SECTION 3 STUDY APPROACH

This section defines sound and noise, and discusses sound level descriptors and what affects sound levels. It also describes project coordination and how the traffic noise study was performed.

What is the study area for this noise analysis and how was it determined?

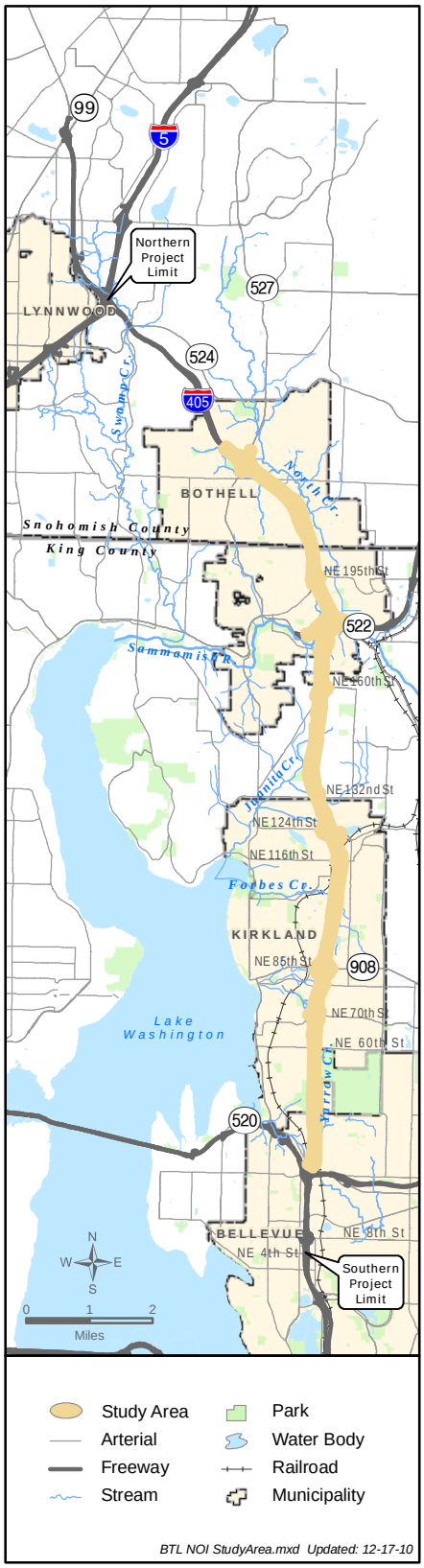
The Bellevue to Lynnwood Improvement Project extends north from the vicinity of the NE 6th Street direct access ramp in Bellevue to the south side of the I-405/I-5 interchange in Lynnwood. The study area for the noise analysis extends approximately 500 feet away from the project between the SR 520 interchange in the south and the SR 527 interchange in the north (see Exhibit 3-1). The project areas south of the SR 520 interchange and north of the SR 527 interchange were not included in the noise study because the project does not involve any changes to the roadway (such as widening or realignment) that would affect noise levels in this area.

A variety of land uses exist in the study area. The area is primarily a mix between commercial/industrial and residential development, interspersed with pockets of multifamily use and park land. Terrain varies throughout the study area.

What are sound and noise?

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure called *sound pressure*. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern.[2] *Magnitude* is a measure of sound energy in the air. Noise is defined as unwanted sound.

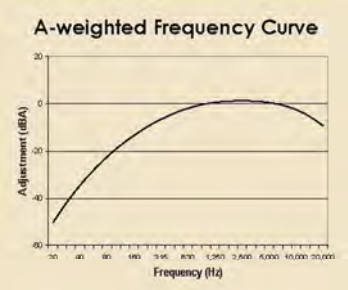
Exhibit 3-1: Noise study area

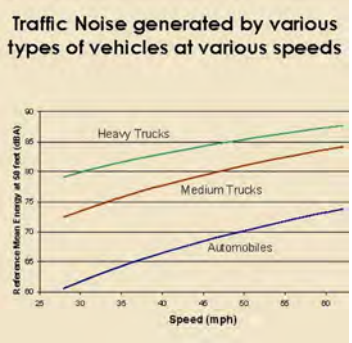


[2] *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Report Number 550/9-74-004. EPA 1974.

What is the Logarithm Scale?

Logarithm is the exponent that indicates the power to which a number must be raised to produce a given number. For example: if $B^2 = N$, the 2 is the logarithm of N (to the base B), or $10^2 = 100$ and the logarithm of 100 (to the base 10) = 2.





The range of magnitude, from the faintest to the loudest sound that the ear can hear, is very large. The sound pressure near an airport runway is approximately one-million times greater than a soft whisper. To accommodate this range, sound levels are expressed on a logarithmic scale in units called *decibels* (dB).

Humans respond to a sound's frequency or pitch. The human ear can very effectively perceive sounds with a frequency between approximately 500 and 5,000 Hertz (Hz). Humans' ability to perceive sounds decreases outside this range. Environmental sounds are composed of many frequencies, each occurring simultaneously at its own sound pressure level. Frequency weighting, which is applied electronically by a sound level meter, combines the overall sound frequency into one sound level that simulates how a typical person hears sounds. The commonly used frequency weighting for environmental sounds is A-weighting (dBA), which is most similar to how humans perceive sounds of low to moderate magnitude.

Loudness, in contrast to sound level, refers to how people subjectively perceive a sound. This varies from person to person, but most people judge relative loudness between sound levels similarly. The human ear can barely perceive a 3-dBA increase, but a 5- or 6-dBA increase is readily noticeable and appears as if the sound is about one-and-a-half times as loud. For most listeners, a 10-dBA increase appears to be a doubling in sound level.

What are typical sound levels and what affects them?

Exhibit 3-2 presents typical A-weighted sound levels from various sources. The sound environments described, from a quiet whisper or light wind at 30 dBA to a jet takeoff at 120 dBA, demonstrate the human ear's large range. A typical conversation is in the range of 60 to 70 dBA.

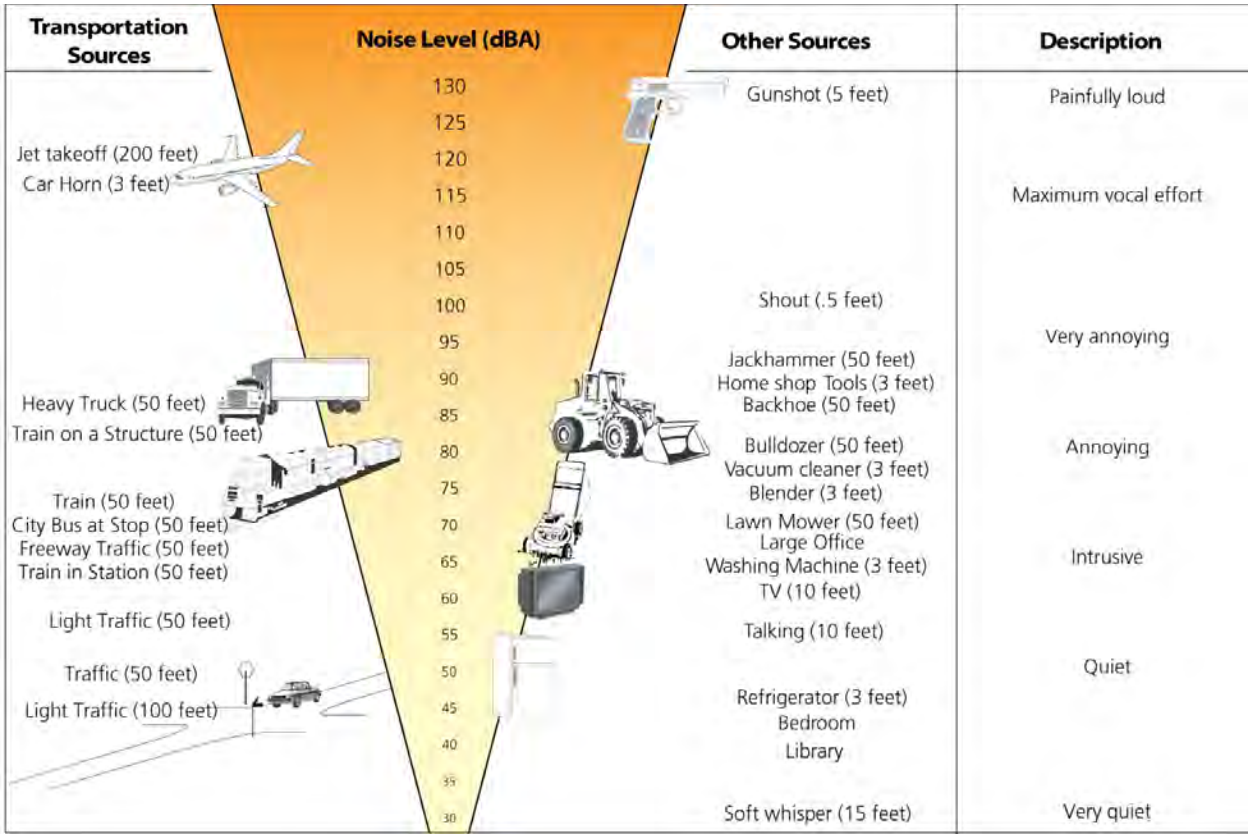
Sources of sound

Because of the logarithmic decibel scale, a doubling of the number of sound sources (e.g., the number of cars operating on a roadway) increases sound levels by 3 dBA. A ten-fold increase in the number of sound sources adds 10 dBA. As a

result, a sound source emitting a sound level of 60 dBA combined with another sound source of 60 dBA yields a combined sound level of 63 dBA (not 120 dBA).

Noise levels from traffic sources depend on volume, speed, and the type of vehicle. An increase in volume, speed, or vehicle size increases traffic noise levels. Vehicular noise is a combination of noises from the engine, exhaust, and tires. Defective mufflers, steep grades, and roadway surface materials and conditions also affect the generation of traffic noise.

Exhibit 3-2: Typical noise levels



The effect of distance

Sound levels decrease with distance from the source. For a line source such as a roadway, sound levels decrease by 3 dBA over hard ground (e.g., concrete, asphalt, pavement) or by 4.5 dBA over soft ground (e.g., grass) for every doubling of distance between the source and the receptor. For point sources such as construction sources, sound levels will

What is a receiver?

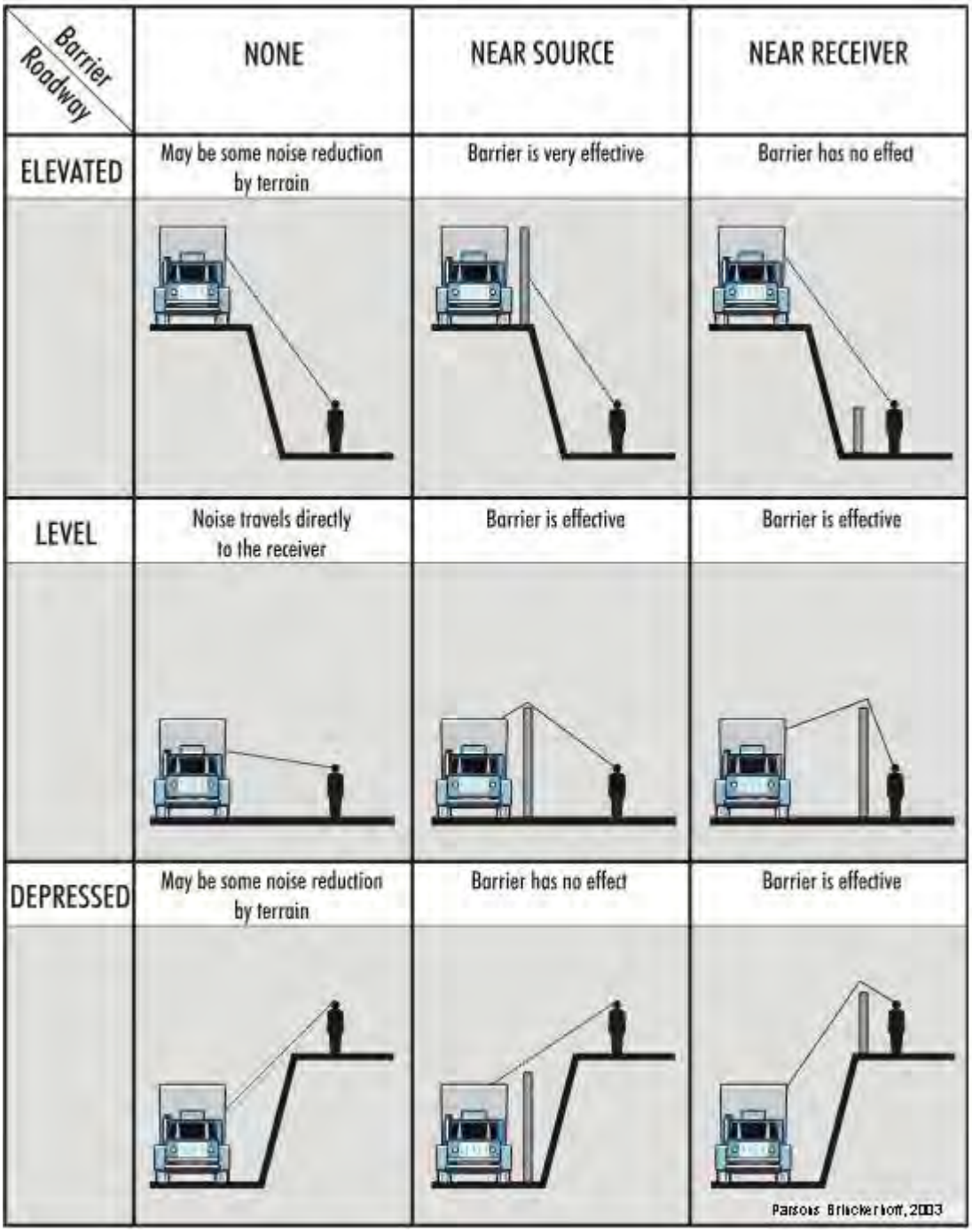
A receiver is the location at which noise is measured (e.g., a residence, school, park, or church).

decrease between 6 and 7.5 dBA for every doubling of distance from the source.

The effect of terrain and shielding

Sound can be greatly affected by terrain and the elevation of the receiver relative to the sound source, as shown in Exhibit 3-3.

Exhibit 3-3: Noise barrier effectiveness



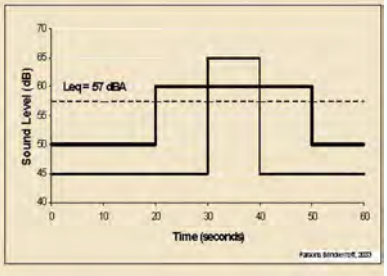
Level ground is the simplest scenario: sound travels in a straight line-of-sight path between the source and receiver. As shown in the bottom row of Exhibit 3-3, if the sound source is depressed or the receiver is elevated, sound will generally travel directly to the receiver. However, sound levels may be reduced if the terrain crests between the source and receiver, resulting in a partial sound barrier near the receiver.

What is terrain?

Terrain is a term used to describe the features of the land.

If the sound source is elevated or the receiver is depressed, sound may be reduced at the receiver by the edge of the roadway. Even a short wall (e.g., a solid concrete Jersey-type safety barrier) can effectively block sound transmission between the source and receiver (see the top row of Exhibit 3-3). If the line of sight between the receiver and the highest elevation of sound source is broken, a noise reduction of approximately 5 dBA will result.

Example of two sound patterns with the same L_{eq} (1 minute interval)



How do we describe sound levels?

The equivalent sound level (Leq) is widely used to describe noise in human environments. Leq is a measure of the average sound energy during a specified period of time. It is defined as the constant level that, over a given period of time, transmits to the receiver the same amount of acoustical energy as the actual time-varying sound. For example, two sounds, one containing twice as much energy but lasting only half as long as the other, can have the same Leq sound levels. Leq measured over a one-hour period is the hourly Leq [Leq(h)], which is used for highway noise effect and mitigation analyses.

What does Leq(24) refer to?

Leq(24) is a measure of the average sound energy over a period of 24 hours.

What are the effects of loud noises?

Prolonged exposure to high-intensity environmental noise directly affects human health by causing hearing loss. The U.S. Environmental Protection Agency (EPA) has established a protective level of 70 dBA Leq(24), below which hearing is conserved for exposure over a 40-year period.[3] Although scientific evidence is not currently conclusive, noise is suspected of causing or aggravating other diseases.

[3] *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Report Number 550/9-74-004. EPA 1974.

Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. The FHWA NAC are based on speech interference, which is a well-documented effect that is relatively reproducible in human response studies. Noise can also disturb wildlife by disrupting communication, interfering with mating, and reducing the ability to obtain sufficient food, water, and cover.

What project coordination did we perform?

The I-405 Team coordinated with federal, state, and local agencies and community members. This included consulting with FHWA, the City of Bellevue, the City of Kirkland, the City of Bothell, King County and Snohomish County, and participating in several community meetings with local residents. Residents received project information and provided input on the project and potential noise monitoring locations.

What criteria did we use to evaluate effects?

Noise analysts used operational noise standards and construction noise standards, as described in the following paragraphs, to evaluate effects on the project.

Operational noise standards

Noise regulations and guidelines are the basis for evaluating potential noise effects. For state and federally funded highway projects, traffic noise effects occur when predicted Leq(h) noise levels approach or exceed the FHWA NAC, or substantially exceed existing noise levels.[4] Although the FHWA does not define "substantially exceed," WSDOT considers an increase of 10 dBA or more to be a substantial increase.[5]

The FHWA NAC specify exterior and interior Leq(h) noise levels for various land activity categories, as shown in Exhibit 3-4. All exterior noise-sensitive uses within the study area are Activity Category B uses. WSDOT considers a noise effect to occur if predicted Leq(h) noise levels approach within

[4] *Procedures for Abatement of Highway Traffic Noise and Construction Noise. Federal-Aid Highway Program Manual.* Volume 7, Chapter 7, Section 3. Washington, D.C. U.S. Department of Transportation, 1982, Noise Abatement Council.
[5] *Traffic Noise Analysis and Abatement Policy and Procedures.* Olympia, Washington. WSDOT, 2006.

1 dBA of the NAC in Exhibit 3-4. Therefore, a noise level of 66 dBA or higher approaches or exceeds the FHWA NAC of 67 dBA for residences.

WSDOT defines severe traffic noise effects as 80 dBA or more for Activity Category B areas, or 30 dBA or more above existing traffic noise levels for Activity Category B areas.

Exhibit 3-4: FHWA Noise Abatement Criteria

Activity Category	Leq(h) (dBA)	Description of Activity Category
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (exterior)	Developed lands, properties, or activities not included in Categories A or B.
D	--	Undeveloped lands.

Source: USDOT, 1982

The Washington State Department of Ecology (Ecology) regulates noise levels at property lines of neighboring properties (WAC Chapter 173-60-040). Traffic noise is exempt from property line noise limits, but these limits apply to construction noise during certain hours. The maximum permissible noise levels depend on the land uses of the noise source and the receiving property, as shown in Exhibit 3-5.

King County and the City of Bothell have adopted the State of Washington's property line standards, with King County Code Chapter 12.88.020 and Bothell Municipal Code Chapter 8.26.040. Snohomish County regulates noise using standards that correspond with WAC Chapter 173-60-040, set forth in Snohomish County Code Chapter 10.01.030. The City of Kirkland and the City of Bellevue regulate noise as a nuisance with Kirkland Municipal Code Chapter 11.84A.070 and City of Bellevue Municipal Code Chapter 9.18.

Exhibit 3-5: Maximum permissible environmental noise levels

EDNA[1] of Noise Source	EDNA of Receiving Property		
	Residential	Commercial	Industrial
Residential	55	57	60
Commercial	57	60	65
Industrial	60	65	70

[1] Environmental Designation for Noise Abatement
Source: WAC 173-60-040.

The maximum permissible environmental noise level at residential receiving properties is reduced by 10 dBA between 10:00 p.m. and 7:00 a.m. Short-term exceedences above the permissible sound level are allowed. The maximum level may be exceeded by 5 dBA for a total of 15 minutes, by 10 dBA for a total of 5 minutes, or by 15 dBA for a total of 1.5 minutes during any one-hour period, as shown in Exhibit 3-6.

Exhibit 3-6: Allowed exceedences of the maximum permissible noise

Duration of Exceedance	Allowed Exceedance	Equivalent Leq(h) Increase
15 minutes	5 dBA	2 dBA
5 minutes	10 dBA	2 dBA
1.5 minutes	15 dBA	2 dBA

Source: WAC 173-60-040

Considering the allowed short-term exceedences in Exhibit 3-6, the permissible hourly Leq is approximately 2 dBA higher than the values in Exhibit 3-4. For example, a noise level of 57 dBA for 45 minutes and 62 dBA for 15 minutes (57 dBA + a 5-dBA exceedance) is permissible for noise from a commercial activity received by a residential property. This sound pattern has a Leq(h) of 59 dBA.

Construction noise standards

Construction noise from projects within the State of Washington is exempt from Ecology property line regulations during daytime hours, but regulations apply to construction noise during nighttime hours (10:00 p.m. to 7:00 a.m. on weekdays and 10:00 p.m. to 8:00 a.m. on weekends). For construction activities during nighttime hours, noise variances from the City of Bothell, City of Kirkland, and City of Bellevue will be required.

How did we perform the noise study on project operations?

Ambient noise levels were measured for 15-minute periods at 105 locations near the study area. These measurements help identify major noise sources in the study area, validate the noise model, and characterize the weekday background environmental noise levels. Appendix A describes the results of these measurements.

Measurement locations characterize a variety of noise conditions and represent other sensitive receptors near the proposed project. Existing (year 2005), Baseline (year 2014) and future noise levels for the No Build (year 2030) and Build (design year 2030) Alternatives are modeled at all 105 of the 15-minute noise measurement locations. These noise levels are also modeled at 141 additional locations that may potentially be affected by the project. In total, noise levels at 246 sites were evaluated for each scenario.

Measured sites are locations where a physical noise measurement has been recorded. Modeled sites refer to those locations where an additional noise receptor is added to the TNM model. Modeled sites are included in the TNM model in areas where collecting noise measurements at each noise sensitive location is not reasonable and does not add value to the analysis. In most cases, measured and modeled sites represent more than one sensitive noise receptor as adjacent homes for example often share similar distances from a nearby roadway and have similar elevation in relation to a nearby roadway, which in turn experience similar noise levels.

The year 2005 was evaluated as the existing year, to be consistent with the available transportation analysis. The year 2014 was evaluated as the baseline year, to correspond with anticipated completion of the Kirkland Nickel Project.

Traffic noise prediction

The FHWA Traffic Noise Model (TNM) Version 2.5 computer model[6] was used to predict $L_{eq}(h)$ traffic noise levels. TNM provides precise estimates of noise levels at discrete points, by considering interactions between different noise sources and topographical features. This model estimates the noise level at

6 FHWA, 2005.

Why don't the highest noise levels occur during rush hour?

Small changes in vehicle speed have a greater effect on noise than small changes in traffic volume. Therefore, the loudest traffic noise levels are often not experienced during rush hour. During rush hour traffic, traffic volumes increase and vehicle speeds decrease, resulting in lower traffic noise levels.

receiver locations, which is calculated from a series of straight-line roadway sections. Noise emissions from the roadway are calculated based on the number of automobiles, medium trucks, and heavy trucks per hour; vehicular speed; and the reference noise emission levels of a typical vehicle. TNM also considers the effects of intervening walls, topography, trees, and atmospheric absorption.

Noise from sources other than traffic is not included. When non-traffic noise such as aircraft noise is considerable in an area, TNM under-predicts the actual noise level. Because the project effects only depend on traffic noise levels, under-predicting the total environmental noise level does not affect the study's findings. Noise monitoring results were used to validate the Existing Conditions TNM model.

I-405 Team noise specialists imported base maps and design files into the TNM package. Major roadways, topographical features, building rows, and sensitive receptors were digitized into the model. Elevations were added from the 2-foot contour data. Elevations for planned improvements were taken from design profiles, proposed cross-sections, and proposed cut-and-fill limits.

Analysis of operational effects

Predicted noise levels are based on the loudest traffic hour of the day (when volumes are high but not congested) to estimate worst-case noise levels.

Existing peak-hour traffic analysis for the year 2005 shows that the traffic volumes on this portion of I-405 are at capacity for part of the day. Congestion on I-405 in 2014 and 2030 is expected to increase substantially and to exceed the roadway's capacity for baseline conditions and the No Build and Build alternatives.

For use in TNM 2.5, the No Build Alternative assumed the same traffic volume on I-405 as the Baseline Conditions model during the loudest hour. The two Build Alternatives each added 1,750 vehicles per new lane to the baseline conditions' loudest-hour traffic volumes on I-405, in areas where extra lanes will be built. For other roadways in the study area, predicted future traffic volumes were used. This approach ensures that the loudest traffic hour is represented in the

model, because small changes in vehicle speed have a greater effect on noise than small changes in traffic volume.

The traffic volumes and vehicle mix that the I-405 Team noise specialists used to create the TNM models were based on the *Bellevue to Lynnwood Improvement Project Transportation Discipline Report*.[7]

Noise mitigation analysis

What is WSDOT's Noise Abatement Criteria level?

Noise levels are considered to approach or exceed the noise abatement criteria (NAC) at 66 dBA.

I-405 Team noise specialists compared predicted noise levels to the FHWA NAC and counted the receptors affected by the two Build Alternatives. At receptors where noise levels are modeled to approach or exceed the NAC, I-405 Team noise specialists evaluated whether mitigation measures could reduce traffic noise substantially enough to warrant the cost of constructing, replacing, upgrading noise barriers. This evaluation was based on WSDOT feasibility and reasonableness criteria. (A detailed discussion of WSDOT feasibility and reasonableness criteria is provided in the *Measures to Avoid or Minimize Project Effects* section of this report.) Noise barriers were evaluated using TNM in areas where noise effects are predicted to result from this project.

I-405 Team noise specialists evaluated the effectiveness of noise barriers at the outermost right-of-way boundary. They considered the importance of minimizing the potential for future corridor roadway projects to require removing or relocating noise barriers.

How did we analyze construction noise?

Construction noise was assessed using EPA reference levels. The analysis was based on noise levels from construction equipment typically used on this type of project. Noise levels were assessed at various distances from the construction site.

[7] *I-405, SR 520 to I-5 Project Transportation Discipline Report,* I-405 Corridor Program, 2007.

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SECTION 4 BASELINE CONDITIONS

Baseline conditions (year 2014) for the Bellevue to Lynnwood Project include Stages 1 and 2 of the Kirkland Nickel Project.

Where are the modeled noise receptor locations?

Baseline noise levels are modeled at 246 locations that represent noise exposure at 1,770 residences, one hotel, two schools, one church and one park. Traffic noise from I-405 and local arterials is the dominant noise source in the study area.

The locations of the 246 modeled sensitive receptors are shown on even-numbered Exhibits 4-2 through 4-12, and in Appendix C for locations that were reevaluated in 2011. Appendix A describes noise measurements taken at 105 locations in the study area.

What are the modeled noise levels?

Existing noise levels in the study area were modeled using TNM, and levels ranged from 49 to 76 dBA. These levels range from typical suburban outdoor sound levels (between 50 to 60 dBA[8]) and lower to very noisy levels (above 70 dBA). This is typical of locations within 100 feet of a busy freeway. Noise levels at 93 sites, representing an equivalent of 446 residences, are modeled to approach or exceed the FHWA criteria of 67 dBA for existing conditions.

These modeling results represent the loudest traffic hour of the day, when volumes are high but not congested, so traffic speeds remain high.

[8] *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Report Number 550/9-74-004. EPA 1974.

Exhibit 4-1: Modeled noise levels at receptors – 1

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
1	School	62	62	62	63
2	6	66	66	66	67
3	5	64	64	64	65
4	10	65	66	66	66
5	4	70	71	71	71
6	4	67	67	67	70
7	8	63	63	63	64
8	30	64	64	64	65
9	7	61	61	61	61
10	12	62	62	62	63
11	9	60	61	61	61
12	5	62	63	63	63
13	24	64	65	65	65
14	3	64	65	65	65
15	5	59	59	59	59
16	8	63	64	64	64
17	12	62	63	63	64
18	8	68	69	69	70
19	6	64	65	65	65
20	6 & church	66	67	67	68
21	20	63	64	64	65
22	16	62	63	63	63
23	114	60	62	62	62
24	16	67	67	67	68
25	10	63	64	64	64
26	6	59	60	60	60

*Values in BOLD approach or exceed the NAC

Exhibit 4-2: Modeled noise receptor locations – 1

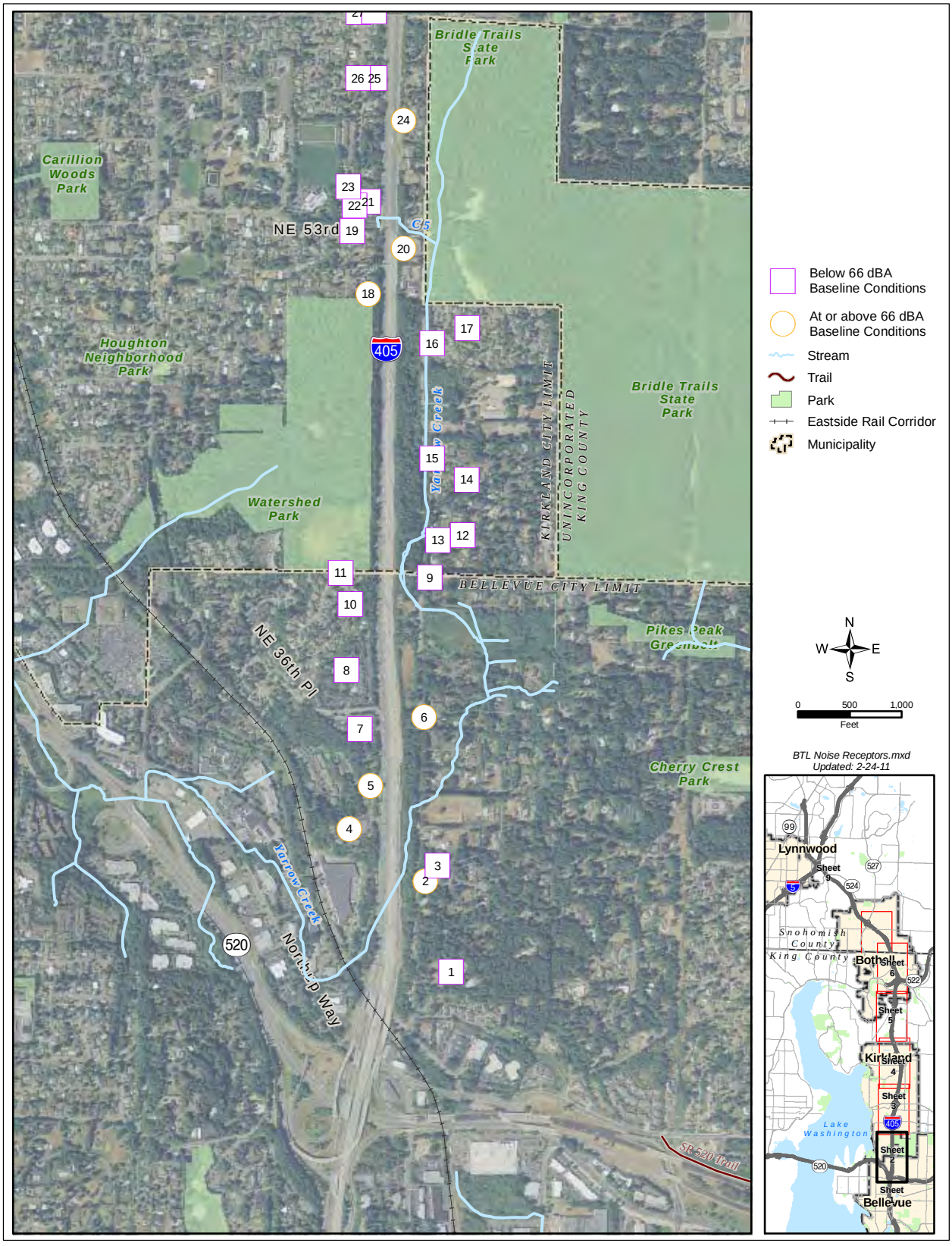


Exhibit 4-3: Modeled noise levels at receptors – 2

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
27	8	59	60	60	60
28	7	64	65	65	65
29	15	73	65	65	65
30	6	65	65	65	65
31	8	59	60	60	60
32	8	68	69	69	69
33	14	58	58	58	58
34	10	61	62	62	62
35	15	64	65	65	65
36	8	63	64	64	64
37	5	64	65	65	65
38	33	61	62	62	62
39	24	63	64	64	64
40	22	62	63	63	63
41	12	64	65	65	65
42	10	61	63	63	63
43	24	64	65	65	65
44	6	68	69	69	69
45	8	67	69	69	69
46	14	59	61	61	61
47	8	68	69	69	69
48	5	68	65	65	65
49	4	62	64	64	64
50	9	74	64	64	64
51	5	68	63	63	63
52	4	62	63	63	63
53	9	74	63	63	63
54	6	60	61	61	61
55	18	68	70	70	70
56	6	63	64	64	64
57	4	65	66	66	66

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
58	4	67	69	69	69
59	3	66	69	69	69
60	6	64	66	66	66
61	4	61	63	63	63
62	15	65	65	65	65
63	4	61	62	62	62
64	9	62	63	63	63
65	9	65	66	66	66
66	11	58	59	59	59
67	11	62	63	63	63
68	8	58	60	60	60
69	12	62	63	63	63
70	18	61	63	63	63
71	3	63	65	65	65
72	4	62	64	64	64
73	Park	63	65	65	65
74	8	60	62	62	62

Values in **BOLD approach or exceed the NAC*

Exhibit 4-4: Modeled noise receptor locations – 2

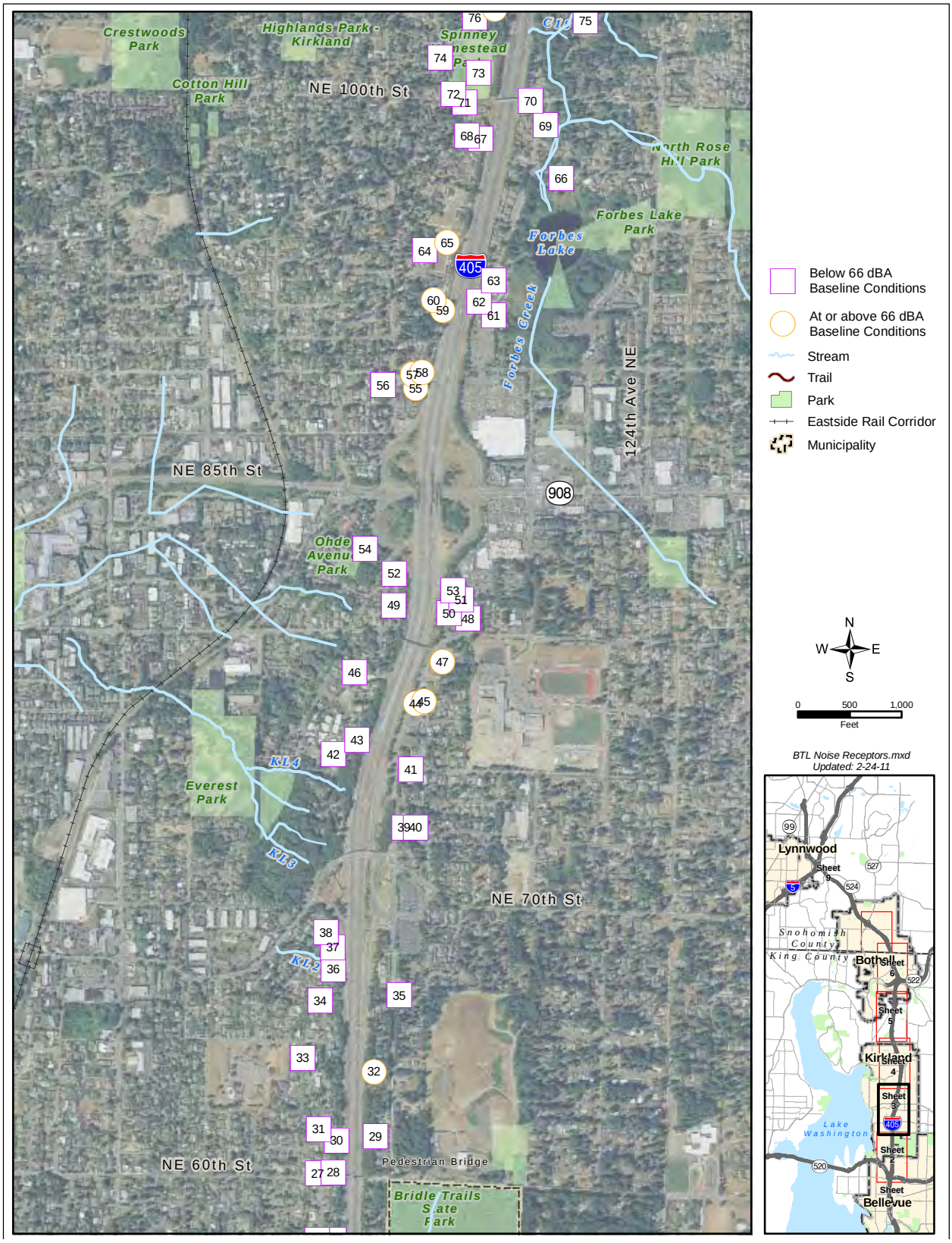


Exhibit 4-5: Modeled noise levels at receptors – 3

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
75	12	63	64	64	64
76	11	63	65	65	65
77	6	66	67	67	67
78	5	63	65	65	65
79	10	61	64	64	64
80	10	64	65	65	65
81		70			
84		71			
NK1-R1	1	68		72	73
NK1-R2	1	71		75	75
NK1-R3	1	75		78	78
NK1-R4	1	74		77	78
NK1-R5	2	74		77	78
NK1-R6	2	66		71	72
NK1-R7	2	64		67	68
NK1-R8		61		64	64
NK1-R9	1	65		70	71
NK1-R10	2	68		73	77
NK1-R11	2	67		72	74
NK1-R12	1	65		69	70
NK1-R13	2	62		67	66
NK1-R14	2	62		66	66
NK1-R15		59		63	62
NK1-R16		60		62	62
NK1-R17	1	76		80	80
NK1-R18	1	67		72	77
NK1-R19	1	69		69	71
NK1-R20		62		65	63
NK1-R21		59		63	61
NK1-R22		58		60	59
NK1-R23		58		60	59

NK1-R24		59		60	60
NK1-R25		61		64	63
NK1-R26		62		66	65
NK1-R27	1	64		67	66
NK1-R28	1	67		67	71
NK1-R29	1	70		70	74
NK1-R30	1	74		74	78
NK1-R31		63		63	67
NK1-R32		62		62	66
NK1-R33	1	66		66	70
NK1-R34	1	70		70	73
NK1-R35		69		69	71
86	20	63	65	65	65
87	12	61	61	61	62
88	16	63	64	64	64
89	16	59	61	61	61
90	10	63	63	63	64
91	6	64	65	65	66

Values in **BOLD approach or exceed the NAC*
Receptors NK1-R1 through NK1-R35 were reevaluated for modeled existing and 2030 No Build and Build noise levels. Receptors 81and 84 are in the area reevaluated with additional receptors, but are included for their existing conditions noise level measurements (see Appendix A for a list of noise measurement sites).

Exhibit 4-6: Modeled noise receptor locations – 3

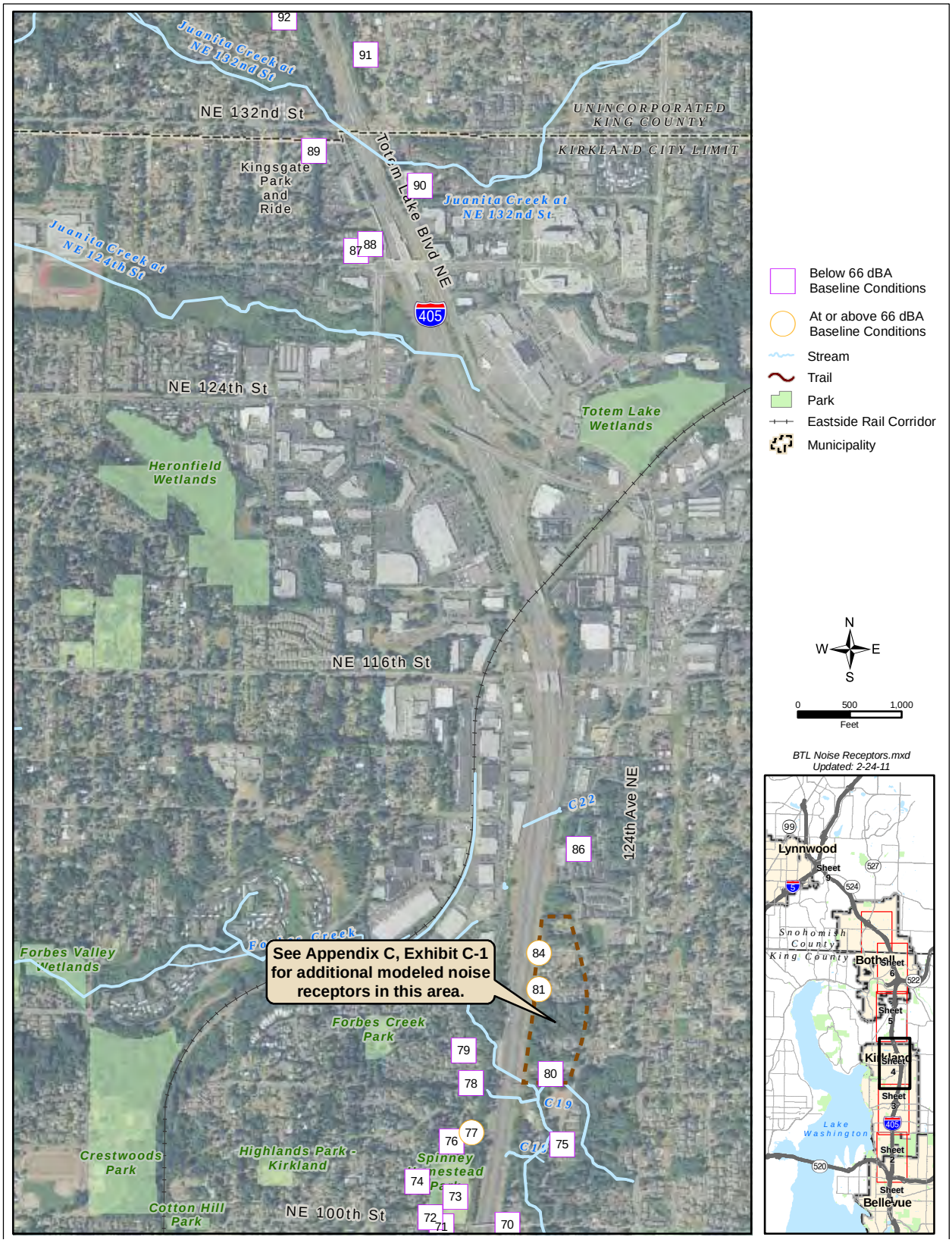


Exhibit 4-7: Modeled noise levels at receptors – 4

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
92	32	67	63	63	64
93	28	60	61	61	62
94	18	59	60	60	61
95	16	64	65	65	66
96	6	69	62	62	62
97	16	60	61	61	62
98	6	66	66	66	67
99	11	58	59	59	60
100	8	66	67	67	68
101	20	62	64	64	64
102	27	57	58	58	59
103	21	62	63	63	64
104	13	63	64	64	65
105	28	62	63	63	64
106	13	62	63	63	64
107	8	64	60	60	60
108	12	63	61	61	62
109	14	63	65	65	65
110	6	62	64	64	63
111	10	63	63	63	65
112	17	64	65	65	66
113	10	61	63	63	63
UK10-R1	2	64		65	65
UK10-R2	2	63		64	65
UK10-R3	2	62		63	63
UK10-R4	2	61		62	63
UK10-R5	4	63		64	65
UK10-R6	4	60		61	62
UK10-R7	4	63		64	64
UK10-R8	4	61		62	62
UK10-R9	1	62		63	64
UK10-R10	1	61		62	63
UK10-R11	1	62		63	64
UK10-R12	1	61		62	63
116	16	70	71	71	72

117	8	65	66	66	66
118	46	70	62	62	63
119	18	56	58	58	58
120	12	51	54	54	52

Values in **BOLD approach or exceed the NAC*

Receptors UK10-R1 through UK10-R12 were reevaluated for modeled existing and 2030 No Build and Build noise levels.

Exhibit 4-8: Modeled noise receptor locations – 4

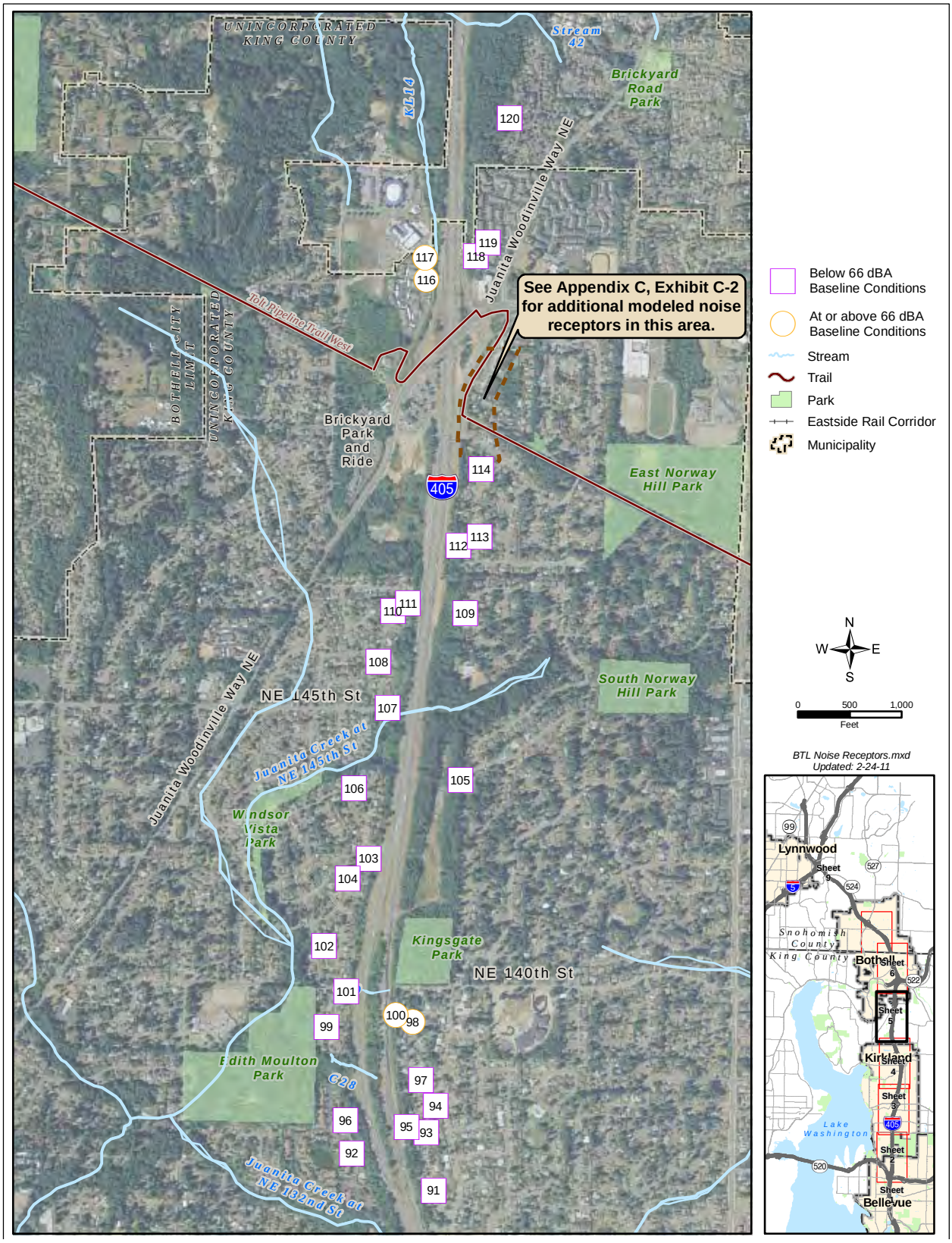


Exhibit 4-9: Modeled noise levels at receptors – 5

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
121	18	57	57	57	58
122	8	67	67	67	68
123	8	67	67	67	68
124	10	58	58	58	58
125	2	65	66	66	66
128A		66			
129		63			
130A		74			
NB3-R1	1	74		75	73
NB3-R2	1	73		74	74
NB3-R3	4	71		72	71
NB3-R4	4	72		73	72
NB3-R5	8	72		73	73
NB3-R6	4	72		73	71
NB3-R7	4	73		74	73
NB3-R8	4	71		72	70
NB3-R9	4	72		73	72
NB3-R10	4	72		73	73
NB3-R11	6	72		73	70
NB3-R12	6	73		74	72
NB3-R13	6	73		74	74
NB3-R14	4	70		71	68
NB3-R15	4	71		72	71
NB3-R16	4	70		71	68
NB3-R17	4	71		72	71
NB3-R18	8	71		72	72
NB3-R19		70		71	70
NB3-R20	1	66		68	66
NB3-R21	1	64		66	65
NB3-R22	1	64		65	65

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
132		77			
133	4	61	61	61	62
134	5	56	58	58	57

Values in **BOLD approach or exceed the NAC*
Receptors NB3-R1 through NB3-R22 were reevaluated for modeled existing and 2030 noise levels. Receptors 128A, 129, 130A and are in the area reevaluated with additional receptors, but are included for their existing conditions noise level measurements (see Appendix A for a list of noise measurement sites).

Exhibit 4-10: Modeled noise receptor locations – 5

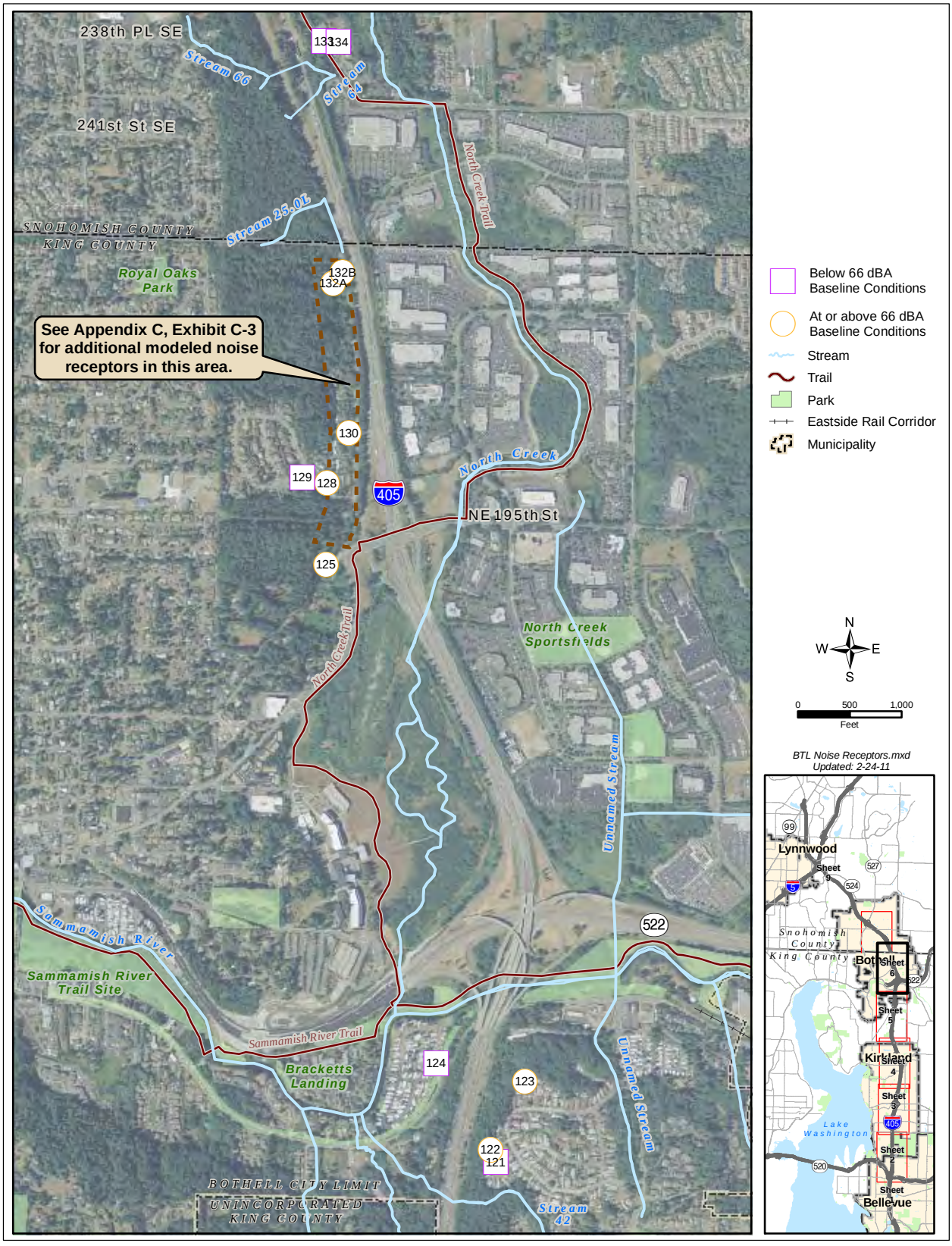


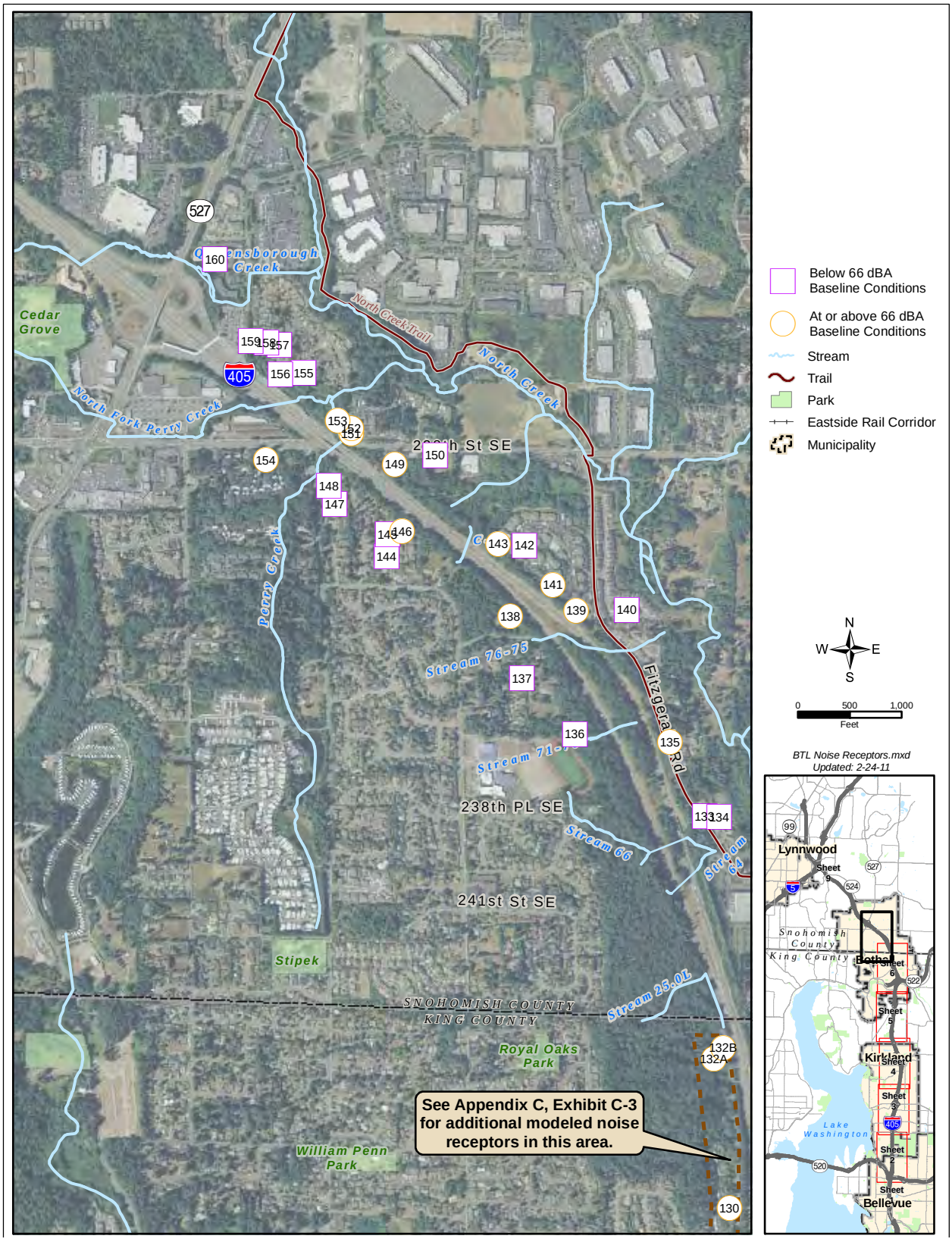
Exhibit 4-11: Modeled noise levels at receptors – 6

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
135	5	67	67	67	67
136	School	49	49	49	50
137	7	55	56	56	56
138	4	70	70	70	71
139	12	66	66	66	68
140	16	56	56	56	57
141A	16	62	62	62	64
141B	16	68	68	68	69
141C	16	71	71	71	72
142A	24	50	50	50	51
142B	24	49	50	50	50
142C	24	51	51	51	52
143A	16	61	61	61	62
143B	16	69	69	69	71
143C	16	71	72	72	73
144	11	63	63	63	64
145	11	63	63	63	64
146	6	74	74	74	75
147	9	60	60	60	61
148	5	63	64	64	64
149	8	67	67	67	68
150	4	62	62	62	62
151A	3	72	72	72	72
151B	3	73	73	73	74
151C	3	75	76	76	76
152A	3	69	70	70	70
152B	3	71	71	71	72
152C	3	74	74	74	74
153	2	68	68	68	69
154A	12	64	65	65	65
154B	12	67	68	68	68

Noise Receptor Number	Total Residences Represented	Modeled Existing Noise Level (dBA)	Modeled 2014 Baseline Noise Level (dBA)	Future Modeled Noise Levels (dBA) without Additional Mitigation	
				2030 No Build	2030 Build
154C	12	68	69	69	69
155	8	60	60	60	60
156	9	59	60	60	60
157	10	55	56	56	56
158	8	56	56	56	57
159	6	53	54	54	54
160	Hotel	59	61	61	61

**Values in BOLD approach or exceed the NAC*

Exhibit 4-12: Modeled noise receptor locations – 6



SECTION 5 PROJECT EFFECTS

How will the project affect noise levels in the study area?

Build Alternative 1

Modeling for Build Alternative 1 indicates that without mitigation, and with completion of Kirkland Nickel Project noise walls, noise levels will approach or exceed the NAC at 102 locations that represent 406 residences.

With the proposed mitigation, noise levels at 77 locations, representing 354 residences, will continue to approach or exceed the NAC.

Noise Barrier NW1, which is built under the Kirkland Nickel Project, will be moved to a new location for Build Alternative 1 to be constructed.

Build Alternative 2

Modeling for Build Alternative 2 presents the same results as Build Alternative 1.

No Build Alternative

Modeling for the No Build Alternative indicates that noise levels will approach or exceed the NAC at 102 locations representing 368 residences.

How do the existing conditions, no build, and build alternatives differ?

Existing noise levels approach, meet or exceed the NAC at 446 residences Noise levels for the No Build Alternative, after completion of Kirkland Nickel Project noise walls, are predicted to approach, meet, or exceed the NAC at 368 residences.

Noise levels for the Build Alternatives, without mitigation were predicted to approach, meet, or exceed the NAC at 102 locations that represent 406 residences. With the proposed mitigation, noise levels at 77 locations, representing 354 residences, will continue to approach or exceed the NAC.

Will project construction affect noise levels?

Construction activities will generate noise during the construction period. Construction is usually carried out in reasonably distinct steps, each with its own mix of equipment and its own noise characteristics. Roadway construction involves clearing, cut-and-fill (grading) activities, removing old roadways, importing and compacting fill, paving, and pile driving.

Noise sources during construction

The internal combustion engine will be the most prevalent noise source at construction sites. Engine-powered equipment includes earth-moving and compaction, material-handling, and stationary equipment. Mobile equipment operates intermittently, with periods of high and low noise. Stationary equipment (e.g., generators and compressors) operates at sound levels fairly constant over time. Because trucks will be present during most construction stages and will not be confined to the active construction area, truck noise could affect more area residents. Other construction noise sources will include impact equipment and tools such as pile drivers. Impact tools could be pneumatically powered, hydraulic, or electric.

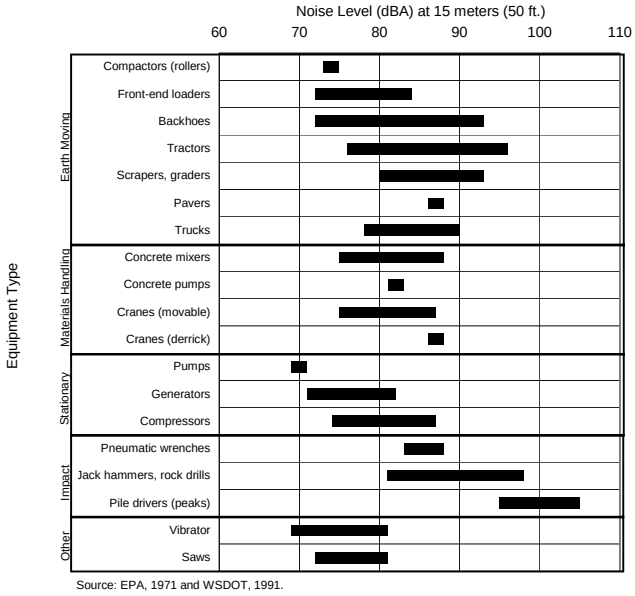
Construction noise will be intermittent. These noise levels will depend on the type, amount, and location of construction activities. The type of construction methods used will establish the maximum noise levels for the construction equipment used. The amount of construction activity will define how often noise will occur. The proximity of construction equipment to adjacent properties will affect the receptors' noise levels. The maximum noise levels of construction equipment for either of the two Build Alternative will be similar to the typical maximum levels presented in Exhibit 5-1.

Range of noise from construction equipment

As shown in Exhibit 5-1, maximum noise levels from construction equipment will range from 69 to 106 dBA at 50 feet. Construction noise at residences farther away will decrease at a rate of 6 dBA per doubling of distance from the source. The number of maximum noise level occurrences will increase during construction, particularly during pile-driving

activities. Because some equipment will be turned off, idling, or operating at less than full power at any time; and because construction machinery is typically used to complete short-term tasks at any given location, the average Leq noise levels during the day will be less than the maximum noise levels presented in Exhibit 5-1. The construction practices identified in the *Measures to Avoid or Minimize Project Effects* section of this report could help reduce construction noise levels.

Exhibit 5-1: Typical construction noise levels



Source: EPA, 1971 and WSDOT, 1991.

Does the project have other effects that may be delayed or distant from the project?

An effect is considered indirect when it occurs later in time or farther removed from an original project action. Indirect effects may include effects related to changes in land use patterns, population density or growth rate, and related effects on other natural systems.

The noise analysis for this project is based on the transportation demand forecasting model and includes the effects of unmet demand on the transportation system. By including unmet demand, the indirect effects of increased transportation capacity are included in the analysis.

Did noise specialists consider this project's cumulative noise effects?

The team did not evaluate cumulative effects for this discipline report. A report of cumulative effects is not needed for every discipline studied for NEPA and SEPA documentation. The disciplines that were studied for cumulative effects are Air Quality, Surface Water and Water Quality, Fisheries and Aquatic Habitat, and Wetlands. The cumulative effects for these disciplines are presented in the *Cumulative Effects Analysis Discipline Report* (Bellevue to Lynnwood Improvement Project, 2011a).

The results of the noise analysis reflect the Bellevue to Lynnwood Improvement Project's potential delayed and distant effects. The data presented in the odd-numbered Exhibits 4-1 to 4-11 reflect modeled noise levels for the two Build Alternatives through 2030.

Did we consider potential cumulative effects for noise?

In accordance with the Council on Environmental Quality (CEQ) guidelines, an analysis of cumulative effects is not needed for every discipline studied in NEPA documentation. Disciplines selected for cumulative effects analysis are determined on a case-by-case basis early in the NEPA process. This Noise Discipline Report was not identified for a cumulative effects analysis.

SECTION 6 MEASURES TO AVOID OR MINIMIZE EFFECTS

WSDOT can control noise at three locations: 1) at noise sources (with mufflers and quieter engines for example); 2) along noise paths (with barriers); and 3) at receptors (with insulation). Noise abatement (mitigation) is only necessary where frequent human use occurs and where a lower noise level will provide benefits (USDOT, 1982).

What measures will be taken to mitigate effects during construction?

To reduce construction noise, WSDOT will incorporate the following activities where practicable:

- As construction takes place in the area where the noise barrier is to be built, if possible, construct the proposed noise barrier before other construction activities begin;
- Limit the noisiest construction activities (e.g., pile driving) to between 7 AM and 10 PM to reduce construction noise levels during sensitive nighttime hours;
- Equip construction equipment engines with adequate mufflers, intake silencers, and engine enclosures to reduce their noise;
- Turn off construction equipment during prolonged periods of nonuse to eliminate noise;
- Where possible, locate stationary equipment away from residences to decrease noise;
- Construct temporary noise barriers or curtains around stationary equipment that must be located close to residences, to decrease noise levels at nearby sensitive receptors; and
- Require the use of Occupational Safety and Health Administration (OSHA)-approved ambient sound-sensing backup alarms to reduce disturbances from backup alarms during quieter periods.

What measures will be taken to mitigate effects during operation?

FHWA regulations (23 CFR 772) specify that when project proponents identify noise effects, they must evaluate

abatement (mitigation) measures to reduce those effects. For FHWA approval, noise abatement measures must be determined to be both feasible and reasonable, after considering input from local residents.

A variety of mitigation methods can effectively reduce traffic noise levels. For example, noise generated from long-term operation of the project can be reduced by implementing traffic management measures, acquiring land as buffer zones, realigning the roadway, noise-insulating public use, or nonprofit institutional structures, and constructing noise barriers or berms. I-405 Team noise specialists evaluated these measures for their potential to reduce noise caused by the proposed project and concluded that noise barriers were the most effective method for attenuating noise due to the characteristics of the freeway, proposed improvements, and affected receptors. This section summarizes the results of this evaluation.

A final determination of the size and placement of noise barriers or berms and the implementation of other noise-attenuating methods will take place during final project design. This determination will occur after the public has had additional opportunities to comment and the I-405 Team receives the necessary local, state, and federal approvals.

Noise barriers

Noise barriers include noise walls, berms, and buildings with uses that are not noise sensitive. A noise barrier's effectiveness is determined by its height and length and by site topography.

WSDOT evaluates many factors to determine whether barriers are feasible and/or reasonable. To be feasible, a barrier must be constructible in a location that achieves a noise reduction of at least 7 dBA at one or more receptors, and must provide a reduction of at least 5 dBA at the majority of first-row receptors. The determination of reasonableness depends on the number of sensitive receptors benefited by a reduction in noise of at least 3 dBA, the barriers' cost-effectiveness, and concerns such as aesthetics, safety, and the desires of nearby residents.

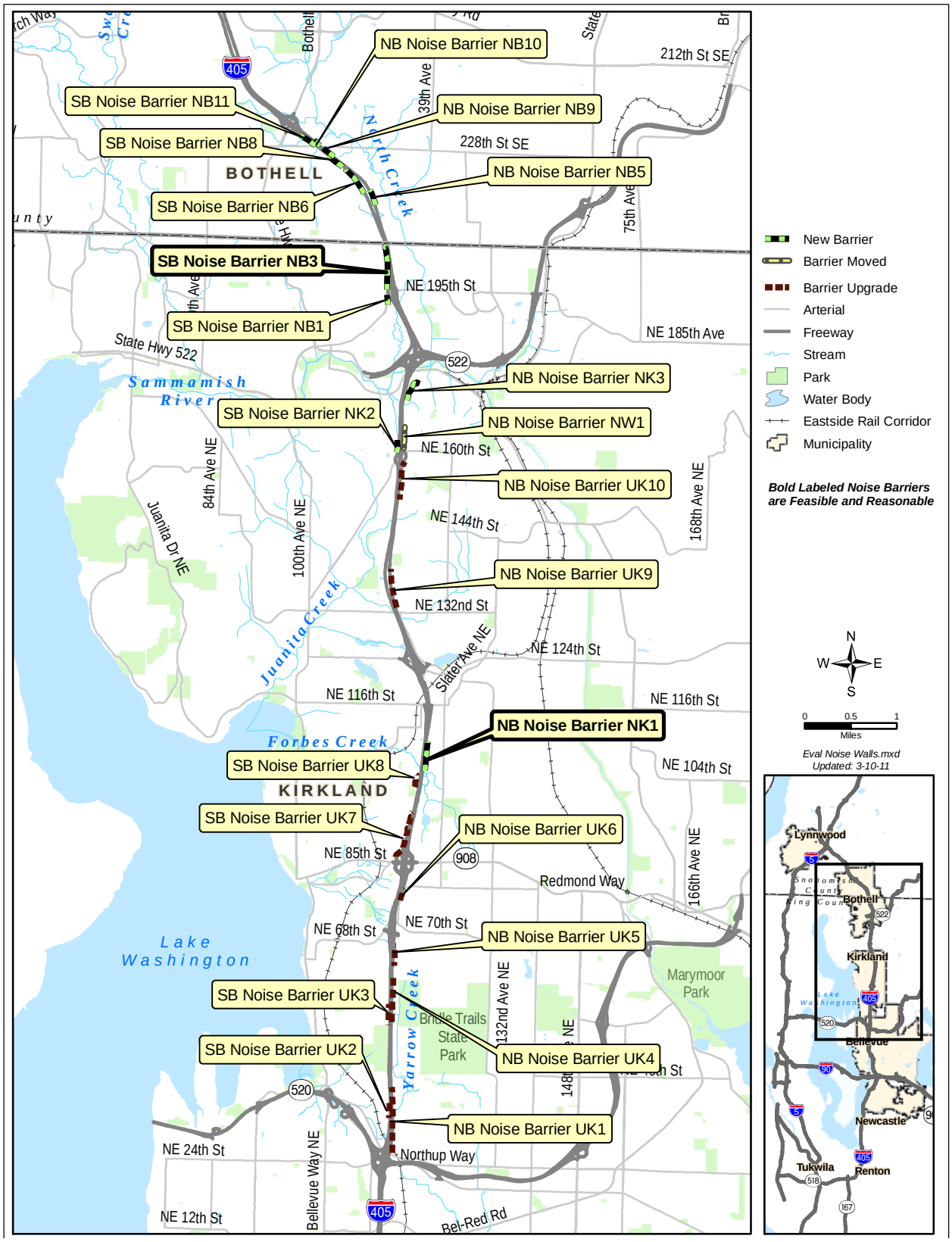
Noise barriers were evaluated in areas where noise levels are predicted to approach or exceed the NAC if the project is built.

A total of 24 noise barriers (10 upgrade walls and 14 new walls) were evaluated for the Bellevue to Lynnwood Improvement Project. Exhibit 6-1 shows evaluated noise barrier locations for baseline and No Build conditions. The two noise barriers that meet WSDOT Feasibility and Reasonableness Criteria are shown in bold on Exhibit 6-1. The "NB" and "SB" included on each noise barrier label on Exhibit 6-1 define the I-405 direction and side of the freeway, southbound or northbound, on which the barrier is located. Noise Barrier NW1, which has not yet been constructed, was analyzed in the Kirkland Nickel Project (2005). This barrier is included in the baseline conditions and the No Build Alternative, and will be relocated under Build Alternative 1 and 2 due to reconfiguration of the I-405 mainline.

The two of the barriers meeting WSDOT Feasibility and Reasonableness Criteria (NK1 and NB3) were reevaluated and optimized for lengths and heights. These barriers were re-analyzed because of concerns over wall panel heights, end flanking of noise and new homes built near the ends of the proposed barrier that were not considered in the original analysis. The detailed analysis for the two walls that were reevaluated is provided in the following sections.

This section summarizes the evaluation of each noise barrier. Refer to Appendix B for additional barrier evaluations. The information presented in Appendix B details on why each barrier meets or does not meet the criteria for feasibility and reasonableness by describing the evaluation of multiple barrier heights. The information presented in Appendix B also provides background on how the optimal barrier height was selected for those barriers that were both feasible and reasonable.

Exhibit 6-1: Evaluated noise barriers



Noise Barrier UK1 (Not Reasonable)

Noise Barrier UK1 is located along northbound I-405 in the vicinity of 116th Avenue NE, between Northup Way and NE 36th Place (see Exhibit 6-1). The Bellevue to Lynnwood Improvement Project will not affect the existing noise wall at location UK1. However, future noise levels in the vicinity of Noise Barrier UK1 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK1 was evaluated for a height upgrade as part of this project. This noise barrier is currently approximately 10 feet tall and 3,778 feet long.

I-405 Team noise specialists evaluated increasing Noise Barrier UK1's height by 14 feet in order to achieve noise levels at or near 66 dBA at noise sensitive sites located behind UK1. This upgrade would provide a maximum reduction of 5 dBA for the 4 residences represented by Modeled Site 6 (see Appendix B). Upgrading the height of Noise Barrier UK1 is not reasonable because the barrier area required to achieve noise levels of 66 dBA or below is over seven times greater than the allowable barrier area.

Noise Barrier UK2 (Not Reasonable)

Noise Barrier UK2 is located along southbound I-405 in the vicinity of 115th Avenue NE and NE 36th Place, approximately one-half-mile north of the I-405/SR 520 Interchange (see Exhibit 6-1). The Bellevue to Lynnwood Improvement Project will not affect the existing noise wall at location UK2. However, future noise levels in the vicinity of Noise Barrier UK2 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK2 was evaluated for a height upgrade as part of this project. Noise Barrier UK2 is currently approximately 4 to 12 feet tall and 1,029 feet long.

I-405 Team noise specialists evaluated increasing Noise Barrier UK2's height by 8 feet (see Exhibit 6-2) in order to achieve noise levels at or near 66 dBA at residences located behind UK2. This increase would provide a maximum reduction of 5 dBA for the 4 first-row residences represented by Modeled Site 5.

WSDOT's allowable wall area for this evaluated upgrade to Noise Barrier UK2 is 4,164 square feet. This is based on the noise level that would occur at the receptors if Noise Barrier

UK2 did not already exist. The wall area required for the evaluated upgrade to Noise Barrier UK2 would be 8,232 square feet. This means that reconstructing Noise Barrier UK2 with 8 feet of additional height is not reasonable.

Exhibit 6-2: Allowed barrier area for Noise Barrier UK2

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
4	10	66	0	65	1
5	4	71	4,164	66	5
Existing Barrier Area (ft^2)			-	6,116	
Total Barrier Area for Replacement (ft^2)			-	14,348	
Barrier Area for Replacement (ft^2)			4,164	8,232	
Planning-Level Cost ($)			$222,357	$439,588	

Noise Barrier UK3 (Not Reasonable)

Noise Barrier UK3 is located along southbound I-405 in the vicinity of 114th Avenue NE and NE 53rd Street (see Exhibit 6-1). The existing noise wall at location UK3 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK3 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK3 was evaluated for a height upgrade as part of this project. Noise Barrier UK3 is currently approximately 16 feet tall and 1,195 feet long.

I-405 Team noise specialists evaluated increasing Noise Barrier UK3's height by 12 feet (see Exhibit 6-3) in order to reduce noise levels near 66 dBA at residences located behind Noise Barrier UK3. This increase provides a 3 dBA reduction for all residences represented by Modeled Sites 18 and 19.

WSDOT's allowable wall area is 11,984 square feet, based on the noise level that would occur at the receptors if Noise Barrier UK3 did not already exist. The wall area required for this upgrade to Noise Barrier UK3 would be 14,340 square feet. This means that reconstructing Noise Barrier UK3 with 12 feet of additional height is not reasonable.

Exhibit 6-3: Allowed barrier area for Noise Barrier UK3

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
18	8	70	7,784	67	3
19	6	65	4,200	62	3
Existing Barrier Area (ft^2)			-	19,120	
Total Barrier Area for Replacement (ft^2)			-	33,460	
Barrier Area for Replacement (ft^2)			11,984	14,340	
Planning-Level Cost ($)			$639,945	$765,756	

Noise Barrier UK4 (Not Reasonable)

Noise Barrier UK4 is located along northbound I-405 in the vicinity of 116th Avenue NE and between approximately NE 53rd Street and NE 60th Street (see Exhibit 6-1). The existing noise wall at location UK4 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK4 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK4 was evaluated for a height upgrade as part of this project. Noise Barrier UK4 is currently approximately 12 to 14 feet tall and 2,567 feet long.

I-405 Team noise specialists evaluated increasing the height of Noise Barrier UK4 by 12 feet (see Exhibit 6-4) in order to reduce noise levels near 66 dBA at residences located behind Noise Barrier UK4. This increase provides a maximum reduction of 3 dBA for the 16 first-row residences represented by Modeled Site 24. The 13 remaining first-row residences are represented by Modeled Site 20 and also receive a reduction of 3 dBA.

WSDOT's allowable wall area is 24,273 square feet for this evaluated upgrade to Noise Barrier UK4, based on the noise level that would occur at the receptors if Noise Barrier UK4 did not already exist. The wall area required for this upgrade would be 30,804 square feet. This means that reconstructing Noise Barrier UK4 with 12 feet of additional height is not reasonable.

Exhibit 6-4: Allowed barrier area for Noise Barrier UK4

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
20	13	68	10,881	65	3
24	16	68	13,392	65	3
Existing Barrier Area (ft^2)			-	32,392	
Total Barrier Area for Replacement (ft^2)			-	42,660	
Barrier Area for Replacement (ft^2)			24,273	30,804	
Planning-Level Cost ($)			$1,296,178	$1,644,933	

Noise Barrier UK5 (Not Reasonable)

Noise Barrier UK5 is located along northbound I-405 in the vicinity of 116th Avenue NE and NE 67th Street (see Exhibit 6-1). The existing noise wall at location UK5 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK5 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK5 was evaluated for a height upgrade as part of this project. Noise Barrier UK5 is currently approximately 8 to 12 feet tall and 1,151 feet long.

I-405 Team noise specialists evaluated increasing Noise Barrier UK5's height by 8 feet (see Exhibit 6-5) in order to reduce noise levels near 66 dBA at residences located behind Noise Barrier UK5. This increase provides a maximum reduction of 4 dBA for the 8 first-row residences represented by Modeled Site 32.

WSDOT's allowable wall area is 7,240 square feet for this evaluated upgrade to Noise Barrier UK5, based on the noise level that would occur at the receptors if Noise Barrier UK5 did not already exist. The wall area required for this 8-foot upgrade would be 9,208 square feet. This means that reconstructing Noise Barrier UK5 with 8 feet of additional height is not reasonable.

Exhibit 6-5: Allowed barrier area for Noise Barrier UK5

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
32	8	69	7,240	65	4
35	15	65	0	64	1
Existing Barrier Area (ft^2)			-	11,589	
Total Barrier Area for Replacement (ft^2)			-	20,797	
Barrier Area for Replacement (ft^2)			7,240	9,208	
Planning-Level Cost ($)			$386,616	$491,707	

Noise Barrier UK6 (Not Reasonable)

Noise Barrier UK6 is located along northbound I-405 in the vicinity of 116th Avenue NE and NE 80th Street (see Exhibit 6-1). The existing noise wall at location UK6 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK6 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK6 was evaluated for a height upgrade as part of this project. Noise Barrier UK6 is currently approximately 12 feet tall and 946 feet long.

I-405 Team noise specialists evaluated increasing the height of Noise Barrier UK6 by 10 feet. Upgrading the height of Noise Barrier UK6 to achieve noise levels below 66 dBA (10 feet higher) provides a 1 to 5-dBA reduction in I-405 traffic noise levels for the residences represented by Modeled Sites 41, 44, 45, and 47 (see Appendix B). Noise Barrier UK6 is not reasonable because the barrier area required to achieve noise levels below 66 dBA is greater than the allowable barrier area.

Noise Barrier UK7 (Not Reasonable)

Noise Barrier UK7 is located along the southbound I-405 off-ramp to NE 85th Street (see Exhibit 6-1). The existing noise wall at location UK7 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK7 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK7 was evaluated for a height upgrade as part of this project. Noise Barrier UK7 is currently approximately 8 to 20 feet tall and 2,785 feet long.

I-405 Team noise specialists evaluated increasing the height of Noise Barrier UK7 by 10 feet (see Exhibit 6-6) in order to reduce noise levels near 66 dBA at residences located behind Noise Barrier UK7. This increase provides a maximum reduction of 3 dBA for 22 residences represented by Modeled Sites 55 and 58. The 41 remaining first-row residences in the area are represented by Modeled Sites 56, 57, 59, 60, 64 and 65 and receive reductions that range from 1 to 2 dBA.

WSDOT's allowable wall area is 21,134 square feet for this evaluated upgrade to Noise Barrier UK7, based on the noise level that would occur at the receptors if Noise Barrier UK7 did not already exist. The wall area required for this upgrade to Noise Barrier UK7 would be 27,850 square feet. This means that reconstructing Noise Barrier UK7 with 10 feet of additional height is not reasonable. Adding additional height, beyond 10 feet, to the existing barrier UK7 was deemed not feasible.

Exhibit 6-6: Allowed barrier area for Noise Barrier UK7

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
55	18	70	17,514	67	3
56	6	64	0	63	1
57	4	66	0	64	2
58	4	69	3,620	66	3
59	3	69	0	67	2
60	6	66	0	65	1
64	9	63	0	62	1
65	9	66	0	65	1
Existing Barrier Area (ft^2)			-	38,691	
Total Barrier Area for Replacement (ft^2)			-	66,541	
Barrier Area for Replacement (ft^2)			21,134	27,850	
Planning-Level Cost ($)			$1,128,555	$1,487,190	

Noise Barrier UK8 (Not Reasonable)

Noise Barrier UK8 is located along southbound I-405, in the vicinity of 118th Place NE between NE 100th Street and NE 112th Street (see Exhibit 6-1). The existing noise wall at

location UK8 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK8 are predicted to approach or exceed the NAC. For this reason, Noise Barrier UK8 was evaluated for an upgrade as part of this project. Noise Barrier UK8 is currently approximately 14 to 18 feet tall and 895 feet long.

I-405 Team noise specialists evaluated increasing the height of Noise Barrier UK8 by 8 feet (see Exhibit 6-7) in order to reduce noise levels below 66 dBA at residences behind UK8. This increase provides a maximum reduction of 5 dBA for 6 of the 11 first-row residences represented by Modeled Site 77. The 5 remaining first-row residences in the area are represented by Modeled Site 78 and receive 0 to 1 dBA noise reductions.

An allowable wall area of 4,620 square feet is available for this upgrade in noise barrier height to Noise Barrier UK8. Increasing the height of Noise Barrier UK8 8 feet would not achieve 3 dBA reductions in noise levels at Modeled Sites 76 and 78. This means that reconstructing Noise Barrier UK8 with 8 feet of additional height is not reasonable.

Exhibit 6-7: Allowed barrier area for Noise Barrier UK8

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
76	11	65	0	64	1
77	6	67	4,620	62	5
78	5	65	0	65	0
Existing Barrier Area (ft^2)			-	14,053	
Total Barrier Area for Replacement (ft^2)			-	23,003	
Barrier Area for Replacement (ft^2)			4,620	8,950	
Planning-Level Cost ($)			$246,708	$477,930	

Noise Barrier UK9 (Not Reasonable)

Noise Barrier UK9 is located along northbound I-405, in the vicinity of 115th Avenue NE between NE 132nd Street and NE 140th Street (see Exhibit 6-1). The existing noise wall at location UK9 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK9 are predicted to approach or

exceed the NAC. For this reason, Noise Barrier UK9 was evaluated for an upgrade as part of this project. Noise Barrier UK9 is currently approximately 12 to 14 feet tall and 2,237 feet long.

I-405 Team noise specialists evaluated increasing the height of Noise Barrier UK9 by 10 feet (see Exhibit 6-8) in order to reduce noise levels below 66 dBA at residences behind UK9. This increase provides a maximum reduction of 4 dBA for the 16 first-row residences represented by Modeled Site 95. The 8 remaining first-row residences in the area are represented by Modeled Site 100 and receive a reduction of 3 dBA.

WSDOT's allowable wall area is 61,296 square feet for this evaluated upgrade to Noise Barrier UK9, based on the noise level that would occur at the receptors if Noise Barrier UK9 did not already exist. The wall area required for this upgrade to Noise Barrier UK9 would be 81,628 square feet. This means that reconstructing Noise Barrier UK9 with 10 feet of additional height is not reasonable.

Exhibit 6-8: Allowed barrier area for Noise Barrier UK9

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
91	6	66	0	64	2
93	28	62	0	61	1
94	18	61	0	60	1
95	16	66	11,200	62	4
97	16	62	0	61	1
98	6	67	0	65	2
100	8	68	6,696	65	3
Existing Barrier Area (ft^2)			-	31,866	
Total Barrier Area for Replacement (ft^2)			-	54,236	
Barrier Area for Replacement (ft^2)			17,896	22,370	
Planning-Level Cost ($)			$955,646	$1,194,558	

Noise Barrier UK10, Southern Section (Feasible, Not Reasonable)

Noise Barrier UK10 is located along northbound I-405 in the vicinity of 116th Place NE and 116th Avenue NE (see Exhibit

6-1). The existing noise wall at location UK10 will not be affected by the Bellevue to Lynnwood Improvement Project. However, future noise levels in the vicinity of Noise Barrier UK10 are predicted to approach or exceed the NAC. For this reason, the section of Noise Barrier UK10 south of NE 155th Street was evaluated for a height upgrade as part of this project. This southern section of the barrier is currently approximately 12 to 16 feet tall and 1,298 feet long. The northern section of Noise Barrier UK10, along the east side of the I-405 off ramp to NE 160the Street, was evaluated for its existing height.

I-405 Team noise specialists evaluated increasing the height of the southern section Noise Barrier UK10 by 8 feet (see Exhibit 6-9) in order to reduce noise levels below 66 dBA for residences located behind UK10. This increase provides a maximum reduction of 3 dBA for the 8 residences represented by Modeled Site 112.

WSDOT's allowable wall area is 5,600 square feet for the evaluated upgrade to the south section of Noise Barrier UK10, based on the noise level that would occur at the receptors if Noise Barrier UK10 did not already exist. The wall area required for this upgrade to Noise Barrier UK10 is 10,384 square feet. This means that reconstructing Noise Barrier UK10 with 8 feet of additional height is not reasonable.

Exhibit 6-9: Allowed barrier area for Noise Barrier UK10

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
112	17	66	0	65	1
113	10	63	0	62	1
114	8	64	5,600	61	3
Existing Barrier Area (ft^2)			-	23,247	
Barrier Area for Replacement (ft^2)			-	33,361	
TOTAL Barrier Area for Replacement (ft^2)			5,600	10,384	
Planning-Level Cost ($)			$299,040	$554,505	

Noise Barrier UK10, Northern Section Reevaluation

The reevaluation of the northern section of UK10 modeled the barrier at its existing height. Additional modeled noise receptors represent 8 residential units in two buildings constructed after the initial noise evaluations were completed in 2007. Additional receptors also represent townhomes further south on 116th Avenue NE and single family houses along NE 115th Street. The locations of the additional receptors for the northern section of Noise Barrier UK10 are shown in Appendix C on Exhibit C-2. Exhibit 6-10 shows the results of the UK10 reevaluation. None of the modeled noise levels with the Build Alternatives approached or exceeded the NAC with the existing noise barrier configuration. Therefore, no barrier upgrade was evaluated for the north section of UK10.

Exhibit 6-10: Noise Barrier UK10 existing north section noise analysis

Modeled Site	Residences Represented	2030 Modeled Noise Levels (dBA)		
		No Build	Build	Change
UK10-R1	2	64.5	64.8	0.3
UK10-R2	2	64.2	64.7	0.5
UK10-R3	2	62.6	63.1	0.5
UK10-R4	2	62.3	62.8	0.5
UK10-R5	4	64.1	64.5	0.4
UK10-R6	4	61.3	61.9	0.6
UK10-R7	4	63.5	63.9	0.4
UK10-R8	4	61.7	62.2	0.5
UK10-R9	1	63.3	63.7	0.4
UK10-R10	1	62.0	62.5	0.5
UK10-R11	1	63.1	63.7	0.6
UK10-R12	1	62.0	62.5	0.5

Source: Michael Minor & Associates, 2011b.

Noise Barrier NK1 (Feasible, Reasonable)

Noise Barrier NK1 is located along northbound I-405, approximately one-half-mile south of NE 116th Street, near Slater Avenue NE (see Exhibit 6-11). The single-family residences in the Rose Hill neighborhood were reevaluated for a noise barrier. Noise Barrier NK1 was reevaluated along the I-405 right-of-way, running between approximately 200 feet south of NE 105th Street and approximately 150 feet north of NE 108th Street. The noise levels in this area range from 59 to 80 dBA without a barrier. The modeled site locations are shown in Appendix C on Exhibit C-1.

Exhibit 6-11: Noise Barrier NK1

At an average height of 15 feet varying between 10 and 20 feet tall, Noise Barrier NK1 provides a maximum reduction of 16 dBA for the 12 first-row residences represented by Modeled Site NK1-R17. The remaining first-row residences in the area receive reductions between 7 and 14 dBA. Noise Barrier NK1 meets WSDOT feasibility criteria at an average height of 15 feet, because a greater than 7-dBA reduction is achieved at one first row residence and all but one of 12 first row receivers achieves a greater than 5-dBA reduction is provided in the area.

An area of approximately 24,547 square feet is required for Noise Barrier NK1 at this average height and a length of 1,610 feet. WSDOT's allowable wall area is 32,422 square feet for this evaluation of Noise Barrier NK1, as shown in Exhibit 6-12. This means that Noise Barrier NK1 is reasonable. Note that this wall will likely require some smoothing, and the wall heights presented are the minimum recommended heights for the noise barrier panels.

Exhibit 6-12: Allowed barrier area for Noise Barrier NK1

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
NK1-R1	1	**73**	1,176	**69**	**4**
NK1-R2	1	**75**	1,312	**71**	**4**
NK1-R3	1	**78**	1,380	**71**	**7**
NK1-R4	1	**78**	1,380	**68**	**10**
NK1-R5	2	**78**	2,760	**69**	**9**
NK1-R6	2	**72**	2,216	**67**	**5**
NK1-R7	2	**68**	1,672	65	**3**
NK1-R8	0	64	0	63	1
NK1-R9	1	**71**	1,040	65	**6**
NK1-R10	2	**77**	2,760	65	**12**
NK1-R11	2	**74**	2,488	65	**9**
NK1-R12	1	**70**	972	64	**6**
NK1-R13	2	**66**	1400	63	**3**
NK1-R14	2	**66**	1400	63	**3**
NK1-R15	0	62	0	61	1
NK1-R16	0	62	0	61	1
NK1-R17	1	**80**	1380	64	**16**
NK1-R18	1	**77**	1380	63	**14**
NK1-R19	1	**71**	1040	63	**8**
NK1-R20	0	63	700	60	**3**
NK1-R21	0	61	0	59	2
NK1-R22	0	59	0	59	0
NK1-R23	0	59	0	59	0
NK1-R24	0	60	0	60	0
NK1-R25	0	63	0	61	2
NK1-R26	0	65	0	63	2
NK1-R27	1	**66**	700	62	**4**
NK1-R28	1	**68**	836	63	**5**
NK1-R29	1	**70**	972	63	**7**
NK1-R30	1	**78**	1380	62	**16**
NK1-R31	0	**66**	0	64	2

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
NK1-R32	0	65	0	64	1
NK1-R33	1	**69**	904	**66**	**3**
NK1-R34	1	**73**	1176	63	**10**
NK1-R35	0	**71**	0	**70**	1
TOTAL Barrier Area (ft^2)			32,4221	24,547	
Planning-Level Cost ($)			$1,731,340	$1,310,809.8	

Noise Barrier NK2 (Feasible, Not Reasonable)

Noise Barrier NK2 is located along southbound I-405 in the vicinity of 115th Avenue NE, just north of NE 160th Street. The condominiums located on 115th Avenue NE were evaluated for a noise barrier. Noise Barrier NK2 was evaluated along the eastern edge of the I-405 right-of-way along the NE 160th Street southbound on-ramp to 118th Avenue NE in three similar locations. The noise levels in the area range from 66 to 72 dBA without a barrier.

Noise Barrier NK2 was evaluated: atop a retaining wall west of I-405, along the WSDOT right-of-way line continuing through a stream buffer, and along the WSDOT right-of-way stopping short of the stream buffer. Exhibit 6-15 presents the barrier evaluation results for the NK2 alignment that passes through the stream buffer as it is the closest to achieving both feasibility and reasonableness. At a height of 20 to 26 feet, Noise Barrier NK2 provides a maximum reduction of 8 dBA for the 16 first-row residences represented by Modeled Site 116. Receptor 117, which represents 8 residences, receives a reduction of 2 dBA. Noise Barrier NK2 meets WSDOT feasibility criteria at a height of 20 to 26 feet, because a 7-dBA reduction is achieved and a 5-dBA or more reduction is provided at a majority of first-row residences in the area.

An area of approximately 21,314 square feet is required for Noise Barrier NK2 at this height and a length of 918 feet. WSDOT's allowable wall area is 17,744 square feet for this evaluation of Noise Barrier NK2, as shown in Exhibit 6-13. This means that Noise Barrier NK2 is reasonable. Adding

additional height to this noise barrier did not provide further noise reduction at Modeled Site 117 that was comparable to the additional allowable area provide by Modeled Site 117.

Two alignments for Noise barrier NK2 were evaluated: one alignment included a shorter wall length to prevent stream buffer mitigation and one alignment included placing NK2 atop a retaining wall; however, neither alignment met WSDOT criteria for reasonableness.

Exhibit 6-13: Allowed barrier area for Noise Barrier NK2

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
116	16	72	17,744	64	8
117	8	66	0	64	2
TOTAL Barrier Area (ft^2)			17,744	21,314	
Cost of Stream Buffer Mitigation			-	$100,000	
Planning-Level Cost ($)			$947,529	$1,238,167	

Noise Barrier NK3 (Feasible, Not Reasonable)

Noise Barrier NK3 is located along northbound I-405 in the vicinity of 117th Court NE and Woodcrest Drive NE (see Exhibit 6-1). The single-family residences in the vicinity of Woodcrest Drive NE were evaluated for a noise barrier. Noise Barrier NK3 was evaluated along the right-of-way that runs the length of the neighborhood. Noise levels in the area range from 58 to 68 dBA without a noise barrier.

At a height of 20 feet, Noise Barrier NK3 provides a maximum reduction of 14 for the 3 first-row residences represented by Modeled Site 123. Receptor 122, which represents the 10 remaining first-row residences in the area, receives a reduction of 7 dBA. The 8 remaining residences in the area are represented by Receptor 121 and do not receive a reduction in noise levels. Noise Barrier NK3 meets WSDOT feasibility criteria at a height of 20 feet, because a 7-dBA reduction is achieved and a 5-dBA or more reduction is provided at all 13 of the first-row residences in the area.

An area of approximately 29,480 square feet is required for Noise Barrier NK3 at this height and a length of 1,474 feet.

WSDOT's allowable wall area is 10,881 square feet for this evaluation of Noise Barrier NK3, as shown in Exhibit 6-14. This means that Noise Barrier NK3 is not reasonable.

Exhibit 6-14: Allowed barrier area for Noise Barrier NK3

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
121	8	58	0	58	0
122	10	68	8,370	61	7
123	3	68	2,511	54	14
TOTAL Barrier Area (ft^2)			10,881	29,480	
Planning-Level Cost ($)			$581,045	$1,574,232	

Noise Barrier NB1 (Not Feasible)

The pocket of single-family residences along the northern boundary of Ross Road was evaluated for a noise barrier. Noise Barrier NB1 was evaluated along the right-of-way that runs between the eastern edge of Beardslee Road and the western edge of the NE 195th Street to I-405 southbound on-ramp (see Exhibit 6-1). The noise level in the area is 66 dBA without a noise barrier.

At a height of 40 feet, Noise Barrier NB1 provides a maximum reduction of 3 dBA for the 2 residences represented by Modeled Site 125. Noise Barrier NB1 is not feasible because it does not provide a 7-dBA reduction in I-405 traffic noise levels for any of the residences represented by Modeled Site 125 (see Appendix B).

The primary reason that Noise Barrier NB1 does not reduce traffic noise in this area is because the WSDOT right-of-way line is located alongside the NE 195th Street to I-405 southbound on-ramp, approximately 40 feet below the elevation of the modeled site.

Noise Barrier NB3 (Feasible, Reasonable)

The North Creek Apartment community was reevaluated for a noise barrier because it was decided to move the base of the wall in some locations to save several trees along the corridor. The reason for this analysis is to re-evaluate the top of wall elevations based on the new base of wall location. Noise

Barrier NB3 was reevaluated along the right-of-way that runs between the I-405 southbound to NE 195th Street off-ramp and 112th Avenue NE (see Exhibit 6-15). In addition to the North Creek Apartment Community, the evaluated area includes pockets of single family residences both south and north of the apartments along 112th Avenue NE. Noise levels in the area range from 65 to 74 dBA without a noise barrier. The modeled noise sites area shown in Appendix C on Exhibit C-3.

Exhibit 6-15: Noise Barrier NB3

The noise barrier was relocated slightly, which allowed for slightly lower wall heights, while still achieving the noise reduction required under WSDOT policy (Exhibit 6-16). At an average height of 20.9 feet, Noise Barrier NB3 provides a maximum reduction of 10 dBA for the 4 of 12 first-row residences represented by Modeled Sites NB3-R2, NB3-R3, NB3-R6 and NB3-R8. The remaining receptors NB3-R1, NB3-NB3-R2, NB3-R11, NB3-R14, NB3-R16, NB3-R20, NB3-R21 and NB3-R22 represent 8 additional first-row residences and achieve reductions ranging from 1 to 8 dBA. The NB3-R20, NB3-R21 and NB3-R22 residences represented experience 1 to 3 dBA reductions and are the only first-row residences in the area that do not achieve a reduction of 5 dBA or greater. Noise Barrier NB3 meets WSDOT feasibility criteria at an average height of 20.9 feet because a 7-dBA reduction is achieved and a 5-dBA or greater reduction is provided at 9 out of 12 first-row residences.

An area of approximately 53,910 square feet is required for Noise Barrier NB3 at this height and a length of 2,551 feet. WSDOT's allowable wall area is 54,978 square feet for this evaluation of Noise Barrier NB3, as shown in Exhibit 6-16. This means that Noise Barrier NB3 is reasonable under typical conditions.

See Appendix B for additional height evaluations.

Exhibit 6-16: Allowed barrier area for Noise Barrier NB3

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
NB3-R1 North house	1	73	1,176	68	5
NB3-R2 House near Apts	1	74	1,244	64	10
NB3-R3 Bldg H GF	4	71	4,160	61	10
NB3-R4 Bldg H SF	4	72	4,431	65	7
NB3-R5 Bldg H TF	8	73	9,407	68	5
NB3-R6 Bldg G GF	4	71	4,160	61	10
NB3-R7 Bldg G SF	4	73	4,703	66	7
NB3-R8 Bldg F GF	4	70	3,888	60	10
NB3-R9 Bldg F SF	4	72	4,431	66	6
NB3-R10 Bldg F TF	4	73	0	71	2
NB3-R11 Bldg E GF	6	70	5,831	62	8
NB3-R12 Bldg E SF	6	72	0	70	2
NB3-R13 Bldg E TF	6	74	0	73	1
NB3-R14 Bldg D GF	4	68	3,344	62	6
NB3-R15 Bldg D SF	4	71	4,160	68	3
NB3-R16 Bldg C GF	4	68	3,344	63	5
NB3-R17 Bldg C SF	4	71	0	69	2
NB3-R18 Bldg C TF	8	72	0	72	0
NB3-R19 Pool	-	70	-	66	4
NB3-R20	1	66	700	63	3
NB3-R21	1	65	0	64	1
NB3-R22	1	65	0	64	1
TOTAL Barrier Area (ft^2)			54,978	53,910	
Planning-Level Cost ($)			$2,935,830	$2,878,794	

GF - ground floor
SF – second floor
TF – top floor

Noise Barrier NB5 (Feasible, Not Reasonable)

The pocket of single-family residences along Fitzgerald Road in the area east of I-405 northbound and north of the commercial complex located at the Snohomish County/King

County border was evaluated for a noise barrier. Noise Barrier NB5 was evaluated along the right-of-way that runs between the eastern edge of I-405 and Fitzgerald Road (see Exhibit 6-1). The noise level in the area is 67 dBA without a noise barrier.

At a height of 20 feet, Noise Barrier NB5 provides a reduction of 7 dBA for the 5 residences represented by Modeled Site 135. Noise Barrier NB5 meets WSDOT feasibility criteria at this height, because a 7-dBA reduction is achieved and a 5-dBA or greater reduction is provided at all of the residences in the area.

An area of approximately 11,700 square feet is required for Noise Barrier NB5 at a height of 20 feet and a length of 585 feet. WSDOT's allowable wall area is 3,850 square feet for this evaluation of Noise Barrier NB5, as shown in Exhibit 6-17. This means that Noise Barrier NB5 is not reasonable.

Exhibit 6-17: Allowed barrier area for Noise Barrier NB5

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
135	5	67	3,850	60	7
TOTAL Barrier Area (ft^2)			3,850	11,700	
Planning-Level Cost ($)			$205,590	$624,780	

The area along Fitzgerald Road was reevaluated in 2009 prior to the construction of the NE 195th Street to SR 527 Auxiliary Lane Project and noise barrier (WSDOT, 2009). The noise barrier along the I-405 northbound lanes begins at approximately the 23200 block of Fitzgerald Road and continues northwestward along the Stonemeadow Farms Apartments. Noise modeling at residences along Fitzgerald Road between the 23200 block and 240th Street SE forecast design year noise levels of 65 dBA or less.

Noise Barrier NB6 (Feasible, Not Reasonable)

The pocket of single-family residences along 233rd Place SE and 25th Drive SE in the area west of I-405 and north of Canyon Park Junior High was evaluated for a noise barrier. Noise Barrier NB6 was evaluated along the right-of-way that runs along the edge of I-405 southbound (see Exhibit 6-1).

Noise levels in the area range from 56 to 71 dBA without a noise barrier.

At a height of 30 feet, Noise Barrier NB6 provides a maximum reduction of 7 dBA for the 4 first-row residences represented by Modeled Site 138. A 3-dBA reduction is achieved at the 7 second-row residences represented by Modeled Site 137. Noise Barrier NB6 meets WSDOT feasibility criteria at this height, because a 7-dBA reduction is achieved and a 5-dBA or greater reduction is provided at all first-row residences in the area.

An area of approximately 28,350 square feet is required for Noise Barrier NB6 at a height of 30 feet and a length of 945 feet. WSDOT's allowable wall area is 9,064 square feet for this evaluation of Noise Barrier NB6, as shown in Exhibit 6-18. This means that Noise Barrier NB6 is not reasonable.

At a height of 30 feet, Noise Barrier NB6 would exceed the maximum height of 24 feet for a typically constructed noise barrier. This would require non-typical construction techniques and engineering to support the barrier. This would increase construction costs and enhance the unreasonableness of Noise Barrier NB6. (Note: Additional costs are not included in Exhibit 6-18.)

Exhibit 6-18: Allowed barrier area for Noise Barrier NB6

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
137	7	56	4,900	53	3
138	4	71	4,164	64	7
TOTAL Barrier Area (ft^2)			9,064	28,350	
Planning-Level Cost ($)			$484,018	$1,513,890*	

** Planning-level cost is based on typical construction techniques and engineering for noise barriers with a maximum height of 24 feet.*

Noise Barrier NB8 (Feasible, Not Reasonable)

The pocket of single-family residences in the vicinity of 21st Avenue SE was evaluated for a noise barrier. Noise Barrier NB8 was evaluated as an extension of the existing noise wall that begins southwest of the I-405 overpass at 228th Street SE and runs along the I-405's western right-of-way, ending in the vicinity of 20th Avenue SE. Noise Barrier NB8 was evaluated

to continue further south along the I-405's western right-of-way, ending well past 21st Avenue SE which is the area of concern (see Exhibit 6-1). Noise levels in the area are predicted to range from 64 to 75 dBA without a noise barrier.

At a height of 28 feet, Noise Barrier NB8 provides a maximum reduction of 7 dBA for the 6 first-row residences represented by Modeled Site 146. Receptors 144 and 145 represent a total of 22 residences and achieve 2-dBA reductions. Noise Barrier NB8 meets WSDOT feasibility criteria at this height, because a 7-dBA reduction is achieved and a 5-dBA or greater reduction is provided at all first-row residences in the area.

An area of approximately 20,944 square feet is required for Noise Barrier NB8 at a height of 28 feet and a length of 748 feet. WSDOT allowable wall area is 7,884 square feet for this evaluation of Noise Barrier NB8, as shown in Exhibit 6-19. This means that Noise Barrier NB8 is not reasonable.

At a height of 28 feet, Noise Barrier NB8 would exceed the 24-foot maximum height of a typically constructed noise barrier. This would require non-typical construction techniques and engineering to support the barrier. This would increase the cost of the barrier and enhance Noise Barrier NB8's unreasonableness. (Note: Additional costs are not included in Exhibit 6-19.)

Exhibit 6-19: Allowed barrier area for Noise Barrier NB8

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
144	11	64	0	62	2
145	11	64	0	62	2
146	6	75	7,884	68	7
TOTAL Barrier Area (ft^2)			7,884	20,944	
Planning-Level Cost ($)			$421,006	$1,118,410*	

** Planning-level cost is based on typical construction techniques and engineering for noise barriers with a maximum height of 24 feet.*

Noise Barrier NB9 (Not Feasible)

The town homes in the area southeast of the I-405 overpass at 228th Street SE were evaluated for a noise barrier. Noise Barrier NB9 was evaluated along I-405's eastern right-of-way, running south of 228th Street SE toward the wetlands just

south of the town home development (see Exhibit 6-1). Noise levels in the area are predicted to range from 62 to 68 dBA without a noise barrier.

At a height of 24 feet, Noise Barrier NB9 provides a maximum reduction of 6 dBA for the 8 first-row residences represented by Modeled Site 149. Noise Barrier NB9 is not feasible, because it does not provide a 7-dBA reduction in I-405 traffic noise levels for the 12 residences represented by Modeled Sites 149 and 150.

The primary reason that Noise Barrier NB9 does not reduce traffic noise in this area is that it would need to extend further north along the WSDOT right-of-way. Extending this barrier to the north is not feasible, because of the additional complexities and costs associated with engineering a noise barrier on the actual structure of the I-405 overpass at 228th Street SE.

Noise Barrier NB10 (Not Feasible)

The multi-family residences in the area northeast of the I-405 overpass at 228th Street SE were evaluated for a noise barrier. Noise Barrier NB10 was evaluated along the eastern right-of-way of I-405, running north of 228th Street SE to the southern end of an existing noise wall that runs along the I-405 northbound off-ramp to SR 527 (see Exhibit 6-1). Noise levels in the area range from 69 to 76 dBA without a noise barrier.

At a height of 32 feet, Noise Barrier NB10 provides a maximum reduction of 4 dBA for the 2 first-row residences represented by Modeled Site 153. Noise Barrier NB10 is not feasible, because it does not provide a 7-dBA reduction in I-405 traffic noise levels for the 20 residences represented by Modeled Sites 151A, 151B, 151C, 152A, 152B, 152C, and 153.

The primary reason that Noise Barrier NB10 does not reduce I-405 traffic noise in this area is that it would need to extend further south along WSDOT right-of-way. Extending it to the south is not feasible, because of the additional complexities and costs associated with engineering a noise barrier on the actual structure of the I-405 overpass at 228th Street SE.

Noise Barrier NB11 (Not Feasible)

The Canyon Pointe Apartments' easternmost buildings, which are located closest to the western edge of I-405 and 228th Street SE, were evaluated for a noise barrier. Noise Barrier NB11 was evaluated along I-405's western right-of-way, running north of 228th Street NE along the SR 527 on-ramp to I-405 southbound (see Exhibit 6-1). Noise levels in the area are predicted to range from 65 to 69 dBA without a noise barrier.

At a height of 32 feet, Noise Barrier NB11 provides a maximum reduction of 5 dBA for the 12 residences represented by Modeled Site 154C. Noise Barrier NB11 is not feasible, because it does not provide a 7-dBA reduction in I-405 traffic noise levels for any of the residences represented by Modeled Sites 154A, 154B and 154C.

The primary reason that Noise Barrier NB11 does not reduce I-405 traffic noise in this area is that the WSDOT right-of-way line runs along the western edge of I-405 and the SR 527 on-ramp to I-405 southbound, which lies approximately 35 feet below the elevation of the modeled sites. A substantial amount of traffic noise in the area also comes from 228th Street SE.

SECTION 7 UNAVOIDABLE ADVERSE EFFECTS

Does the project cause any substantial adverse effects that cannot be avoided?

For the Build Alternatives, modeling indicates that noise levels will approach or exceed the NAC at 102 locations (representing 406 residences and one church) without the recommended noise barriers. Seventy-seven modeled sites that represent an equivalent of 354 residences and one church will continue to experience noise levels that approach or exceed the NAC with the recommended noise barriers. Two these 77 receptors will experience substantial noise effects (75 to 76 dBA) under the Build Alternatives.

The two receptors that already (and will continue to) experience substantial noise effects represent 9 residences. Modeled Site 146 represents 6 first-row residences and experiences a 74-dBA baseline noise level. Modeled Site 151C represents 3 third-floor apartment residences and experiences a 75-dBA baseline noise level. Both receptors receive a noise level increase of 1-dBA under the Build Alternative. Noise barriers are not recommended in the vicinity of these receptors because they do not meet WSDOT feasibility and reasonability criteria, despite extra barrier area allowances. (See the Noise Barrier NB8 and NB10 analyses in *Measures to Avoid and Minimize Effects* section of this report.)

Construction of the Bellevue to Lynnwood Improvement Project will not cause any substantial unavoidable adverse noise effects, per FHWA guidance stipulating that temporary construction noise effects are not substantial.

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SECTION 8 REFERENCES

GIS data sources

Exhibit 4-1

PB. 2007. Study Area Boundary.

WSDOT (Washington State Department of Transportation). 2006 – 2007. I-405 Staff; project limits.

Exhibits 4-3 to 4-13 (odd numbered)

PB. 2007. Baseline Conditions.

Exhibit 6-1

PB. 2007. Barrier Moved, and Barrier Upgrade.

WSDOT (Washington State Department of Transportation). 2006 – 2011. I-405 Staff; New barrier, barrier moved, project limits.

Exhibit 6-11

PB. 2007. Modeled Site.

WSDOT (Washington State Department of Transportation). 2011. I-405 Staff; New Barrier.

Exhibit 6-13

PB. 2007. New Barrier and Modeled Site.

Exhibit 6-16

PB. 2007. Modeled Site.

WSDOT (Washington State Department of Transportation). 2011. I-405 Staff; New Barrier.

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1999 WAC Chapter 173-60. *Maximum Environmental Noise Levels*. Olympia, Washington, 1999.

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APPENDIX A NOISE MEASUREMENT AND MODEL VALIDATION

I Noise measurement and model validation

Ambient noise levels were measured for 15-minute periods at 96 locations near the study area to identify major noise sources in the study area, validate the noise model, and characterize the weekday background environmental noise levels. Measurement locations characterize the variety of noise conditions and represent other sensitive receptors near the proposed project.

The FHWA Traffic Noise Model (TNM) Version 2.5 computer model (FHWA, 2005) was used to predict Leq(h) traffic noise levels. The TNM is used to obtain precise estimates of noise levels at discrete points, by considering interactions between different noise sources and the effects of topographical features on the noise level. The TNM estimates the acoustic intensity at a receiver location, which is calculated from a series of straight-line roadway sections. Noise emissions from free-flowing traffic depend on the number of automobiles, medium trucks, and heavy trucks per hour; vehicular speed; and the reference noise emission levels of an individual vehicle. TNM also considers the effects of intervening barriers, topography, trees, and atmospheric absorption. Noise from sources other than traffic is not included. Therefore, when non-traffic noise such as aircraft noise is considerable in an area, TNM under-predicts the actual noise level. Because project effects only depend on traffic noise levels, under-predicting the total environmental noise level does not affect the study's findings. Noise monitoring results were used to validate the Existing Conditions TNM model.

The I-405 Team's noise specialists exported base maps and design files from MicroStation as DXF files and imported them into the TNM package. Major roadways, topographical features, building rows, and sensitive receptors from the MicroStation files were digitized into the TNM. Elevations were added from the 2-foot contour data. Elevations for planned improvements were taken from design profiles, proposed cross-sections, and proposed cut-and-fill limits.

Ninety-six measured sites were chosen to represent noise-sensitive sites in the study area. Fifteen-minute noise measurements were taken at each of these 96 sites to estimate the Leq(h), as shown in Exhibit A-1. The measured sites represent approximately 2,036 single-family residences and multifamily units, one church, one park, one hotel and two schools. For noise model calibration, traffic volumes were adjusted to match field counts during the time of day the noise measurement occurred. Additional topographical and geometrical detail was added to the TNM model until the model results at each of the 96 measurement sites were within 2 dBA of the measured levels for the model's validation run. Measured Leq values are rounded up at 0.5 dBA.

Exhibit A-1: Summary of noise measurements

Receptor Number	Location	Date	Time	Leq(h)
1	2820 116th Ave NE	September 28, 2006	1:40 PM	61.0
2	11600 Block NE 30th	September 28, 2006	2:25 PM	64.4
5	3305 115th Ave NE	October 6, 2004	1:30 PM	70.1
6	11601 NE 36th Pl	February 1, 2007	11:25 AM	66.4
7	11249 NE 36th Pl	October 6, 2004	1:05 PM	63.1
10	3880 113th Ave, Bellevue	October 6, 2004	12:35 PM	61.6
11	3948 112TH Ave, Bellevue	October 6, 2004	12:15 PM	61.0
12	11716 NE 41st St	February 10, 2005	10:45 AM	61.7
13	11704 NE 41st St	February 10, 2005	11:00 AM	65
14	4144 117th Ave NE	February 10, 2005	10:00 AM	64.1
16	4719 117th Pl NE	April 20, 2004	10:30 AM	63.8
17	11708 NE 48th Pl	April 20, 2004	10:30 AM	64.3
19	11329 NE 53rd St	February 1, 2007	10:45 AM	63.5
20	5421 116th Ave NE	April 20, 2004	11:15 AM	66.8
21	5338 114th Ave NE	April 22, 2004	11:50 AM	63.8
22	5310 114th Ave NE	April 22, 2004	12:05 PM	61.8
23	5325 113 Pl NE	April 22, 2004	12:05 PM	60.1
24	5545 116th Ave NE	April 20, 2004	11:15 AM	67.8
25	5806 114th Ave NE	April 22, 2004	11:00 AM	63.9
26	5807 114th Ave NE	April 22, 2004	11:00 AM	60.0
29	6111 116th Ave NE	April 20, 2004	12:40 PM	73.2
30	6116 114th Ave NE	April 22, 2004	10:30 AM	65.8
31	6119 114th Ave NE	April 22, 2004	10:30 AM	60.8
32	6321 116th Ave NE	April 20, 2004	12:45 PM	68.8
34	6509 114th Ave NE 2nd row	April 20, 2004	1:50 PM	62.4
36	6518 114th Ave NE	April 20, 2004	1:30 PM	64.4
37	11335 NE 67th St	April 20, 2004	1:25 PM	65.4
38	11405 NE 67th St	April 20, 2004	1:45 PM	61.4
41	11613 75th St	April 22, 2004	1:20 PM	64.2
42	11505 75th (or76th) Ave	April 26, 2004	11:15 AM	60.4
43	7610 115th Ave NE	April 26, 2004	11:15 AM	64.7
44	7560 116th Ave NE	April 22, 2004	1:40 PM	68.4
45	7560 116th Ave NE	April 22, 2004	1:25 PM	66.7

Receptor Number	Location	Date	Time	Leq(h)
49	8027 116th Ave NE	April 22, 2004	2:40 PM	62.9
51	8044 118th St	April 22, 2004	2:10 PM	68.2
52	8201 116th Ave NE	April 22, 2004	2:40 PM	62.6
53	Cul-de-sac 118th St	April 22, 2004	2:10 PM	74.3
55	11615 NE 90th St	April 27, 2004	10:15 AM	67.7
57	11625 NE 90th St	April 27, 2004	10:15 AM	63.4
58	11630 NE 90th St	April 27, 2004	10:00 AM	67.5
59	11637 NE 92nd St	January 31, 2007	11:00 AM	67.2
60	11638 NE 92nd St	January 31, 2007	11:00 AM	62.9
61	9224 Slater Ave NE	October 13, 2004	10:55 AM	62.0
62	9224 Slater Ave NE	October 13, 2004	10:55 AM	69.0
67	9818 117th Pl NE	April 27, 2004	10:50 AM	69.2
68	9817 117th Pl NE	January 31, 2007	12:00 PM	58.2
69	12045 NE 100th St	April 26, 2004	12:05 PM	59.6
70	12011 NE 100th St	April 26, 2004	12:05 PM	59.4
71	11623 NE 100th St	January 31, 2007	12:00 PM	61.4
72	11642 NE 100th St	October 13, 2004	10:00 AM	62.6
73	Park near NE 100th St	April 26, 2004	2:40 PM	61.2
74	10110 117th Pl NE	April 27, 2004	11:30 AM	61.1
76	10217 119th Pl	April 27, 2004	11:30 AM	63.4
77	10218 119th Ave	May 8, 2006	12:00 PM	66.0
78	11849 NE 105th Lane	April 27, 2004	1:30 PM	63.1
79	11846 NE 105th Lane	April 27, 2004	1:15 PM	61.5
79b	11850 105th St	May 8, 2006	11:15 AM	61.5
81	12101 NE 107th St	January 26, 2007	12:50 PM	68.2
84	12106 NE 108th St	April 26, 2004	12:50 PM	68.8
86	11007 112 Lane	April 27, 2004	12:00 PM	61.6
87	Country Estates Condos	May 17, 2004	11:00 AM	57.8
88	Country Estates Condos	May 17, 2004	11:00 AM	63.3
89	Hamilton Square	May 17, 2004	11:30 AM	58.2
90	Totem Lake Apartments	May 17, 2004	10:30 AM	61.6
92	11400 NE 132nd St	May 17, 2004	11:30 AM	65.9
93	13500 block 115th Ave NE 2nd row	May 17, 2004	1:15 PM	58.5
95	13500 block 115th Ave NE 1st row	May 17, 2004	1:15 PM	65.4

Receptor Number	Location	Date	Time	Leq(h)
99	13917 113th Ave NE	May 17, 2004	2:00 PM	56.7
101	13940 113th Ave NE	May 17, 2004	2:00 PM	61.4
103	14131 113th Ave NE	June 2, 2004	11:15 AM	59.8
104	14202 113th Ave NE	June 2, 2004	11:15 AM	60.5
105	11601 NE 143rd Pl	May 24, 2004	10:00 AM	58.6
107	11414 NE 145th St	June 2, 2004	10:00 AM	64.0
110	14733 114th Ave NE	June 2, 2004	10:55 AM	59.3
111	14720 114th Ave NE	June 2, 2004	10:55 AM	61.8
112	15005 116th Pl NE	May 24, 2004	10:20 AM	63.9
113	15018 116th Pl NE	May 24, 2004	10:20 AM	58.0
115	15600 116th Ave NE	May 24, 2004	11:00 AM	61.8
116	Bldg H 103	February 1, 2007	12:45 PM	71.1
117	Bldg G 103	May 24, 2004	1:45 PM	64.3
118	16125 Sonoma Villa (700s)	May 24, 2004	12:30 PM	68.3
119	16125 Sonoma Villa (1000s)	May 24, 2004	12:30 PM	56.0
120	11709 NE 166 Ct	May 24, 2004	1:20 PM	52.1
121	17128 117th Pl NE	May 24, 2004	1:00 PM	58.7
122	17123 117th Pl NE	May 24, 2004	1:00 PM	68.4
124	11330 E Riverside Drive	May 24, 2004	2:20 PM	56.5
125	19229 Ross Road	August 16, 2006	10:50 AM	66.0
128A	19702 112th Ave NE	August 16, 2006	12:14 PM	65.4
129	11027 NE 197th St	August 16, 2006	12:43 PM	62.3
130A	19701 112th Ave NE	August 16, 2006	11:42 AM	75.2
132	20329 112th Ave NE	August 16, 2006	1:06 PM	77.3
138	2331 233rd Pl SE	August 18, 2006	3:25 PM	69.3
141A	23116 27th Ave SE	August 18, 2006	2:46 PM	61.0
143A	23002 27th Ave SE	August 18, 2006	2:26 PM	59.8
145	23012 21st Ave SE	August 16, 2006	4:02 PM	62.1
146	23005 21st Ave SE	August 16, 2006	3:35 PM	75.5
148	22921 19th Drive SE	August 17, 2006	12:32 PM	61.6
149	2018A 228th St SE	August 18, 2006	1:54 PM	67.3
151A	22714 20th Drive SE	August 31, 2006	10:40 AM	70.1
152A	22714 20th Drive SE	August 31, 2006	10:45 AM	67.8
153	22740 20th Ave SE	August 16, 2006	11:03 AM	67.0

Receptor Number	Location	Date	Time	Leq(h)
154A	1630 228th St SE	August 16, 2006	2:45 PM	63.4
155	1732 225th Ave SE	August 31, 2006	11:25 AM	60.0
158	22429 18th Ave SE	August 31, 2006	11:25 AM	55.1
160	22122 17th Ave SE	August, 17, 2006	10:17 AM	56.9

II Description of measurement locations

The measurement represented by **Receptor 1** is located on a playground that is part of the Little School, an independent day school located in the South Bridle Trails area of Bellevue/Kirkland. The measurement was taken approximately 350 feet from the eastern edge of I-405. Receptor 1 is representative of one school.

The measurement represented by **Receptor 2** is located in the 11600 block of NE 30th Street. The measurement was taken approximately 250 feet from the eastern edge of I-405. Receptor 2 is representative of 6 residences.

The measurement represented by **Receptor 5** is located in the front of apartments at 3305 115th Avenue NE facing I-405 Southbound. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 5 is representative of 4 residences.

The measurement represented by **Receptor 6** is located in front of the residence at 11601 block of NE 36th Street. The measurement was taken approximately 250 feet from the eastern edge of I-405. Receptor 6 is representative of 4 residences.

The measurement represented by **Receptor 7** is located in the front of apartments at 11249 NE 36th Place facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 7 is representative of 8 residences.

The measurement represented by **Receptor 10** is located in the backyard of 3880 113th Avenue facing I-405 Southbound in the Yarrow Ridge neighborhood. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 10 is representative of 12 residences.

The measurement represented by **Receptor 11** is located in the backyard of 3948 112th Avenue facing I-405 Southbound in the Yarrow Ridge neighborhood. The measurement was taken approximately 300 feet from the western edge of I-405. Receptor 11 is representative of 9 residences.

The measurement represented by **Receptor 12** is located in the front yard of 11716 NE 41st Street facing I-405 Northbound. The measurement was taken approximately 700 feet from the eastern edge of I-405. Receptor 12 is representative of 5 residences.

The measurement represented by **Receptor 13** is located in the backyard of 11704 NE 41st Street facing I-405 Northbound. The measurement was taken approximately 500 feet from the eastern edge of I-405. Receptor 13 is representative of 24 residences.

The measurement represented by **Receptor 14** is located in the front yard of 4144 117th Avenue NE facing I-405 Northbound. The measurement was taken approximately 700 feet from the eastern edge of I-405. Receptor 14 is representative of 3 residences.

The measurement represented by **Receptor 16** is located in the backyard of 4719 117th Avenue NE facing I-405 Northbound. The measurement was taken approximately 400 feet from the eastern edge of I-405. Receptor 16 is representative of 8 residences.

The measurement represented by **Receptor 17** is located in the front yard of 11708 NE 48th Place facing I-405 Northbound. The measurement was taken approximately 600 feet from the eastern edge of I-405. Receptor 17 is representative of 12 residences.

The measurement represented by **Receptor 19** is located in front of the residence at 11329 NE 53rd Street. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 19 is representative of 6 residences.

The measurement represented by **Receptor 20** is located in the church parking lot of 5241 116th Avenue NE facing I-405 Northbound. The measurement was taken approximately 100 feet from the eastern edge of I-405. Receptor 20 is representative of 6 residences and 1 church.

The measurement represented by **Receptor 21** is located in the backyard of 5338 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405. Receptor 21 is representative of 20 residences.

The measurement represented by **Receptor 22** is located in the front yard of 5310 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 22 is representative of 16 residences.

The measurement represented by **Receptor 23** is located in the front of apartments at 5324 113th Place NE facing I-405 Southbound. The measurement was taken approximately 350 feet from the western edge of I-405. Receptor 23 is representative of 114 residences.

The measurement represented by **Receptor 24** is located in the backyard of 5545 116th Avenue NE facing I-405 Northbound. The measurement was taken approximately 50 feet from the eastern edge of I-405. Receptor 24 is representative of 16 residences.

The measurement represented by **Receptor 25** is located in the backyard of 5806 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405. Receptor 25 is representative of 10 residences.

The measurement represented by **Receptor 26** is located in the front yard of 5807 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 26 is representative of 6 residences.

The measurement represented by **Receptor 29** is located in the backyard of 6111 116th Avenue NE facing I-405 Northbound. The measurement was taken approximately 50 feet from the eastern edge of I-405. Receptor 29 is representative of 15 residences.

The measurement represented by **Receptor 30** is located in the backyard of 6116 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405. Receptor 30 is representative of 6 residences.

The measurement represented by **Receptor 31** is located in the front yard of 6119 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 31 is representative of 8 residences.

The measurement represented by **Receptor 32** is located in the backyard of 6321 116th Avenue NE facing I-405 Northbound. The measurement was taken approximately 50 feet from the eastern edge of I-405. Receptor 32 is representative of 8 residences.

The measurement represented by **Receptor 34** is located in the front yard of 6509 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 34 is representative of 10 residences.

The measurement represented by **Receptor 36** is located in the backyard of 6518 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 25 feet from the western edge of I-405 Southbound on Ramp from NE 70th Street. Receptor 36 is representative of 8 residences.

The measurement represented by **Receptor 37** is located in the backyard of 11335 NE 67th Street facing I-405 Southbound. The measurement was taken approximately 25 feet from the western edge of I-405 Southbound on Ramp from NE 70th Street. Receptor 37 is representative of 5 residences.

The measurement represented by **Receptor 38** is located in an apartment complex at 11405 NE 67th Street facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405 Southbound on Ramp from NE 70th Street. Receptor 38 is representative of 33 residences.

The measurement represented by **Receptor 41** is located in the front yard of 11613 75th Street facing I-405 Northbound. The measurement was taken approximately 200 feet from the eastern edge of I-405. Receptor 41 is representative of 12 residences.

The measurement represented by **Receptor 42** is located in the backyard of 11505 75th Street facing I-405 Southbound. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 42 is representative of 10 residences.

The measurement represented by **Receptor 43** is located in the front yard of 7610 115th Avenue NE facing I-405 Southbound. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 43 is representative of 24 residences.

The measurement represented by **Receptor 44** is located in the backyard of 7560 116th Avenue NE facing I-405 Northbound. The measurement was taken approximately 100 feet from the eastern edge of I-405. Receptor 44 is representative of 6 residences.

The measurement represented by **Receptor 45** is located in the front yard of 7560 116th Avenue NE facing I-405 Northbound. The measurement was taken approximately 200 feet from the eastern edge of I-405. Receptor 45 is representative of 8 residences.

The measurement represented by **Receptor 49** is located in the front yard of 8027 116th Avenue NE facing I-405 Southbound. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 49 is representative of 4 residences.

The measurement represented by **Receptor 51** is located in the front yard of 8044 118th Street facing I-405 Northbound. The measurement was taken approximately 200 feet from the eastern edge of I-405. Receptor 51 is representative of 5 residences.

The measurement represented by **Receptor 52** is located in the front yard of 8201 116th Avenue NE facing I-405 Southbound. The measurement was taken approximately 150 feet from the western edge of I-405. Receptor 52 is representative of 4 residences.

The measurement represented by **Receptor 53** is located in the cul-de-sac of 118th Street facing I-405 Northbound. The measurement was taken approximately 100 feet from the eastern edge of I-405. Receptor 53 is representative of 9 residences.

The measurement represented by **Receptor 55** is located in the front yard of 11615 NE 90th Street facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405. Receptor 55 is representative of 18 residences.

The measurement represented by **Receptor 57** is located in the front yard of 11625 NE 90th Street facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 57 is representative of 4 residences.

The measurement represented by **Receptor 58** is located in the backyard of 11630 NE 90th Street facing I-405 Southbound. The measurement was taken approximately 30 feet from the western edge of I-405. Receptor 58 is representative of 4 residences.

The measurement represented by **Receptor 59** is located in the front yard of 11637 NE 92nd Street facing I-405 Southbound. The measurement was taken approximately 20 feet from the western edge of I-405. Receptor 59 is representative of 3 residences.

The measurement represented by **Receptor 60** is located in the front yard of 11638 NE 92nd Street facing I-405 Southbound. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 60 is representative of 6 residences.

The measurements represented by **Receptors 61** and **62** are located in an apartment complex at 9224 Slater Avenue NE facing I-405 Northbound. The measurements at Receptors 61 and 62 were taken approximately 300 and 100 feet from the eastern edge of I-405 and are representative of 4 and 15 residences, respectively.

The measurement represented by **Receptor 67** is located in the backyard of 9818 117th Place NE facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405. Receptor 67 is representative of 11 residences.

The measurement represented by **Receptor 68** is located in the front yard of 9817 117th Place NE facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 68 is representative of 8 residences.

The measurement represented by **Receptor 69** is located in the front yard of 12045 NE 100th Street facing I-405 Northbound. The measurement was taken approximately 300 feet from the eastern edge of I-405. Receptor 69 is representative of 12 residences.

The measurement represented by **Receptor 70** is located in the front yard of 12011 NE 100th Street facing I-405 Northbound. The measurement was taken approximately 200 feet from the eastern edge of I-405. Receptor 70 is representative of 18 residences.

The measurement represented by **Receptor 71** is located in the front yard of 11623 NE 100th Street facing I-405 Southbound. The measurement was taken approximately 300 feet from the western edge of I-405. Receptor 71 is representative of 3 residences.

The measurement represented by **Receptor 72** is located in the front yard of 11642 NE 100th Street facing I-405 Southbound. The measurement was taken approximately 500 feet from the western edge of I-405. Receptor 72 is representative of 4 residences.

The measurement represented by **Receptor 73** is located in a park near NE 100th Street facing I-405 Southbound. The measurement was taken approximately 300 feet from the western edge of I-405. Receptor 73 is representative of a single park.

The measurement represented by **Receptor 74** is located in the backyard of 10110 117th Place NE facing I-405 Southbound. The measurement was taken approximately 600 feet from the western edge of I-405. Receptor 74 is representative of 8 residences.

The measurement represented by **Receptor 76** is located in the front yard of 10217 119th Place facing I-405 Southbound. The measurement was taken approximately 400 feet from the western edge of I-405. Receptor 76 is representative of 11 residences.

The measurement represented by **Receptor 77** is located in the backyard of 10218 19th Avenue facing I-405 Southbound. The measurement was taken approximately 150 feet from the western edge of I-405. Receptor 77 is representative of 6 residences.

The measurement represented by **Receptor 78** is located in the backyard of 11849 NE 105th Lane facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 78 is representative of 5 residences.

The measurement represented by **Receptor 79** is located in the front yard of 11846 NE 105th Lane facing I-405 Southbound. The measurement was taken approximately 250 feet from the western edge of I-405. Receptor 79 is representative of 10 residences.

The measurement represented by **Receptor 81** is located in the backyard of 12101 NE 107th Street facing I-405 Northbound. The measurement was taken approximately 100 feet from the eastern edge of I-405. Receptor 81 is representative of 4 residences.

The measurement represented by **Receptor 84** is located in the front yard of 12106 NE 108th Street facing I-405 Northbound. The measurement was taken approximately 100 feet from the eastern edge of I-405. Receptor 81 is representative of 7 residences.

The measurement represented by **Receptor 86** is located in the front yard of 11007 112th Lane facing I-405 Northbound. The measurement was taken approximately 300 feet from the eastern edge of I-405. Receptor 86 is representative of 20 residences.

The measurement represented by **Receptor 87** is located in the front yard of the first row of houses at the Country Estate Condos facing I-405 Southbound. The measurement was taken approximately 150 feet from the western edge of I-405. Receptor 87 is representative of 12 residences.

The measurement represented by **Receptor 88** is located in the front yard of the second row of houses at the Country Estate Condos facing I-405 Southbound. The measurement was taken approximately 300 feet from the western edge of I-405. Receptor 88 is representative of 16 residences.

The measurement represented by **Receptor 89** is located in the back yard of the Hamilton Square Apartments facing I-405 Northbound. The measurement was taken approximately 200 feet from the eastern edge of I-405. Receptor 89 is representative of 16 residences.

The measurement represented by **Receptor 90** is located in the backyard of Totem Lake Apartments facing I-405 Southbound. The measurement was taken approximately 400 feet from the western edge of I-405. Receptor 90 is representative of 10 residences.

The measurement represented by **Receptor 92** is located in the front yard of 11400 NE 132nd Street facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 92 is representative of 32 residences.

The measurement represented by **Receptor 93** is located in the front yard of the second row of the 13500 block of 115th Avenue NE facing I-405 Northbound. The measurement was taken approximately 150 feet from the eastern edge of I-405. Receptor 93 is representative of 28 residences.

The measurement represented by **Receptor 95** is located in the backyard of the first row of the 13500 block of 115th Avenue NE facing I-405 Northbound. The measurement was taken approximately 50 feet from the eastern edge of I-405. Receptor 95 is representative of 16 residences.

The measurement represented by **Receptor 99** is located in the front yard of 13917 113th Avenue NE facing I-405 Southbound. The measurement was taken approximately 250 feet from the western edge of I-405. Receptor 99 is representative of 11 residences.

The measurement represented by **Receptor 101** is located in the backyard of 13940 113th Avenue NE facing I-405 Southbound. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 101 is representative of 20 residences.

The measurement represented by **Receptor 103** is located in the backyard of 14131 113th Avenue NE facing I-405 Southbound. The measurement was taken approximately 100 feet from the western edge of I-405. Receptor 103 is representative of 21 residences.

The measurement represented by **Receptor 104** is located in the front yard of 14202 113th Avenue NE facing I-405 Southbound. The measurement was taken approximately 250 feet from the western edge of I-405. Receptor 104 is representative of 13 residences.

The measurement represented by **Receptor 105** is located in the backyard of 11601 NE 143rd Place facing I-405 Northbound. The measurement was taken approximately 500 feet from the eastern edge of I-405. Receptor 105 is representative of 28 residences.

The measurement represented by **Receptor 107** is located in the front yard of 11414 NE 145th Street facing I-405 Southbound. The measurement was taken approximately 250 feet from the western edge of I-405. Receptor 107 is representative of 8 residences.

The measurement represented by **Receptor 110** is located in the front yard of 14733 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 110 is representative of 6 residences.

The measurement represented by **Receptor 111** is located in the backyard of 14720 114th Avenue NE facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405. Receptor 111 is representative of 10 residences.

The measurement represented by **Receptor 112** is located in the backyard of 15005 116th Place NE facing I-405 Northbound. The measurement was taken approximately 150 feet from the eastern edge of I-405. Receptor 112 is representative of 17 residences.

The measurement represented by **Receptor 113** is located in the front yard of 15018 116th Place NE facing I-405 Northbound. The measurement was taken approximately 300 feet from the eastern edge of I-405. Receptor 113 is representative of 10 residences.

The measurement represented by **Receptor 115** is located in the front yard of 15600 116th Avenue NE facing I-405 Northbound. The measurement was taken approximately 150 feet from the eastern edge of I-405. Receptor 115 is representative of 16 residences.

The measurement represented by **Receptor 116** is located in the front yard of unit 103 Building H of the apartment complex facing I-405 Southbound. The measurement was taken approximately 50 feet from the western edge of I-405. Receptor 116 is representative of 16 residences.

The measurement represented by **Receptor 117** is located in the front yard of unit 103 Building G of the apartment complex facing I-405 Southbound. The measurement was taken approximately 150 feet from the western edge of I-405. Receptor 117 is representative of 8 residences.

The measurement represented by **Receptor 118** is located in the back yard of first row residences of 16125 Sonoma Villa facing I-405 Northbound. The measurement was taken approximately 150 feet from the eastern edge of I-405. Receptor 118 is representative of 46 residences.

The measurement represented by **Receptor 119** is located in the back yard of second row residences of 16125 Sonoma Villa facing I-405 Northbound. The measurement was taken approximately 300 feet from the eastern edge of I-405. Receptor 119 is representative of 18 residences.

The measurement represented by **Receptor 120** is located in the front yard of 11709 NE 166 Crescent facing I-405 Northbound. The measurement was taken approximately 400 feet from the eastern edge of I-405. Receptor 120 is representative of 12 residences.

The measurement represented by **Receptor 121** is located in the front yard of 17128 117th Place NE facing I-405 Northbound. The measurement was taken approximately 400 feet from the eastern edge of I-405. Receptor 121 is representative of 18 residences.

The measurement represented by **Receptor 122** is located in the back yard of 17123 117th Place NE facing I-405 Northbound. The measurement was taken approximately 200 feet from the eastern edge of I-405. Receptor 122 is representative of 8 residences.

The measurement represented by **Receptor 124** is located in the back yard of 11330 E Riverside Drive facing I-405 Southbound. The measurement was taken approximately 200 feet from the western edge of I-405. Receptor 124 is representative of 10 residences.

The measurement represented by **Receptor 125** is located in the front yard of 19229 Ross Road, which is elevated approximately 15 feet above Ross Road, facing I-405, the I-405 Southbound on-ramp from 195th Street and Beardsley Road. The measurement was taken approximately 650 feet from the western edge of I-405 and approximately 425 feet from the western edge of the I-405 southbound on-ramp from 195th Street. Receptor 125 is representative of 2 residences.

The measurement represented by **Receptor 128A** is located in the front of the southeast corner of the 19702 112th Street NE building of the North Creek Heights Apartment Homes. The measurement was taken facing I-405, approximately 450 feet from its western edge. Receptor 128A is in the second-row of the apartment homes and is representative of 12 ground floor second-row apartment residences.

The measurement represented by **Receptor 129** is located in the front yard of 19701 NE 197th Street, facing I-405. The front yard is elevated approximately 15 feet above NE 197th Street, which is in the line of sight of Receptor 129. the measurement was taken approximately 700 feet away from the western edge of I-405. Receptor 129 is representative of 3 residences.

The measurement represented by **Receptor 130A** is located in front of the 19701 112th Street NE building of the North Creek Heights Apartment Homes, facing I-405. The measurement is located on a plateau with 112th Street NE running along the base approximately 20 feet below. The measurement was taken approximately 215 feet from the western edge of I-405. Receptor 130A is representative of 15 ground floor apartment residences.

The measurement represented by **Receptor 132** is located on the edge of the pavement and the front yard property line of 20329 112th Avenue NE, facing I-405. The measurement was taken approximately 100 feet away from the western edge of I-405. Receptor 132 is representative of 2 front row residences.

The measurement represented by **Receptor 138** is located in the backyard of 2331 233rd Place SE, facing I-405. The measurement was taken approximately 75 feet from the western edge of I-405. Receptor 138 is representative of 4 residences.

The measurement represented by **Receptor 141A** is located on the slightly sloped grassy lawn at the northwestern corner of the 23116 27th Avenue SE building of the Stone Meadow Apartment Homes, facing I-405. The measurement was taken approximately 175 feet from the eastern edge of I-405. Receptor 141A is representative of 16 ground floor apartment residences.

The measurement represented by **Receptor 143A** is located on the slightly sloped grassy lawn at the southwestern corner of the 23002 27th Avenue SE building of the Stone Meadow Farms Apartment Homes, facing I-405. The measurement was taken approximately 175 feet from the eastern edge of I-405. Receptor 143A is representative of 16 ground floor apartment residences.

The measurement represented by **Receptor 145** is located on the western edge of the sidewalk lining 21st Avenue SE and the front yard property line of 23012 21st Avenue SE in the second-row of houses facing I-405. The measurement was taken approximately 275 feet from the western edge of I-405. Receptor 145 is representative of 11 residences.

The measurement represented by **Receptor 146** is located on the backyard elevated patio of 23005 21st Avenue SE, facing I-405. The measurement was taken approximately 125 feet from the western edge of I-405. Receptor 146 is representative of 6 residences.

The measurement represented by **Receptor 148** is located on the elevated backyard patio of 22921 19th Avenue SE, facing I-405 and an existing noise wall. The measurement was taken approximately 250 feet from the western edge of I-405. Receptor 148 is representative of 5 residences.

The measurement represented by **Receptor 149** is located on the backyard patio of 2018A 228th Street SE in a 12-town home complex, facing I-405. The measurement was taken approximately 100 feet from the eastern edge of I-405. Receptor 149 is representative of 8 town home residences.

The measurement represented by **Receptor 151A** is located on a slight grassy slope between the southern sidewalk lining 20th Avenue SE and the backside of building G of the Salmon Run at Perry Creek Apartment Homes located on 22174 20th Drive SE. 20th Avenue SE, 228th Street SE and I-405 are all within the line of sight of Receptor 151A. The measurement was taken approximately 125 feet from the eastern edge of I-405. Receptor 151A is representative of 3 ground floor apartment residences.

The measurement represented by **Receptor 152A** is located on a slight grassy slope between the southern sidewalk lining 20th Avenue SE and the backside of building G of the Salmon Run at Perry Creek Apartment Homes located on 22174 20th Drive SE. 20th Avenue SE, 228th Street SE and I-405 are all within the line of sight of Receptor 152A. The measurement was taken approximately 160 feet from the eastern edge of I-405. Receptor 152A is representative of 3 ground floor apartment residences.

The measurement represented by **Receptor 153** is located in the backyard of 22740 20th Avenue SE, facing I-405. The measurement was taken approximately 150 feet from the eastern edge of I-405. Receptor 153 is representative of 2 residences.

The measurement represented by **Receptor 154A** is located near the ground level balcony of the southeastern unit in the most southeastern building at Canyon Pointe Apartments, facing I-405 and 228th Street SE. The measurement was taken approximately 500 feet from the western edge of I-405. Receptor 154A is representative of 12 ground floor residences.

The measurement represented by **Receptor 155** is located in the backyard of 1732 225th Street SE, facing I-405 and an existing noise wall. The measurement was taken approximately 175 feet from the eastern edge of I-405. Receptor 155 is representative of 8 first-row residences.

The measurement represented by **Receptor 158** is located on the edge of the sidewalk and the southern corner of the front yard property line at 22429 18th Avenue SE, just north of where 18th Avenue SE turns into 225th Street SE. Receptor 158 is in the second-row of houses facing an existing noise wall and the eastern edge of I-405, which is approximately 325 feet from the measurement. Receptor 158 is representative of 8 second-row residences.

The measurement represented by **Receptor 160** is located on the southwest side of the engineer's office by the outdoor pool at Extended Stay Suites, facing I-405 and SR 527. The measurement was taken approximately 275 feet from the eastern edge of the I-405 northbound exit to SR 527. Receptor 160 is representative of one hotel.

III Validation results

Exhibit A-2: Measured noise levels and validation Traffic Noise Model (TNM) outputs

Receptor Number	Address	Measured Leq(h)	Modeled Leq(h)
1	2820 116th Ave NE	61.0	62
2	11600 Block NE 30th	64.4	66
5	3305 115th Ave NE	70.1	70
6	11601 NE 36th Pl	66.4	67
7	11249 NE 36th Pl	63.1	63
10	3880 113th Ave, Bellevue	61.6	62
11	3948 112TH Ave, Bellevue	61.0	60
16	4719 117th Pl NE	63.8	63
17	11708 NE 48th Pl	64.3	62
19	11329 NE 53rd St	63.5	64
20	5421 116th Ave NE	66.8	66
21	5338 114th Ave NE	63.8	63
22	5310 114th Ave NE	61.8	62
23	5325 113 Pl NE	60.1	60
24	5545 116th Ave NE	67.8	67
25	5806 114th Ave NE	63.9	63
26	5807 114th Ave NE	60.0	59
29	6111 116th Ave NE	73.2	73
30	6116 114th Ave NE	65.8	65
31	6119 114th Ave NE	60.8	59
32	6321 116th Ave NE	68.8	68
34	6509 114th Ave NE 2nd row	62.4	61
36	6518 114th Ave NE	64.4	63

Receptor Number	Address	Measured Leq(h)	Modeled Leq(h)
37	11335 NE 67th St	65.4	64
38	11405 NE 67th St	61.4	61
41	11613 75th St	64.2	64
42	11505 75th (or76th) Ave	60.4	61
43	7610 115th Ave NE	64.7	64
44	7560 116th Ave NE	68.4	68
45	7560 116th Ave NE	66.7	67
49	8027 116th Ave NE	62.9	62
51	8044 118th St	68.2	68
52	8201 116th Ave NE	62.6	62
53	Cul-de-sac 118th St	74.3	74
55	11615 NE 90th St	67.7	68
57	11625 NE 90th St	63.4	65
58	11630 NE 90th St	67.5	67
59	11637 NE 92nd St	67.2	66
60	11638 NE 92nd St	62.9	64
61	9224 Slater Ave NE	62.0	63
62	9224 Slater Ave NE	69.0	69
67	9818 117th Pl NE	69.2	69
68	9817 117th Pl NE	58.2	58
69	12045 NE 100th St	59.6	62
70	12011 NE 100th St	59.4	61
71	11623 NE 100th St	61.4	63
72	11642 NE 100th St	62.6	62
73	Park near NE 100th St	61.2	63
74	10110 117th Pl NE	61.1	60
76	10217 119th Pl	63.4	63
77	10218 119th Pl	66.0	66
78	11849 NE 105th Lane	63.1	62
79	11846 NE 105th Lane	61.5	60
81	12101 NE 107th St	64.1	64
84	12106 NE 108th St	68.8	70
86	11007 112 Lane	61.6	63
87	Country Estates Condos	58.8	61

Receptor Number	Address	Measured Leq(h)	Modeled Leq(h)
88	Country Estates Condos	63.3	63
89	Hamilton Square	58.2	59
90	Totem Lake Apartments	61.6	63
92	11400 NE 132nd St	65.9	67
93	13500 block 115th Ave NE 2nd row	58.5	60
95	13500 block 115th Ave NE 1st row	65.4	64
99	13917 113th Ave NE	56.7	58
101	13940 113th Ave NE	61.4	62
103	14131 113th Ave NE	59.8	62
104	14202 113th Ave NE	60.5	63
105	11601 NE 143rd Pl	58.6	61
107	11414 NE 145th St	64.0	64
110	14733 114th Ave NE	60.3	62
111	14720 114th Ave NE	61.8	63
112	15005 116th Pl NE	63.9	64
113	15018 116th Pl NE	58.0	61
115	15600 116th Ave NE	61.8	62
116	Bldg H 103	71.1	70
117	Bldg G 103	64.3	65
118	16125 Sonoma Villa (700s)	68.3	70
119	16125 Sonoma Villa (1000s)	56.0	56
120	11709 NE 166 Ct	52.1	51
121	17128 117th Pl NE	58.7	57
122	17123 117th Pl NE	68.4	67
124	11330 E Riverside Drive	56.5	58
125	19229 Ross Road	66.0	65
128A	19702 112th Ave NE	65.4	65
129	11027 NE 197th St	62.3	61
130A	19701 112th Ave NE	75.2	74
132	20329 112th Ave NE	77.3	77
138	2331 233rd Pl SE	69.3	69
141A	23116 27th Ave SE	61.0	62
143A	23002 27th Ave SE	59.8	60
145	23012 21st Ave SE	62.1	62

Receptor Number	Address	Measured Leq(h)	Modeled Leq(h)
146	23005 21st Ave SE	75.5	74
148	22921 19th Drive SE	61.6	60
149	2018A 228th St SE	67.3	67
151A	22714 20th Drive SE	70.1	70
152A	22714 20th Drive SE	67.8	69
153	22740 20th Ave SE	67.0	67
154A	1630 228th St SE	67.3	67
155	1732 225th Ave SE	60.0	59
158	22429 18th Ave SE	55.1	56
160	22122 17th Ave SE	56.9	57

Measured Leq noise levels are rounded up at 0.5. This rounding keeps Receptors 71, 87, 103, 104, 105, and 110 within the 2 dBA range for validation.

APPENDIX B NOISE BARRIER ANALYSIS

This section summarizes the evaluation of each noise barrier. The information presented in Appendix B details on why each barrier meets or does not meet the criteria for feasibility and reasonableness by describing the evaluation of multiple barrier heights. The information presented in Appendix B also provides background on how the optimal barrier height was selected for those barriers that were both feasible and reasonable. Refer to Section 6 for additional barrier evaluations.

WSDOT evaluates many factors to determine whether barriers will be feasible and/or reasonable. To be feasible, a barrier must be constructible in a location that achieves a noise reduction of at least 7 dBA Leq(h) at one or more receptors, and a reduction of at least 5 dBA at most first-row receptors. Once a noise barrier is found to be feasible, WSDOT evaluates whether the noise barrier is reasonable.

To be reasonable, the noise barrier's surface area may not exceed the sum of the allowed barrier surface area per household. Exhibit B-1 summarizes the allowed area for each receptor that will benefit from a reduction of at least 3 dBA. For noise levels above 74 dBA, the allowed barrier surface area per household increases by 70 square feet per dBA increase.

Exhibit B-1: Noise mitigation allowance

Design-Year Traffic Noise Decibel Level	Allowed Barrier Surface Area per Household in Square Feet*
66 dBA	700
67 dBA	770
68 dBA	837
69 dBA	905
70 dBA	973
71 dBA	1,041
72 dBA	1,109
73 dBA	1,176
74 dBA	1,244

Source: WAC, 1999

**For receptors that experience a reduction of at least 3 dBA*

Per WSDOT guidelines, the cost applied to all noise barriers is $53.40 per square foot. This cost represents a planning-level estimate. Once preliminary engineering of a noise barrier is completed, WSDOT's opinion of cost may differ considerably from the planning-level estimate depending on soil conditions, wall height, and integration into other structures.

The remainder of this section describes noise barriers where multiple barrier heights were evaluated. The titles include either a summary of the barriers feasibility and reasonableness, or the size of the proposed barrier.

I Upgrade barriers "UK"

All upgrade barriers have been designated as class "UK" barriers. The total area of an upgrade barrier is calculated by adding the original barrier area to the additional required area for the evaluated upgrade portion of the noise barrier.

Noise Barrier UK1

Upgrading the height of Noise Barrier UK1 to achieve noise levels below 66 dBA (4 feet higher) provides a 3 to 5-dBA reduction in I-405 traffic noise levels for the residences represented by Modeled Sites 2, 3 and 6, as shown below in Exhibit B-2. Noise Barrier UK1 is not reasonable because the barrier area required to achieve noise levels below 66 dBA is greater than the allowable barrier area.

Exhibit B-2: Noise Barrier UK1 - 24 feet tall

Modeled Site	Residences Represented	Leq(h)(dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
2	6	67	4,620	64	3
3	5	65	3,500	62	3
6	4	70	3,892	65	5
Existing Barrier Area (ft^2)			-	37,780	
Barrier Area for Replacement (ft^2)			-	15,112	
TOTAL Barrier Area for Replacement (ft^2)			12,012	15,112	
Planning-Level Cost ($)			$641,441	$806,980	

Noise Barriers UK2, UK3, UK4, UK5, UK7, UK8, UK9 and UK10

Noise Barriers UK2, UK3, UK4, UK5, UK7, UK8, UK9 and UK 10 are fully discussed in Section 6 (Measures to Avoid or Minimize Effects) of this discipline report. There is no additional information for these noise barriers.

Noise Barrier UK6

Upgrading the height of Noise Barrier UK6 to achieve noise levels below 66 dBA (10 feet higher) provides a 1 to 5-dBA reduction in I-405 traffic noise levels for the residences represented by Modeled Sites 41, 44, 45, and 47, as shown below in Exhibit B-3. Noise Barrier UK6 is not reasonable because the barrier area required to achieve noise levels below 66 dBA is over three times greater than the allowable barrier area.

Exhibit B-3: Noise Barrier UK6 - 22 feet tall

Modeled Site	Residences Represented	Leq(h)(dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
41	12	65	0	64	1
44	6	69	0	68	1
45	8	69	7,240	64	5
47	8	69	0	68	1
Existing Barrier Area (ft^2)			-	12,836	
Barrier Area for Replacement (ft^2)			-	9,460	
TOTAL Barrier Area for Replacement (ft^2)			7,240	9,460	
Planning-Level Cost ($)			$386,616	$505,164	

II New barriers "NK" and "NB"

New noise barriers have been designated as class "NK" for new barriers in Kirkland and "NB" for new barriers in Bothell. The total area of a new barrier is calculated by multiplying the length and height of the replacement barrier analyzed.

Noise Barriers NK1, NK2 and NK3

Noise Barriers NK1, NK2 and NK3 are fully discussed in Section 6 (Measures to Avoid or Minimize Effects) of this discipline report. There is no additional information for these noise barriers.

Noise Barrier NB1

Noise Barrier NB1 is not feasible because a 40-foot-tall and 500-foot long wall does not provide a 7-dBA reduction in I-405 traffic noise levels for any of the residences represented by Modeled Site 125, as shown below in Exhibit B-4.

Exhibit B-4: Noise Barrier NB1 - 40 feet tall

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier	Reduction (dBA)
125	2	66	2,800	63	3
Total Barrier Area (ft^2)			2,800	20,000	
Planning-Level Cost ($)			$149,520	$1,068,000	

*Planning-level cost is based on typical construction techniques and engineering for noise barriers with a maximum height of 24 feet.

Noise Barrier NB3

Barrier NB3 is approximately 2,551 feet long and varies between 12 to 24 feet tall with an average height of 20.9 feet. Noise Barrier NB3 meets WSDOT feasibility criteria by providing a

maximum reduction of 10 dBA for the 4 first-row residences represented by Modeled Sites R-2, R-3, R-6 and R-8 and achieving reductions ranging from 1 dBA to 8 dBA at 8 additional first-row receptors (out of 12 total). This is represented in Section 6 (Measures to Avoid or Minimize Effects) of this discipline report.

The average height of 20.9 feet is the recommended height for Noise Barrier NB3 because it provides reductions to noise levels below the NAC for 9 residences and remains within its allowable wall area (see Exhibit B-5).

Exhibit B-5: Noise Barrier NB3 Height 12 - 24 feet

Modeled Site	Residences Represented	Leq(h) (dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
R-1 North house	1	73	1,176	68	5
R-2 House near Apts	1	74	1,244	64	10
R-3 Bldg H GF	4	71	4,160	61	10
R-4 Bldg H SF	4	72	4,431	65	7
R-5 Bldg H TF	8	73	9,407	68	5
R-6 Bldg G GF	4	71	4,160	61	10
R-7 Bldg G SF	4	73	4,703	66	7
R-8 Bldg F GF	4	70	3,888	60	10
R-9 Bldg F SF	4	72	4,431	66	6
R-10 Bldg F TF	4	73	0	71	2
R-11 Bldg E GF	6	70	5,831	62	8
R-12 Bldg E SF	6	72	0	70	2
R-13 Bldg E TF	6	74	0	73	1
R-14 Bldg D GF	4	68	3,344	62	6
R-15 Bldg D SF	4	71	4,160	68	3
R-16 Bldg C GF	4	68	3,344	63	5
R-17 Bldg C SF	4	71		69	2
R-18 Bldg C TF	8	72		72	0
R-19 Pool	-	70		66	4
R-20	1	66	700	63	3
R-21	1	65		64	1
R-22	6	65	0	64	1
TOTAL Barrier Area (ft^2)			54,978	53,910	
Planning-Level Cost ($)			$2,935,830	$2,878,794	

Noise Barriers NB5, NB6 and NB8

Noise Barriers NB5, NB6 and NB8 are fully discussed in Section 6 (Measures to Avoid or Minimize Effects) of this discipline report. There is no additional information for these noise barriers.

Noise Barrier NB9

Noise Barrier NB9 is not feasible because a 24-foot-tall and 805-foot long wall does not provide a 7-dBA reduction in I-405 traffic noise levels for any of the 12 residences represented by Modeled Sites 149 and 150, as shown below in Exhibit B-6.

Exhibit B-6: Barrier NB9 - 24 feet tall

Modeled Site	Residences Represented	Leq(h)(dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
149	8	68	6,696	62	6
150	4	62	0	61	1
TOTAL Barrier Area (ft^2)			6,696	19,320	
Planning-Level Cost ($)			$357,566	$1,031,688	

Noise Barrier NB10

Noise Barrier NB10 is not feasible because a 32-foot-tall and 710-foot long wall does not provide a 7-dBA reduction in I-405 traffic noise levels for any of the 20 residences represented by Modeled Sites 151A, 151B, 151C, 152A, 152B, 152C and 153, as shown below in Exhibit B-7.

Exhibit B-7: Barrier NB10 - 32 feet tall

Modeled Site	Residences Represented	Leq(h)(dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
151A	3	72	0	71	1
151B	3	74	0	72	2
151C	3	76	0	75	1
152A	3	70	0	68	2
152B	3	72	0	70	2
152C	3	74	0	72	2
153	2	69	1,810	65	4
TOTAL Barrier Area (ft^2)			1,810	22,720	
Planning-Level Cost ($)			$96,654	$1,213,248	

Noise Barrier NB11

Noise Barrier NB11 is not feasible because a 40-foot-tall and 1295-foot long wall does not provide a 7-dBA reduction in I-405 traffic noise levels for the 36 residences represented by Modeled Sites 154A, 154B and 154C, as shown below in Exhibit B-8.

Exhibit B-8: Barrier NB9 - 40 feet tall

Modeled Site	Residences Represented	Leq(h)(dBA)	Allowed Barrier Area (ft^2)	Noise Level with Barrier (dBA)	Reduction (dBA)
154A	12	65	8,400	60	5
154B	12	68	10,044	62	5
154C	12	69	10,860	63	6
TOTAL Barrier Area (ft^2)			29,304	51,800	
Planning-Level Cost ($)			$1,564,834	$2,766,120	

III Recommended noise barrier data

Exhibit B-9: Noise barrier data

Barrier	Coordinates and Elevations			
	X (ft)	Y (ft)	Bottom of Wall Elevation	Top of Wall Elevation
Noise Barrier NK1	1,308,761.60	255,914.90	226	244
	1,308,765.40	255,944.40	227	245
	1,308,770.10	255,982.00	226	246
	1,308,776.80	256,033.30	228	248
	1,308,782.90	256,081.30	232	248
	1,308,787.80	256,123.50	238	252
	1,308,792.50	256,160.00	242	256
	1,308,797.80	256,202.80	242	256
	1,308,803.60	256,253.20	241	255
	1,308,809.80	256,303.30	240	254
	1,308,816.50	256,368.50	242	256
	1,308,829.50	256,467.40	240	254
	1,308,841.20	256,566.00	238	252
	1,308,828.00	256,664.70	240	254
	1,308,840.60	256,767.40	239	253

Barrier	Coordinates and Elevations			
	X (ft)	Y (ft)	Bottom of Wall Elevation	Top of Wall Elevation
	1,308,852.90	256,866.90	239	253
	1,308,865.20	256,966.80	234	248
	1,308,871.90	257,023.10	229	243
	1,308,877.20	257,068.30	230	244
	1,308,883.00	257,110.60	232	246
	1,308,889.60	257,166.60	226	240
	1,308,901.40	257,266.40	218	232
	1,308,914.20	257,368.50	212	228
	1,308,918.10	257,397.60	210	228
	1,308,929.10	257,487.10	206	222
	1,308,931.80	257,511.80	204	218
	1,308,934.50	257,536.40	205	215
	1,308,937.20	257,561.10	205	
Noise Barrier NB3	1,306,612.00	283,483.40	60	74
	1,306,614.00	283,509.20	60	76
	1,306,615.00	283,533.90	60	76
	1,306,616.00	283,558.70	60	78
	1,306,604.50	283,559.30	62	82
	1,306,605.40	283,592.40	62	84
	1,306,606.30	283,625.60	62	84
	1,306,607.00	283,675.60	62	84
	1,306,607.90	283,725.60	62	84
	1,306,608.80	283,775.60	63	87
	1,306,609.50	283,825.50	64	88
	1,306,610.30	283,875.50	65	89
	1,306,611.10	283,925.50	66	90
	1,306,612.00	283,975.50	67	91
	1,306,612.80	284,025.50	68	92

Barrier	Coordinates and Elevations			
	X (ft)	Y (ft)	Bottom of Wall Elevation	Top of Wall Elevation
	1,306,613.60	284,075.50	69	93
	1,306,614.50	284,125.50	70	94
	1,306,615.30	284,175.50	70	94
	1,306,616.10	284,225.50	70	94
	1,306,617.00	284,275.50	70	94
	1,306,617.80	284,325.50	70	94
	1,306,618.50	284,375.50	70	94
	1,306,619.40	284,425.50	70	94
	1,306,620.10	284,475.40	70	94
	1,306,620.90	284,525.40	70	94
	1,306,621.60	284,575.40	70	94
	1,306,622.40	284,625.40	70	94
	1,306,623.10	284,675.40	71	95
	1,306,623.90	284,725.40	72	96
	1,306,624.60	284,775.40	72	96
	1,306,625.40	284,825.40	72	96
	1,306,626.10	284,875.40	72.5	96.5
	1,306,626.90	284,925.40	73	97
	1,306,639.30	284,928.60	69	93
	1,306,636.60	284,962.00	70	94
	1,306,630.60	285,011.70	70	94
	1,306,624.60	285,061.30	70	94
	1,306,618.60	285,110.90	70	92
	1,306,612.60	285,160.60	70	92
	1,306,606.80	285,210.30	70	88
	1,306,600.80	285,259.90	70	88
	1,306,594.80	285,309.50	70	88
	1,306,588.80	285,359.20	70	88
	1,306,582.80	285,408.80	70	88

Barrier	Coordinates and Elevations			
	X (ft)	Y (ft)	Bottom of Wall Elevation	Top of Wall Elevation
	1,306,576.80	285,458.40	70	88
	1,306,570.80	285,508.10	70.5	88.5
	1,306,564.80	285,557.70	71	89
	1,306,558.50	285,607.30	71.5	87.5
	1,306,552.10	285,656.90	72	88
	1,306,543.90	285,706.20	73	89
	1,306,535.60	285,755.50	74	90
	1,306,525.00	285,804.40	74.5	90.5
	1,306,514.40	285,853.30	75	91
	1,306,504.50	285,902.30	75.5	89.5
	1,306,494.80	285,951.30	76	90
	1,306,489.40	285,975.70	76.5	88.5

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APPENDIX C REEVALUATED NOISE BARRIERS

Noise barriers UK10, NK1and, NB3 were reevaluated in early 2011 either because of changes in land uses that affected the number of noise-sensitive properties, or because of changes in the design or location of the proposed noise barriers since the noise analyses were conducted in 2007. See *Section 6 Measures to Avoid or Minimize Effects* for the findings and recommendations for these noise barriers.

This appendix contains maps of the proposed noise barriers and modeled noise receptors for UK10, NK1, and NB3. These maps are extracted from the two Michael Minor & Associates reports listed in the *Section 8 References*.

Exhibit C-1: Noise Barrier NK1 – Reevaluation

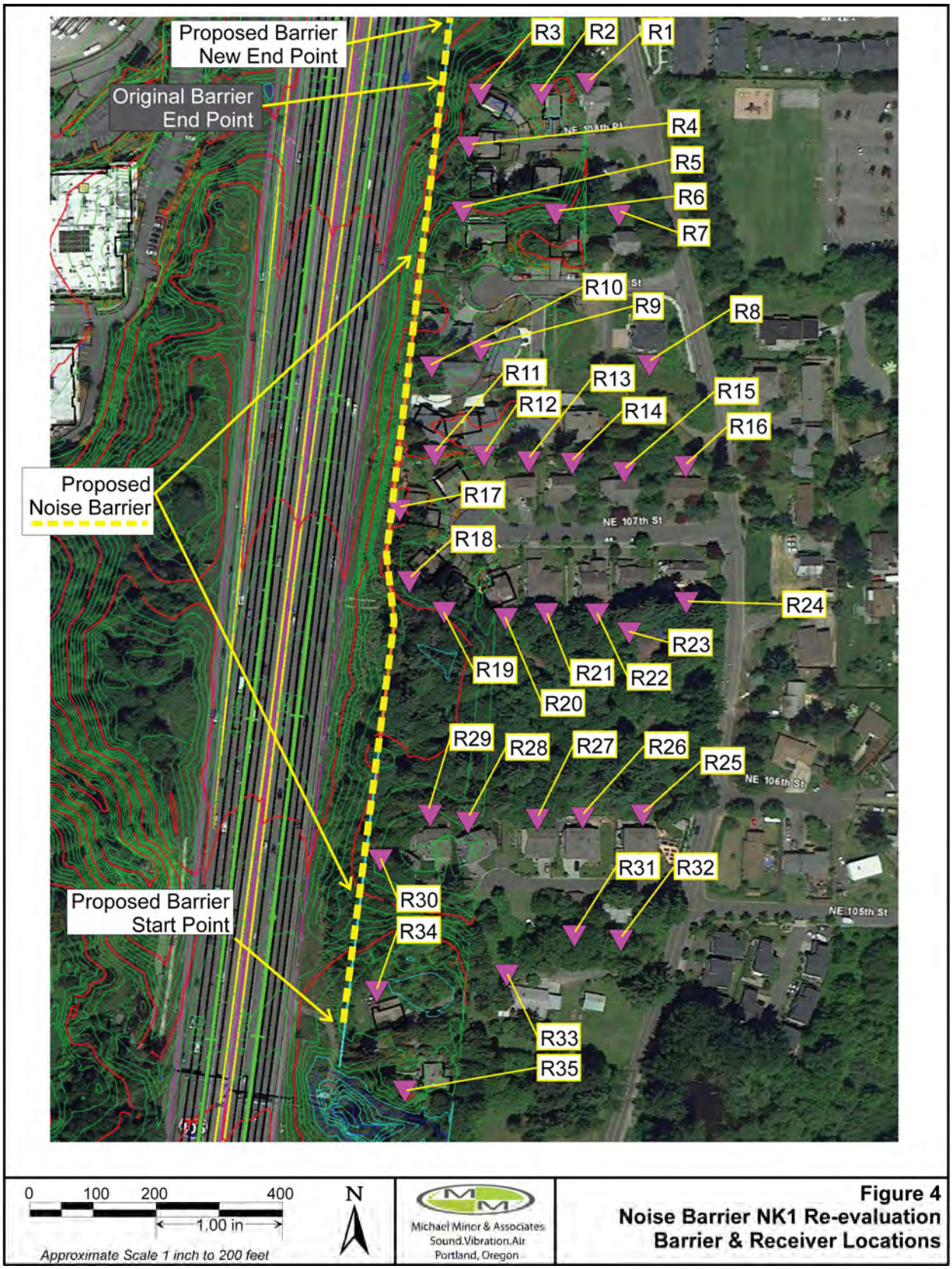

Exhibit C-2: Noise Barrier UK10 – Reevaluation barrier and receptor locations

Exhibit C-3: Noise Barrier NB3 – Reevaluation