construction equipment, diesel engines are typically the dominant noise source. For other activities, such as impact pile driving and jackhammering, noise generated by the actual process dominates. Short-term noise during construction of the project can be intrusive to residents near the construction sites. Most of the construction would consist of site preparation and laying new tracks and should occur primarily during daytime hours, except when required and within city or county noise ordinance procedures for a waiver. At some locations, more extensive work would occur, such as pile driving for elevated structures and retaining walls.

Table 3-5 shows noise levels of typical construction equipment from the FTA guidance manual, in terms of the maximum levels at 50 feet. Construction noise predictions at noise-sensitive locations depend on the amount of noise during each construction phase, the duration of the noise, and the distance from the construction activities to the sensitive receptor. Conducting a construction noise impact assessment requires knowledge of the equipment likely to be used, the duration of its use, and the way it would be used by a contractor. Table 5-11 provides an example of a construction noise projection for typical at-grade track construction. Construction noise projections for other project features, such as station or parking facilities, would have similar results. More specific construction mitigation would be developed as needed when final design yields more detailed information on methods, equipment, and durations. Using the assumptions in the table below, an 8-hour Leq of 88 dBA would be projected at a distance of 50 feet from the construction site.

Using the criteria in Section 3.1.3 and the example for at-grade construction in Table 5-11, screening distances for at-grade track construction noise impact can be determined. For residential land use, the potential for short-term at-grade track construction noise impact could extend to approximately 120 feet from the corridor; however, if nighttime construction is

conducted, the potential for short-term noise impact from at-grade construction could extend to approximately 380 feet from the corridor. For elevated structure construction, the distances could be larger, depending on the type of piling that could occur. When a specific piling method is determined, a screening distance could be calculated.

Based on the distances above, there would be sensitive receptors within the screening distances for all alternatives. Noise impacts perceived by residents and other sensitive receptors would vary depending on the proximity of the construction activity, the type of equipment being used, the time of day, and the overall duration of construction.

Table 5-11 Typical Construction Scenario, At-Grade Track

Equipment Type	Typical Noise Level at 50 feet (dBA)	Equipment Utilization Factor (%)	Leq (dBA)
Grader	85	50	82
Backhoe	80	40	76
Compactor	82	20	75
Loader	85	20	78
Roller	74	20	67
Truck	88	40	84
Crane, Mobile	83	20	76
Total 8-hour workday Leq at 50 feet:			88

5.2 Build Alternatives Vibration Impact Assessment

5.2.1 Operational Impacts

5.2.1.1 Alignment and Station Alternatives

West Alderwood Segment

A summary of the vibration impacts for the Build Alternatives in the West Alderwood Segment is presented below in Table 5-12, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

There are no vibration impacts in the West Alderwood Segment.

Table 5-12 Summary of Vibration Impacts – West Alderwood Segment

Build Alternative	Number of Vibration Impacts
ALD-1B	0
ALD-1B with Alderwood Mall Boulevard Design Option	0

Build Alternative	Number of Vibration Impacts
ALD-2D	0
ALD-2D with Alderwood Mall Boulevard Design Option	0
ALD-2F	0
ALD-2F with Alderwood Mall Boulevard Design Option	0

Ash Way Segment

A summary of the vibration impacts for the Build Alternatives in the Ash Way Segment is presented below in Table 5-13, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

The vibration impacts in the Ash Way Segment are projected to occur at single- and multi-family residences and are due to the proximity to the proposed tracks and the speed of the LRV.

For Alternative ASH-1A, vibration impacts are projected at 23 single-family residences. For Alternative ASH-2D, vibration impacts are projected at three single-family residences.

The vibration impact locations in the Ash Way Segment are shown in Figure 5-60 through Figure 5-66.

Table 5-13 Summary of Vibration Impacts – Ash Way Segment

Build Alternative	Number of Vibration Impacts
ASH-1A	23
ASH-2D	3

Figure 5-60 Vibration Impact Locations – Alternative ASH-1A (1 of 5)



Figure 5-61 Vibration Impact Locations – Alternative ASH-1A (2 of 5)



Figure 5-62 Vibration Impact Locations – Alternative ASH-1A (3 of 5)



Figure 5-63 Vibration Impact Locations – Alternative ASH-1A (4 of 5)



Figure 5-64 Vibration Impact Locations – Alternative ASH-1A (5 of 5)



Figure 5-65 Vibration Impact Locations – Alternative ASH-2D (1 of 2)



Figure 5-66 Vibration Impact Locations – Alternative ASH-2D (2 of 2)



Mariner Segment

A summary of the vibration impacts for the Build Alternatives in the Mariner Segment is presented below in Table 5-14, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

There are no vibration impacts in the Mariner Segment.

Table 5-14 Summary of Vibration Impacts – Mariner Segment

Build Alternative	Number of Vibration Impacts
MAR-1B	0
MAR-1B with Surface Parking Design Option	0
MAR-2D	0
MAR-2D with Surface Parking Design Option	0

SR 99/Airport Road Segment

A summary of the vibration impacts for the Build Alternatives in the SR 99/Airport Road Segment is presented below in Table 5-15, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

There are no vibration impacts in the SR 99/Airport Road Segment.

Table 5-15 Summary of Vibration Impacts – SR 99/Airport Road Segment

Build Alternative	Number of Vibration Impacts
AIR-1A	0
AIR-2B	0

SW Everett Industrial Center Segment

A summary of the vibration impacts for the Build Alternatives in the SW Everett Industrial Center Segment is presented below in Table 5-16, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

There are no vibration impacts in the SW Everett Industrial Center Segment.

Table 5-16 Summary of Vibration Impacts – SW Everett Industrial Center Segment

Build Alternative	Number of Vibration Impacts
SWI-1A	0
SWI-1A with Lower Design Option	0
SWI-1B	0
SWI-1C	0

SR 526/Evergreen Segment

A summary of the vibration impacts for the Build Alternatives in the SR 526/Evergreen Segment is presented below in Table 5-17, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

The vibration impacts in the SR 526/Evergreen Segment are projected to occur at single- and multi-family residences and are due to the proximity to the proposed tracks and the speed of the LRV.

For Alternatives EGN-2B and EGN-3E, vibration impacts are projected at five multi-family buildings with 48 units. Alternative EGN-3E also has one single-family residence with a vibration impact.

The vibration impact locations in the SR 526/Evergreen Segment are shown in Figure 5-67 through Figure 5-70.

Table 5-17 Summary of Vibration Impacts – SR 526/Evergreen Segment

Build Alternative	Number of Vibration Impacts
EGN-1A	0
EGN-2B	48
EGN-2B with North Side of SR 526 Design Option	0
EGN-3E	49
EGN-3E with North Side of SR 526 Design Option	0

Figure 5-67 Vibration Impact Locations – Alternative EGN-2B (1 of 2)



Figure 5-68 Vibration Impact Locations – Alternative EGN-2B (2 of 2)

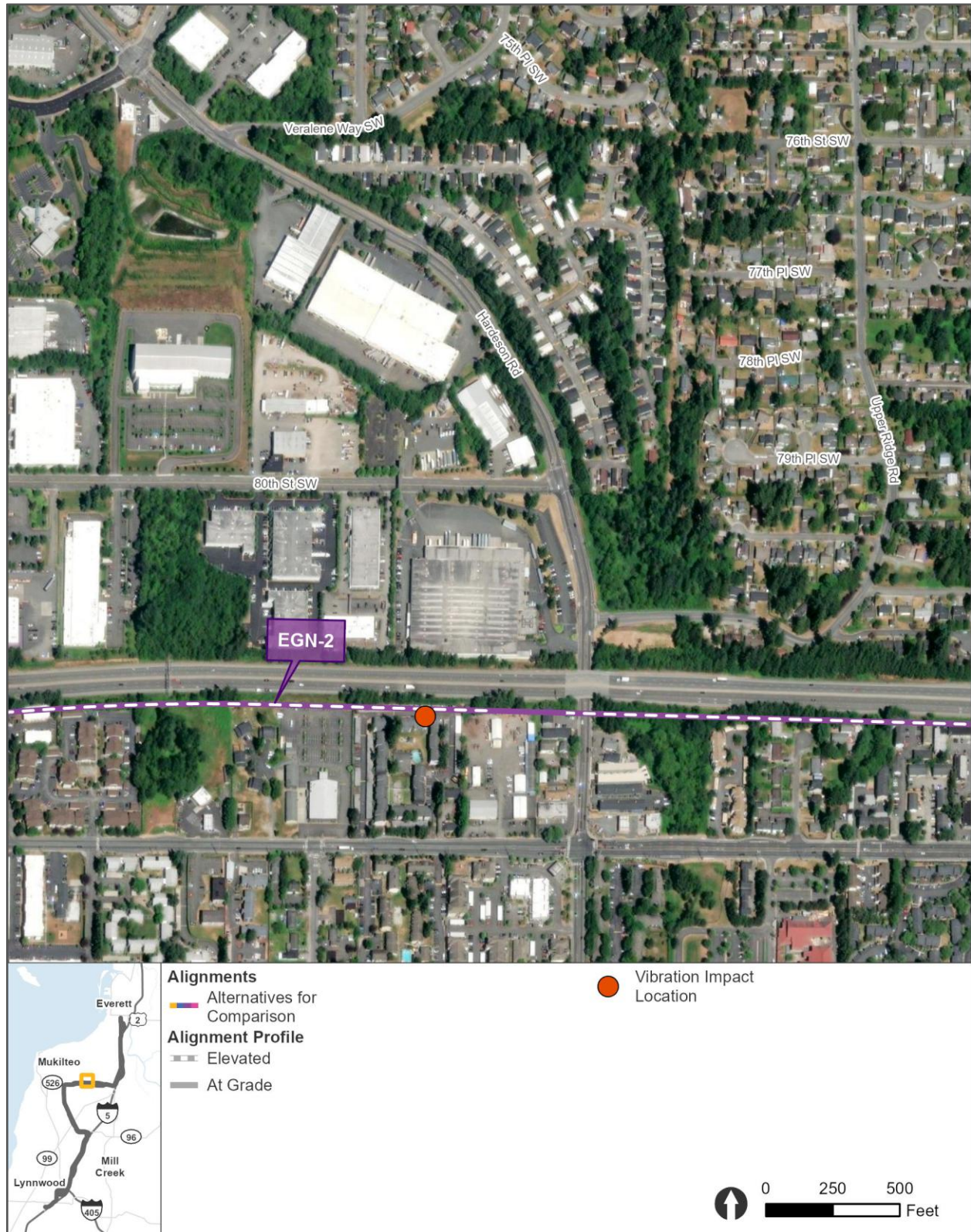
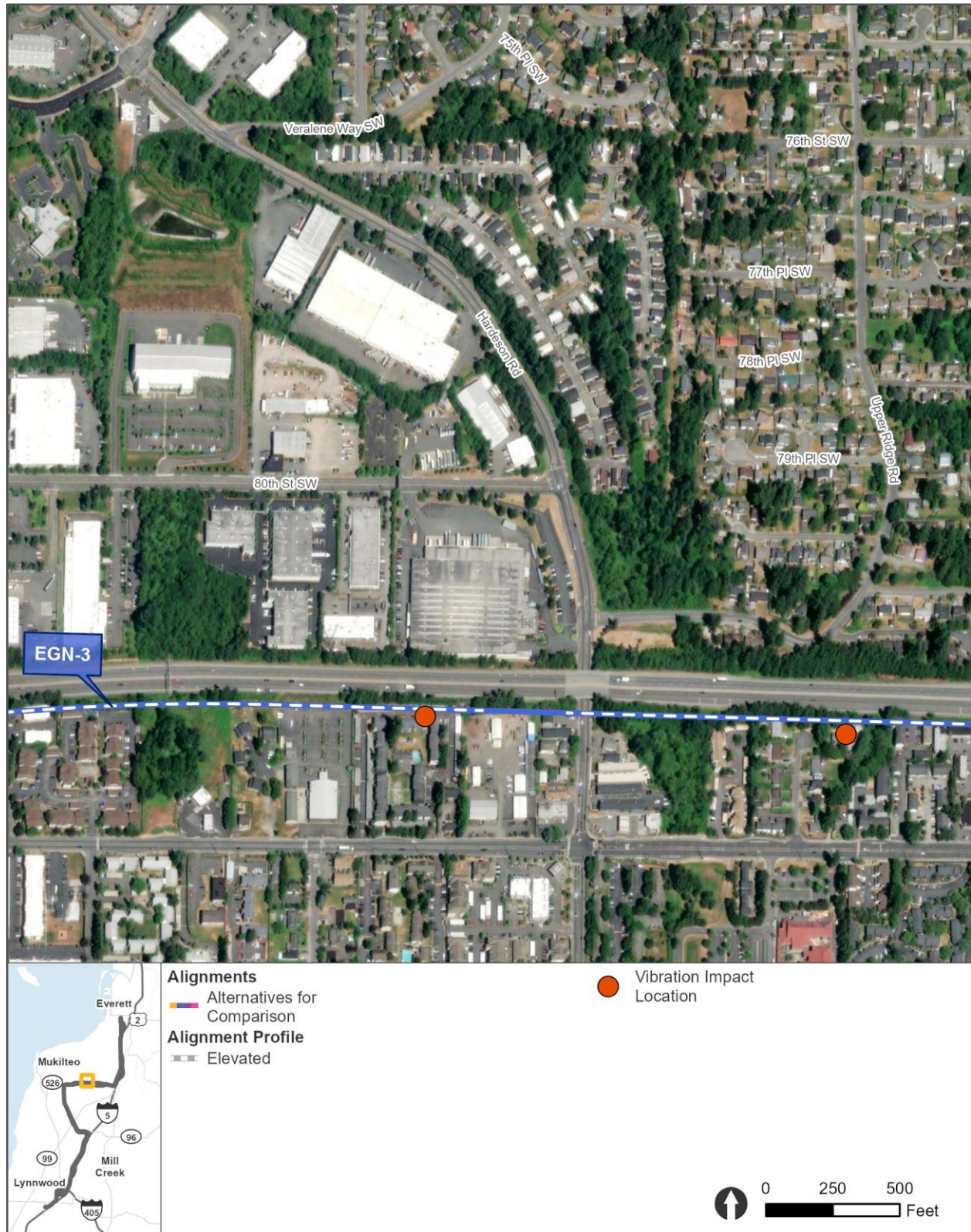


Figure 5-69 Vibration Impact Locations – Alternative EGN-3E (1 of 2)



Figure 5-70 Vibration Impact Locations – Alternative EGN-3E (2 of 2)



Broadway/I-5 Segment

A summary of the vibration impacts for the Build Alternatives in the Broadway/I-5 Segment is presented below in Table 5-18, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

The vibration impacts in the Broadway/I-5 Segment are projected to occur at single- and multi-family residences and are due to the proximity to the proposed tracks and the speed of the LRV. Additionally, the vibration impact along Alternative BI-1 between Madison Street and 61st Street is due to nearby crossovers.

For Alternative BI-1, vibration impacts are projected at 13 single-family residences and one hotel. For Alternative BI-2, vibration impacts are projected at five single-family residences.

The vibration impact locations in the Broadway/I-5 Segment are shown in Figure 5-71 through Figure 5-75.

Table 5-18 Summary of Vibration Impacts – Broadway/I-5 Segment

Build Alternative	Number of Vibration Impacts
BI-1	14
BI-2	5

Figure 5-71 Vibration Impact Locations – Alternative BI-1 (1 of 3)



Figure 5-72 Vibration Impact Locations – Alternative BI-1 (2 of 3)



Figure 5-73 Vibration Impact Locations – Alternative BI-1 (3 of 3)



Figure 5-74 Vibration Impact Locations – Alternative BI-2 (1 of 2)

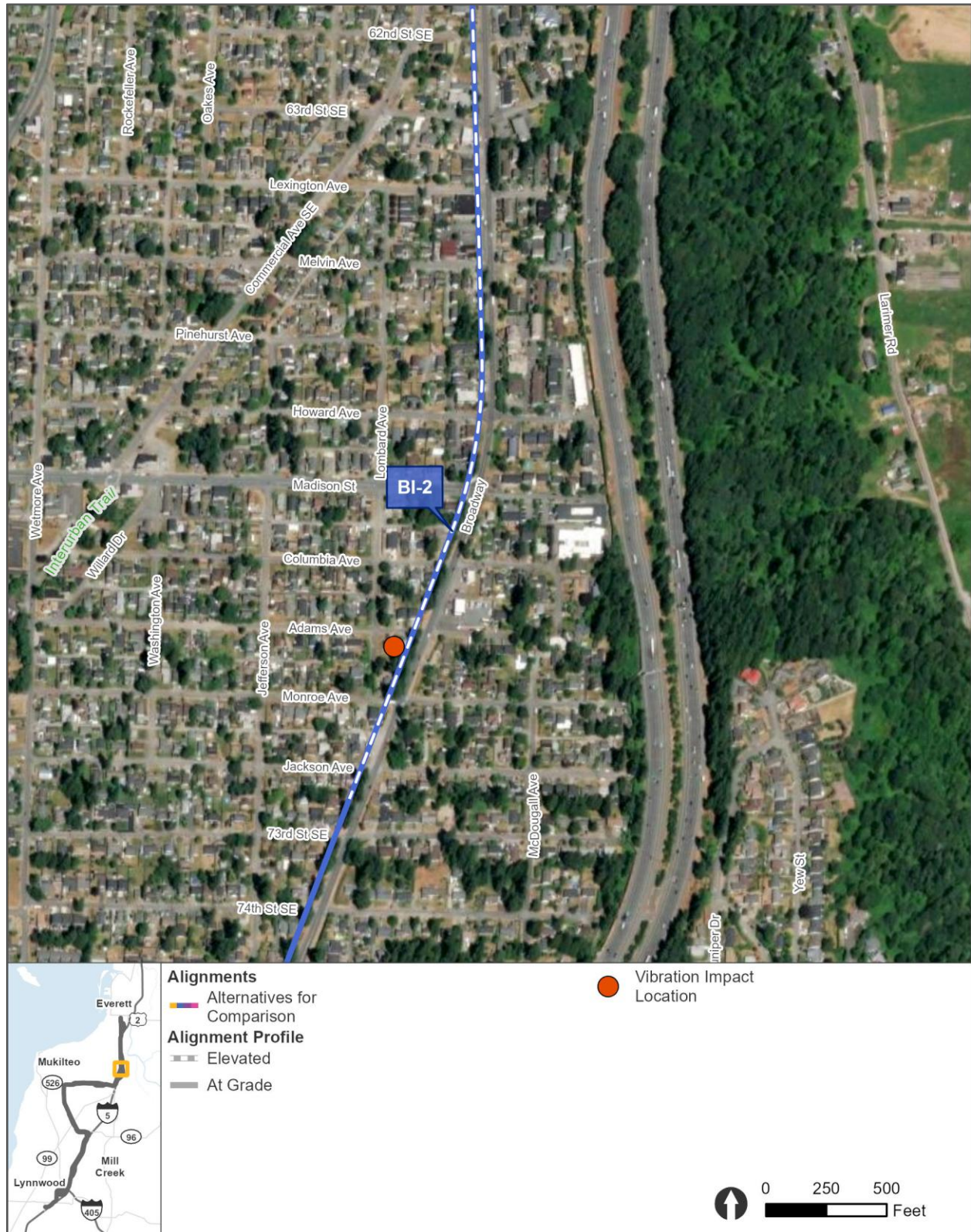


Figure 5-75 Vibration Impact Locations – Alternative BI-2 (2 of 2)



Everett Station Segment

A summary of the vibration impacts for the Build Alternatives in the Everett Station Segment is presented below in Table 5-19, with more detailed information for each of the Build Alternatives in Attachment E. For each Build Alternative, tables are presented that include the side of the track where the receivers are located, the distances to the nearest track, the projected vibration levels from LRT operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to vibration and for FTA Category 3 (institutional) receptors with sensitivity to only daytime vibration, respectively.

The vibration impacts in the Everett Station Segment are projected to occur at single- and multi-family residences and are due to the proximity to the proposed tracks and the speed of the LRV.

For Alternatives EVT-1A and EVT-2C, a vibration impact is projected at one single-family residence. For Alternative EVT-3D, vibration impacts are projected at one single-family residence and one multi-family building with 65 units.

The vibration impact locations in the Everett Station Segment are shown in Figure 5-76 through Figure 5-79.

Table 5-19 Summary of Vibration Impacts – Everett Station Segment

Build Alternative	Number of Vibration Impacts
EVT-1A	1
EVT-2C	1
EVT-3D	66

Figure 5-76 Vibration Impact Locations – Alternative EVT-1A (1 of 1)



Figure 5-77 Vibration Impact Locations – Alternative EVT-2C (1 of 1)



Figure 5-78 Vibration Impact Locations – Alternative EVT-3D (1 of 2)



Figure 5-79 Vibration Impact Locations – Alternative EVT-3D (2 of 2)



5.2.1.2 OMF North Site Alternatives

A summary of the vibration impacts for the OMF North site alternatives is presented below in Table 5-20, with more detailed information for each of the Build Alternatives in Attachment E. For each OMF North site alternative, tables are presented that include the side of the OMF or lead track where the receivers are located, the distances to the nearest portion of the OMF or lead track, the projected vibration levels from OMF operations, the FTA vibration impact criteria, and the number of vibration impacts for FTA Category 2 (residential) receptors with both daytime and nighttime sensitivity to noise and for FTA Category 3 (institutional) receptors with sensitivity to only daytime noise, respectively.

Table 5-20 Summary of Vibration Impacts – OMF North Site Alternatives

OMF North Site Alternative	Number of Vibration Impacts
OMF Site F	0
OMF Site F with Lead Tracks to West Side of Airport Road Design Option	30
OMF Site E	0
OMF Site B	0
OMF Site B with Lead Tracks to South Side of SR 526 Design Option	0

OMF Site F (SR 99)

There are no vibration impacts for OMF Site F.

OMF Site F with Lead Tracks to West Side of Airport Road Design Option

The vibration impacts for OMF Site F with Lead Tracks to West Side of Airport Road Design Option are projected to occur at one multi-family building with 30 units and are due to the proximity to nearby crossovers.

The vibration impact locations are shown in Figure 5-80 for OMF Site F with Lead Tracks to West Side of Airport Road Design Option.

Figure 5-80 Vibration Impact Locations – OMF Site F with Lead Tracks to West Side of Airport Road Design Option



OMF Site E (Airport Road)

There are no vibration impacts for OMF Site E. Due to the location of the site and the location of the lead tracks, there are no vibration sensitive receivers at this location.

OMF Site B (SR 526)

There are no vibration impacts due to the OMF Site B. There are no Category 3 receivers close to the lead tracks.

OMF Site B with Lead Tracks to South Side of SR 526 Design Option

There are no vibration impacts for OMF Site B with Lead Tracks to South Side of SR 526 Design Option. There are no Category 3 receivers close to the lead tracks.

5.2.2 Construction Vibration Impacts

Unlike typical LRT operations, there is the potential for damage to nearby structures at close distances due to construction vibration from activities such as pile driving, hoe rams, vibratory compaction, and loaded trucks. Most limits on construction vibration are based on reducing the potential for damage to nearby structures. Although construction vibrations are only temporary, it is still reasonable to assess the potential for human annoyance and damage.

As a conservative approach, the non-engineered timber and masonry construction category (Category III) was used to assess the potential for construction vibration impacts. A vibration criterion of 94 VdB was used to assess potential damage impact, and 72 VdB was used to assess potential vibration annoyance from construction activities. Vibration source levels at 25 feet and the distances to potential residential annoyance and potential damage are shown in Table 5-21. With the exception of impact pile driving, the potential for damage is limited to within 25 feet of construction activities. For impact pile driving, the distance for the potential for damage is up to 55 feet. There are sensitive receptors within 25 feet of several of the project alternatives, and all of the project alternatives with the exception of those in the SW Everett Industrial Center Segment have buildings within 55 feet. However, any potential for impacts would depend on the piling method chosen.

Because the exact location of construction equipment is important in projecting vibration levels, a more detailed assessment of potential vibration damage will be performed during final design when more accurate equipment locations are known. It is important to note that the Draft EIS assessment does not address potential damage to structures due to soil settlement or displacement due to construction activities.

Table 5-21 Summary of Potential Construction Vibration Impacts

Equipment Type	Typical Vibration Level at 25 feet (VdB)	Distance for Potential Damage (ft)	Distance for Potential Annoyance (ft)
Impact Pile Driving	104	55	290
Push Piling	84	25	125
Hoe Ram	87	15	80
Caisson Drilling	87	15	80
Loaded Trucks	86	15	75
Clam Shovel	94	25	135
Vibratory Roller	94	25	135

5.3 No Build Alternative

The No Build Alternative would not result in any noise or vibration impacts. There would likely be increases in highway and local roadway noise due to increased traffic volumes.

6 POTENTIAL MITIGATION MEASURES

Sound Transit is committed to complying with all applicable federal, state, and local environmental regulations, following best management practices, and designing the EVLE Project in a way that mitigates adverse impacts. As a result, mitigation measures are reflected in the design of Build Alternatives. The following sections present additional potential mitigation measures that would further reduce or eliminate adverse effects. Final mitigation measures will be based on advanced design and will be included in the Final EIS and in FTA's Record of Decision as environmental commitments for the project.

Noise mitigation measures would be required for almost all alternatives in each segment, with the exception of the SW Everett Industrial Center Segment, where no mitigation is required for any alternative. Vibration mitigation measures would be much more limited as compared with noise, with no mitigation required for any alternative in the Mariner Segment, the SR 99/Airport Road Segment, or the SW Everett Industrial Center Segment.

6.1 Operational Noise

Sound Transit would follow its Link Noise Mitigation Policy (Resolution No. R2023-15), which establishes source mitigation (i.e., modifications to track materials or design) as the preferred method of mitigation, followed by path mitigation (i.e., noise barriers), and then receiver mitigation (e.g., sound insulation of buildings).

- Source mitigation would consist of special trackwork. Gaps in the rails at crossovers and turnouts generate around 5 dB of increased noise for locations close to the track. If crossovers are located in sensitive areas and cannot be moved, one approach is to use unique special trackwork, such as spring-rail, moveable point, or flange bearing frogs to eliminate the gap in the rail at the crossover.

- Path mitigation would consist of noise barriers. Installation of noise barriers beside the tracks is commonly used to reduce noise from surface transportation sources. Depending on the height and location relative to the tracks, noise barriers can achieve between 5 and 15 dB of noise reduction. The primary requirements for an effective noise barrier are that (1) the barrier must be high enough and long enough to break the line-of-sight between the sound source and the receiver, (2) the barrier must be of an impervious material with a minimum surface density of 4 pounds per square foot, and (3) the barrier must not have any gaps or holes between the panels or at the bottom. Because many materials meet these requirements, the selection of materials for noise barriers is usually dictated by aesthetics, durability, cost, and maintenance considerations. Noise barriers for transit projects typically range in height from 8 to 12 feet and can be as low 4 feet in height on elevated structures.
- Receiver mitigation would include measures such as building sound insulation. Although sound insulation of buildings has no effect on noise in exterior areas, it may be the best choice for sites where noise barriers are not feasible or desirable and for buildings where indoor sensitivity is of most concern. Substantial improvements in building sound insulation (on the order of 5 to 10 dBA) can often be achieved by adding an extra layer of glazing to the windows, by sealing holes in exterior surfaces that act as sound leaks, and by providing forced ventilation and air-conditioning so that windows do not need to be opened.

The most effective type of mitigation at most locations would be noise barriers. For the purposes of this report, 4-foot-high barriers on elevated structures and 8-foot-high barriers on at-grade sections were assumed. The height of the barriers would be determined during final design.

In most locations, noise barriers and/or special trackwork at crossovers would eliminate the noise impacts. However, there are a few locations where noise barriers would need to be combined with building sound insulation to fully mitigate the noise impacts. Details regarding specific locations of mitigation are provided below by alternative.

For highway noise barriers that would need to be relocated due to the project, Sound Transit would commit to providing the same level of noise mitigation from highway traffic noise as currently exists.

6.1.1 Potential Mitigation for Alignment and Station Alternatives

6.1.1.1 West Alderwood Segment

A summary of the potential noise mitigation locations and types for the Build Alternatives in the West Alderwood Segment is presented in Table 6-1 through Table 6-6.

Table 6-1 Noise Mitigation Locations – Alternative ALD-1B

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
44th Avenue to 196th Street	NB	1000+00 to 1008+00	800	Noise wall
44th Avenue to 196th Street	SB	1017+00 to 1031+50	1,450	Noise wall
Total:			2,250	Noise walls

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-2 Noise Mitigation Locations – Alternative ALD-1B with Alderwood Mall Boulevard Design Option

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
44th Avenue to 196th Street	NB	1000+00 to 1008+00	800	Noise wall
44th Avenue to 196th Street	SB	1018+00 to 1029+00	1,100	Noise wall
196th Street to 188th Street	SB	1033+00 to 1041+00	800	Noise wall
Total:			2,700	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-3 Noise Mitigation Locations – Alternative ALD-2D

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
44th Avenue to 196th Street	NB	1000+00 to 1008+00	800	Noise wall
44th Avenue to 196th Street	SB	1017+00 to 1031+50	1,450	Noise wall
188th Street to Maple Road	SB	1073+50 to 1082+50	900	Noise wall
Total:			3,150	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-4 Noise Mitigation Locations – Alternative ALD-2D with Alderwood Mall Boulevard Design Option

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
44th Avenue to 196th Street	NB	1000+00 to 1008+00	800	Noise wall
44th Avenue to 196th Street	SB	1018+00 to 1029+00	1,100	Noise wall
196th Street to 188th Street	SB	1033+00 to 1041+00	800	Noise wall
188th Street to Maple Road	SB	1073+50 to 1082+50	900	Noise wall
Total:			3,600	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-5 Noise Mitigation Locations –Alternative ALD-2F

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
44th Avenue to 196th Street	NB	1000+00 to 1008+00	800	Noise wall
44th Avenue to 196th Street	SB	1017+00 to 1031+50	1,450	Noise wall
188th Street to Maple Road	SB	1073+50 to 1082+50	900	Noise wall
Total:			3,150	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-6 Noise Mitigation Locations – Alternative ALD-2F with Alderwood Mall Boulevard Design Option

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
44th Avenue to 196th Street	NB	1000+00 to 1008+00	800	Noise wall
44th Avenue to 196th Street	SB	1018+00 to 1029+00	1,100	Noise wall
196th Street to 188th Street	SB	1033+00 to 1041+00	800	Noise wall
188th Street to Maple Road	SB	1073+50 to 1082+50	900	Noise wall
Total:			3,600	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

6.1.1.2 Ash Way Segment

A summary of the potential noise mitigation locations and types for the Build Alternatives in the Ash Way Segment is presented in Table 6-7 and Table 6-8.

Table 6-7 Noise Mitigation Locations – Alternative ASH-1A

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Maple Road to 172nd Street	SB	3005+00 to 3011+50	650	Noise wall
Maple Road to 172nd Street	SB	3015+50 to 3020+00	450	Noise wall
172nd Street to 164th Street	SB	3032+50 to 3038+00	550	Noise wall
172nd Street to 164th Street	SB	3042+00 to 3058+00	600	Noise wall
164th Street to 18th Avenue	SB	3073+00 to 3097+00	2,400	Noise wall
153rd Place to 147th Street	SB	3104+50 to 3122+00	1,750	Noise wall
147th Street to 140th Street	SB	3131+00 to 3145+50	1,450	Noise wall

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
140th Street to 134th Street	SB	3149+50 to 3153+00	350	Noise wall
Total with connection to MAR-1B:			8,200	Noise walls
Total with connection to MAR-2D:			8,200	Noise walls

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-8 Noise Mitigation Locations – Alternative ASH-2D

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Maple Road to 172nd Street	SB	3005+00 to 3011+50	650	Noise wall
Maple Road to 172nd Street	SB	3015+50 to 3020+00	450	Noise wall
172nd Street to 164th Street	SB	3027+00 to 3036+50	950	Noise wall
172nd Street to 164th Street	NB	3038+00 to 3045+50	750	Noise wall
18th Avenue to 153rd Place	NB	3075+00 to 3081+00	600	Noise wall
18th Avenue to 153rd Place	NB	3083+50 to 3086+00	250	Noise wall
153rd Place to 140th Street	NB	3118+50 to 3145+50	2,700	Noise wall
140th Street to 134th Street / Connection to MAR-2D	NB	Noise Wall: 3153+00 to 3161+00 Crossover Mitigation: 3154+50 to 3156+50	800	Noise wall; crossover mitigation
Total with connection to MAR-1B:			6,350	Noise walls
Total with connection to MAR-2D:			7,150	Noise walls and crossover mitigation

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

6.1.1.3 Mariner Segment

A summary of the potential noise mitigation locations and types for the Build Alternatives in the Mariner Segment is presented in Table 6-9 and Table 6-10.

Table 6-9 Noise Mitigation Locations – Alternative MAR-1B

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
132nd Street to 8th Avenue	NB	5010+00 to 5015+50	550	Noise wall
8th Avenue to Gibson Road	SB	Noise Wall: 5028+00 to 5046+50 Crossover Mitigation: 5030+50 to 5041+50	1,850	Noise wall, crossover mitigation
Gibson Road to Admiralty Way	SB	1 single-family home: 5046+00 2 multi-family residences: 5051+00 to 5055+00	--	Sound insulation
Admiralty Way to 19th Place / Connection to AIR-1A	NB	5059+50 to 5066+50	700	Noise wall
Admiralty Way to 19th Place / Connection to AIR-2B	SB	5061+00 to 5068+00	700	Noise wall
Total with connection to AIR-1A:			3,100	Noise walls, crossover mitigation, and sound insulation
Total with connection to AIR-2B:			3,100	Noise walls, crossover mitigation, and sound insulation

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-10 Noise Mitigation Locations – Alternative MAR-2D

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
8th Avenue to Gibson Road	SB	5021+00 to 5028+00	700	Noise wall
8th Avenue to Gibson Road	NB	5019+50 to 5050+00	3,050	Noise wall
Admiralty Way to 19th Place / Connection to AIR-1A	NB	5052+50 to 5058+00	550	Noise wall
Admiralty Way to 19th Place / Connection to AIR-2B	SB	5056+00 to 5060+00	400	Noise wall
Total with connection to AIR-1A:			4,300	Noise walls
Total with connection to AIR-2B:			4,150	Noise walls

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

6.1.1.4 SR 99/Airport Road Segment

A summary of the potential noise mitigation locations and types for the Alternative AIR-2B is presented in Table 6-11. Alternative AIR-1A would not result in operational noise impacts, so no mitigation would be necessary.

Table 6-11 Noise Mitigation Locations – Alternative AIR-2B

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
19th Place to Evergreen Way	SB	7004+00 to 7009+00	500	Noise Wall
Evergreen Way to Holly Drive	NB	7024+00 to 7038+00	1,400	Noise wall
Evergreen Way to Holly Drive	SB	1 single-family house: 7033+00	--	Sound insulation
Total:			1,900	Noise walls and sound insulation

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

6.1.1.5 SW Everett Industrial Center Segment

There would be no noise impacts associated with the SW Everett Industrial Center Segment. No noise mitigation would be necessary in this segment.

6.1.1.6 SR 526/Evergreen Segment

A summary of the potential noise mitigation locations and types for the Build Alternatives in the SR 526/Evergreen Segment is presented in Table 6-12 through Table 6-16.

Table 6-12 Noise Mitigation Locations – Alternative EGN-1A

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Seaway Avenue to 5th Avenue	NB	11048+00 to 11054+00	600	Noise wall
7th Avenue to Interurban Trail	NB	11095+00 to 11106+50	1,150	Noise wall
7th Avenue to Interurban Trail	SB	11100+00 to 11103+50	350	Noise wall
Total:			2,100	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-13 Noise Mitigation Locations – Alternative EGN-2B

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Seaway Avenue to 5th Avenue	NB	9092+00 to 11006+50 ^c	750	Noise wall
Seaway Avenue to 5th Avenue	NB	Noise Wall: 11016+00 to 11071+00 Crossover Mitigation: 11059+00 to 11061+00	5,500	Noise wall, crossover mitigation
7th Avenue to Interurban Trail	NB	11096+00 to 11110+00	1,400	Noise wall
7th Avenue to Interurban Trail	SB	11100+00 to 11102+50	250	Noise wall
7th Avenue to Interurban Trail	SB	11105+50 to 11110+50	500	Noise wall
Total:			8,400	Noise walls and crossover mitigation

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.
- Noise wall starts in the SW Everett Industrial Center Segment.

Table 6-14 Noise Mitigation Locations – Alternative EGN-2B with North Side of SR 526 Design Option

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Seaway Avenue to 5th Avenue	NB	11048+00 to 11054+00	600	Noise wall
5th Avenue to Evergreen Way	SB	11060+50 to 11066+50	600	Noise wall
5th Avenue to Evergreen Way	NB	11067+00 to 11074+50	750	Noise wall
7th Avenue to Interurban Trail	NB	11096+00 to 11110+00	1,400	Noise wall
7th Avenue to Interurban Trail	SB	11100+00 to 11103+50	350	Noise wall
7th Avenue to Interurban Trail	SB	11107+00 to 11111+00	400	Noise wall
Total:			4,100	Noise walls

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-15 Noise Mitigation Locations – Alternative EGN-3E

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Seaway Avenue to 5th Avenue	NB	9092+00 to 11006+50 ^c	750	Noise wall
Seaway Avenue to Evergreen Way	NB	11016+00 to 11071+50	5,550	Noise wall
7th Avenue to Interurban Trail	SB	11094+00 to 11112+00	1,800	Noise wall
7th Avenue to Interurban Trail	NB	11089+00 to 11113+50	2,450	Noise wall
Total:			10,550	Noise walls

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.
- Noise wall starts in the SW Everett Industrial Center Segment.

Table 6-16 Noise Mitigation Locations – Alternative EGN-3E with North Side of SR 526 Design Option

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Seaway Avenue to 5th Avenue	NB	11048+00 to 11054+00	600	Noise wall
7th Avenue to Interurban Trail	SB	11094+00 to 11112+00	1,800	Noise wall
7th Avenue to Interurban Trail	NB	11089+00 to 11113+50	2,450	Noise wall
5th Avenue to Evergreen Way	SB	11060+50 to 11115+00	5,450	Noise wall
Total:			10,300	Noise walls

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

6.1.1.7 Broadway/I-5 Segment

A summary of the potential noise mitigation locations and types for the Build Alternatives in the Broadway/I-5 Segment is presented in Table 6-17 and Table 6-18.

Table 6-17 Noise Mitigation Locations – Alternative BI-1

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Florida Drive to 80th Street	NB	13004+50 to 13009+50	500	Noise wall
Florida Drive to 80th Street	SB	13000+00 to 13017+00	1,700	Noise wall
80th Street to 74th Street	SB	13030+00 to 13035+00	500	Noise wall
74th Street to Madison Street	SB	1 single family home: 13054+00	--	Sound insulation
Madison Street to 61st Street	SB	13069+00 to 13072+00	300	Noise wall
Madison Street to 61st Street	SB	1 multi-family residence: 13079+00	--	Sound insulation
61st Street to Eugene Street	SB	13095+00 to 13106+50	1,150	Noise wall
61st Street to Eugene Street	SB	13108+50 to 13111+50	300	Noise wall
61st Street to Eugene Street	SB	13115+50 to 13123+00	750	Noise wall
Total:			5,200	Noise walls and sound insulation

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

Table 6-18 Noise Mitigation Locations – Alternative BI-2

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
80th Street to 74th Street	SB	13043+00	--	Sound insulation
74th Street to Madison Street	NB	13047+00 to 13058+00	1,100	Noise wall
74th Street to Madison Street	SB	13049+00 to 13061+00	1,200	Noise wall
Madison Street to 61st Street	NB	13059+50 to 13066+00	650	Noise wall
Madison Street to 61st Street	SB	13064+00 to 13067+50	350	Noise wall
Madison Street to Eugene Street	NB	13070+00 to 13100+00	3,000	Noise wall
Madison Street to 61st Street	--	13077+00 to 13082+00	--	Crossover mitigation
Madison Street to 61st Street	SB	13079+00 to 13086+50	750	Noise wall
61st Street to 41st Street	SB	13092+00 to 15012+00 ^c	3,850	Noise wall
Total:			10,900	Noise walls, crossover mitigation, and sound insulation

NOTES:

- Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.
- Noise wall continues into Everett Station Segment.

6.1.1.8 Everett Station Segment

A summary of the potential noise mitigation locations and types for the Build Alternatives in the Everett Station Segment is presented in Table 6-19 through Table 6-21.

Table 6-19 Noise Mitigation Locations – Alternative EVT-1A

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
61st Street to 41st Street	SB	13092+00 to 15017+00 ^c	4,350	Noise wall
Total:			4,350	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.
- c) Noise wall continued from Broadway/I-5 Segment.

Table 6-20 Noise Mitigation Locations – Alternative EVT-2C

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
61st Street to 41st Street	SB	13092+00 to 15017+00*	4,350	Noise wall
36th Street to Hewitt Avenue	SB	Noise Wall: 15079+50 to 15086+00 Crossover Mitigation: 15080+50 to 15085+00 Sound Insulation: 15082+00	650	Noise wall; crossover mitigation; sound insulation
Total:			5,000	Noise walls, crossover mitigation, and sound insulation

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.
- c) Noise wall continued from Broadway/I-5 Segment.

Table 6-21 Noise Mitigation Locations – Alternative EVT-3D

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
61st Street to 41st Street	SB	13092+00 to 15017+00*	4,350	Noise wall
36th Street to Hewitt Avenue	SB	Noise Wall: 15080+00 to 15095+50 Crossover Mitigation: 15091+00 to 15095+00 Sound Insulation: 15082+00 15087+00 15094+00	1,550	Noise wall, crossover mitigation, sound insulation
Total:			5,900	Noise walls, crossover mitigation, and sound insulation

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.
- c) Noise wall continued from Broadway/I-5 Segment.

6.1.2 Potential Mitigation for OMF North Site Alternatives

6.1.2.1 OMF Site F (SR 99)

The noise mitigation required for OMF Site F would be the same as the mitigation needed for Alternative MAR-1B with connection to Alternative AIR-1A. No additional mitigation would be required.

6.1.2.2 OMF Site F with Lead Tracks to West Side of Airport Road Design Option

The noise mitigation required for OMF Site F with Lead Tracks to West Side of Airport Road Design Option would include the noise mitigation required for Alternative AIR-2B and the locations and types described in Table 6-22. The mitigation in the first row of Table 6-22 would replace the mitigation in the fifth row of Table 6-9 (for Admiralty Way to 19th Place with connection to AIR-2B) under Alternative MAR-1B.

Table 6-22 Noise Mitigation Locations – OMF Site F with Lead Tracks to West Side of Airport Road Design Option

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
Admiralty Way to 19th Place / MAR-1B with connection to AIR-2B	SB	5061+00 ^c to 303+00	700	Noise wall
Admiralty Way to 19th Place / MAR-1B with connection to AIR-2B	NB	5060+50* to 7003+00 ^d	1,150	Noise wall
South of OMF Site F	SB	304+50 to 309+00	450	Noise wall
North of OMF Site F	--	115+00 to 119+00	--	Crossover mitigation
Total:			2,300	Noise walls and crossover mitigation

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.
- c) Civil station reference from Alternative MAR-1B.
- d) Civil station reference from Alternative AIR-2B.

6.1.2.3 OMF Site E (Airport Road)

A summary of the noise mitigation locations and types for OMF Site E is presented in Table 6-23.

Table 6-23 Noise Mitigation Locations – OMF Site E

Location	Side of Track	Civil Station ^a	Noise Wall Length (feet)	Mitigation Type ^b
East of OMF Site E	NB	Eastern edge of OMF Site E centered on Lexe Lane	350	Noise wall
Total:			350	Noise walls

NOTES:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Barriers would either be 4-foot-high on elevated structures or retained-fill sections above the ground elevation of receivers and placed at the edge of the structure, or 8-foot-high barriers at-grade at a location as close to the tracks as possible. In a few locations, the barriers would transition in height going to or from elevated structures to at-grade.

6.1.2.4 OMF Site B (SR 526)

The noise mitigation required for OMF Site B would be the same as the mitigation required for Alternative EGN-1A. No additional mitigation would be required.

6.1.2.5 OMF Site B with Lead Tracks to South Side of SR 526 Design Option

The noise mitigation required for OMF Site B with Lead Tracks to South Side of SR 526 Design Option would be the same as the mitigation required for Alternative EGN-2B. No additional mitigation would be required.

6.2 Operational Vibration

A number of different approaches have been used by rail transit systems to reduce ground-borne vibration and ground-borne noise. The most common vibration mitigation measures used on light rail systems consist of placing a resilient layer between the track and the soil. Some standard approaches for vibration mitigation are:

- **Ballast mats:** A ballast mat is a pad made of rubber or other material placed underneath the ballast and mounted on top of an asphalt or concrete base. Ballast mats provide a modest reduction in vibration levels at frequencies above 40 Hz.
- **Tire derived aggregate:** Tire derived aggregate, or shredded tires, consists of a layer of tire shreds wrapped in geotechnical fabric placed underneath the ballast and placed on hard packed ground. This is a low-cost mitigation option that provides a reduction in vibration levels at frequencies above 25 Hz.
- **Resilient fasteners:** Direct-fixation track fasteners are used to attach the rail to the concrete track slab in a tunnel or on an elevated structure. Resilient fasteners include a soft, resilient element to provide greater vibration isolation than standard rail fasteners in the vertical direction.
- **Floating slabs:** Floating slab consists of a concrete slab supported by elastomer springs on a concrete foundation. The frequency range at which a floating slab is effective depends on the thickness of the slab and the stiffness of the springs. Floating slabs are very effective at reducing vibration levels, particularly at low frequencies. However, they are also very expensive.
- **Low-impact special trackwork:** The impacts of vehicle wheels over rail gaps at special trackwork locations such as turnouts and switches can increase vibration levels by up to 10 decibels. If special trackwork cannot be located away from vibration-sensitive receivers, another approach is to use low-impact frogs. Spring-rail and moveable point frogs allow the flangeway gap to remain closed in the main traffic direction for revenue service trains and can almost completely reduce the vibration increase caused by special trackwork. Monoblock frogs are milled out of a single block of steel and their tolerances can be tighter than a traditional frog, which reduces the vibration increase. Flange-bearing frogs include a ramp to support the flange of the wheel to minimize banging. Well-designed monoblock and flange-bearing frogs can reduce the vibration level increase by about half compared to a standard frog.
- **Alternative approaches:** There are alternative vibration mitigation approaches that may be applied under specific circumstances. Examples include increasing the thickness of the concrete under the track, specifying straighter rails, and building the track on top of pile foundation systems when the track would traverse very soft sections of soil.

Vibration predictions will be refined during final design before mitigation measures are finalized. Because detailed engineering information is not available at this time, specific vibration mitigation measures cannot be determined. However, due to the frequency and magnitude of

vibration impacts, in most locations, resilient fasteners (on elevated structures) or ballast mats (on at-grade sections) would be effective types of mitigation. At a few locations, more extensive vibration mitigation might be required. Mitigation is recommended at each location where a vibration impact has been predicted. Details regarding specific locations of mitigation are provided below.

6.2.1 Potential Mitigation for Alignment and Station Alternatives

6.2.1.1 West Alderwood Segment

Error! Reference source not found.There would be no vibration impacts associated with the Build Alternatives in the West Alderwood Segment. No mitigation would be necessary.

6.2.1.2 Ash Way Segment

A summary of the vibration mitigation locations for the Build Alternatives in the Ash Way Segment is presented in Table 6-24 and Table 6-25. More specific details regarding mitigation types will be determined as project design advances.

Table 6-24 Vibration Mitigation Locations – Alternative ASH-1A

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Maple Road to 172nd Street	3005+00 to 3011+50	650	No
Maple Road to 172nd Street	3015+50 to 3020+50	500	No
172nd Street to 164th Street	3050+00 to 3054+00	500	No
164th Street to 18th Avenue	3091+50 to 3096+50	500	No
153rd Place to 140th Street	3119+00 to 3143+00	2,400	No
Total with connection to MAR-1B:		4,550	No
Total with connection to MAR-2D:		4,550	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

Table 6-25 Vibration Mitigation Locations – Alternative ASH-2D

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Maple Road to 172nd Street	3005+50 to 3010+50	500	No
Maple Road to 172nd Street	3015+50 to 3020+50	500	No
Maple Road to 172nd Street	3028+00 to 3033+00	500	No
Total with connection to MAR-1B:		1,500	No
Total with connection to MAR-2D:		1,500	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

6.2.1.3 Mariner Segment

There would be no vibration impacts associated with the Build Alternatives in the Mariner Segment. No mitigation would be necessary.

6.2.1.4 SR 99/Airport Road Segment

There would be no vibration impacts associated with the Build Alternatives in the SR 99/Airport Segment. No mitigation would be necessary.

6.2.1.5 SW Everett Industrial Center Segment

There would be no vibration impacts associated with the Build Alternatives in the SW Everett Industrial Center Segment. No mitigation would be necessary.

6.2.1.6 SR 526/Evergreen Segment

A summary of the vibration mitigation locations for the Build Alternatives in the SR 526/Evergreen Segment is presented in Table 6-26 and Table 6-27. More specific details regarding mitigation types will be determined as project design advances. No vibration impacts were identified for Alternatives EGN-1A, EGN-2B with North Side of SR 526 Design Option, or EGN-3E with North Side of SR 526 Design Option; therefore, no mitigation would be necessary for those alternatives.

Table 6-26 Vibration Mitigation Locations – Alternative EGN-2B

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Seaway Avenue to 5th Avenue	11014+00 to 11020+00	600	No
Seaway Avenue to 5th Avenue	11041+00 to 11046+00	500	No
Total:		1,100	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

Table 6-27 Vibration Mitigation Locations – Alternative EGN-3E

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Seaway Avenue to 5th Avenue	11014+00 to 11020+00	600	No
Seaway Avenue to 5th Avenue	11041+00 to 11046+00	500	No
Total:		1,100	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

6.2.1.7 Broadway/I-5 Segment

A summary of the vibration mitigation locations for the Build Alternatives in the Broadway/I-5 Segment is presented in Table 6-28 and Table 6-29. More specific details regarding mitigation types will be determined as project design advances.

Table 6-28 Vibration Mitigation Locations – Alternative BI-1

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Florida Drive to 80th Street	11122+50 to 13003+50 ^b	500	No
Florida Drive to 80th Street	13005+50 to 13010+50	500	No
80th Street to 74th Street	13029+50 to 13035+00	550	No
74th Street to Madison Street	13052+00 to 13057+00	500	No
Madison Street to 61st Street	13070+00 to 13074+00	--	Yes
Total:		2,050	Yes

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
- b) Civil station reference from SR 526/Evergreen Segment.

Table 6-29 Vibration Mitigation Locations – Alternative BI-2

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
74th Street to Madison Street	13053+50 to 13058+50	500	No
61st Street to Eugene Street	13097+50 to 13102+50	500	No
61st Street to Eugene Street	13105+50 to 13114+00	850	No
Total:		1,850	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

6.2.1.8 Everett Station Segment

A summary of the vibration mitigation locations for the Build Alternatives in the Everett Station Segment is presented in Table 6-30 through Table 6-32. More specific details regarding mitigation types will be determined as project design advances.

Table 6-30 Vibration Mitigation Locations – Alternative EVT-1A

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Eugene Street to 41st Street	15012+50 to 15017+50	500	No
Total:		500	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

Table 6-31 Vibration Mitigation Locations – Alternative EVT-2C

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Eugene Street to 41st Street	15012+50 to 15017+50	500	No
Total:		500	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

Table 6-32 Vibration Mitigation Locations – Alternative EVT-3D

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Eugene Street to 41st Street	15012+50 to 15017+50	500	No
36th Street to Hewitt Avenue	15078+00 to 15084+00	600	No
Total:		1,100	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.

6.2.2 Potential Mitigation for OMF North Site Alternatives

6.2.2.1 OMF Site F (SR 99)

There would be no vibration impacts associated with OMF Site F. No mitigation would be required.

6.2.2.2 OMF Site F with Lead Tracks to West Side of Airport Road Design Option

A summary of the vibration mitigation locations for OMF Site F with Lead Tracks to West Side of Airport Road Design Option is presented in Table 6-33. More specific details regarding mitigation types will be determined as project design advances.

Table 6-33 Vibration Mitigation Locations – OMF Site F with Lead Tracks to West Side of Airport Road Design Option

Location	Civil Station ^a	Mitigation Length (feet)	Crossover?
Admiralty Way to 19th Place / MAR-1B with connection to AIR-2B	5064+50 ^b to 302+50	500	No
Total:		500	No

NOTE:

- a) Civil stations are shown on the conceptual design drawings in Draft EIS Appendix F.
b) Civil station reference from Alternative MAR-1B.

6.2.2.3 OMF Site E (Airport Road)

There would be no vibration impacts associated with OMF Site E. No mitigation would be required.

6.2.2.4 OMF Site B (SR 526)

There would be no vibration impacts associated with OMF Site B. No mitigation would be required.

6.2.2.5 OMF Site B with Lead Tracks to South Side of SR 526 Design Option

There would be no vibration impacts associated with OMF Site B with Lead Tracks to South Side of SR 526 Design Option. No mitigation would be required.

6.3 Construction Noise and Vibration

Construction activities would be carried out in compliance with Sound Transit specifications and all applicable local noise regulations. Construction noise is exempt from the WAC noise limits, except at residential land uses during nighttime hours (10 p.m. to 7 a.m.). If construction is performed during nighttime hours, the contractor must meet the WAC noise level requirements or obtain a noise variance from the governing jurisdiction. Specific construction noise and vibration mitigation measures will be developed during the design phase of the project when more detailed construction information is available. The following mitigation measures would be applied as needed to minimize temporary construction noise and vibration impacts:

- Avoiding nighttime construction in residential neighborhoods.
- Locating stationary construction equipment as far as possible from noise-sensitive sites.
- Constructing noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise-sensitive receivers.
- Routing construction-related truck traffic to roadways that would cause the least disturbance to residents.
- Using alternative construction methods to minimize the use of impact and vibratory equipment (e.g., pile-drivers and compactors).

The primary means of mitigating noise from construction activities begins with a requirement for the contractors to prepare a detailed Noise Control Plan. A noise control engineer or acoustician would work with the contractor to prepare a Noise Control Plan in conjunction with the contractor's specific equipment and methods of construction. Key elements of a Noise Control Plan include:

- Contractor's specific equipment types.
- Schedule and methods of construction.
- Maximum noise limits for each piece of equipment with certification testing.
- Prohibitions on certain types of equipment and processes during the nighttime hours without local agency coordination and approved variances.
- Identification of specific sensitive sites where near construction sites.
- Methods for projecting construction noise levels.
- Implementation of noise control measures where appropriate.
- Methods for responding to community complaints.

7 REFERENCES

Federal Highway Administration (FHWA). 2006. FHWA Construction Noise Handbook. Final Report FHWA-HEP-06-015.

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