City Center Access Project

Federal Way, King County, Washington

Noise Impact Analysis

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City of Federal Way

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EXECUTIVE SUMMARY

The following noise study was prepared as required by the Federal Highway Administration (FHWA) and the Washington State Department of Transportation (WSDOT) for work on a Federal-Aid Highway that meets FHWA definition of a Type 1 Project. The project includes a new interchange with roundabouts and a new bridge over I-5 at S 324th Street. Other elements include new and improved access for vehicles on S 324th Street and S 320th Street to and from I-5, bike lanes and improved pedestrian access. The project also includes transit improvements are also planned along South 320th Street.

To facilitate the noise study on-site inspections, background noise readings, and traffic counts were performed and used to validate the FHWA noise models used for this analysis. Measured noise levels ranged from 53 to 77 dBA Leq. For reference, traffic noise impacts occur at 66 dBA Leq, or if noise levels increase by more than 10 dB when compared to the existing conditions. Traffic on local roads and Interstate 5 (I-5) were the primary noise sources at most monitoring locations, with additional noise coming from aircraft departing and arriving from SeaTac Airport.

Under the existing conditions (year 2017), the modeled PM peak traffic hour noise levels were modeled for 81 representative receiver locations. Overall, noise levels from the traffic noise model ranged from 46 to 75 dBA. However, because the lowest measured noise level was 53 dBA Leq, the measured level was used at locations where the modeled noise levels were below 53 dBA Leq. Based on the modeling, 61 residences had noise levels meeting the WSDOT Noise Abatement Criteria (NAC). The same 81 noise modeling locations used to model the existing conditions were modeled for the No-Build Alternative PM peak hour traffic conditions. The future No-Build conditions assume the Federal Way Link light rail extension (FWLE) will be completed. The FWLE would install several large retaining walls on the west side of I-5, providing substantial noise reduction in the area north of the S 320th Street and west of I-5, along 28th Avenue S. This results in a reduction in the number of impacts, from 61 to 17 and noise levels ranging from 53 to 73 dBA Leq.

Noise levels under the Build alternative range from 53 to 75 dBA Leq and noise impacts were identified at multiple residences, a group home and a park. As part of the Build alternative, an existing noise wall and noise berm combination along the west side of I-5 protecting Belmor Park, along with residences and a park north of South 336th Street, would be removed. The removal of this wall results in noise impacts at 29 of the 51 representative receivers in this area. Additional impacts were identified along South 320th Street near Military Road S. Impacts also continued to occur at the shared outdoor use at a group home off 28th Avenue S, just north of the S 317th Street roundabout.

As required by WSDOT and FHWA, noise abatement was considered for all three areas and all abatement was found to be reasonable and feasible and will be studied for inclusion with project construction. A noise wall 185 feet long, with heights ranging from 6 to 8 feet is proposed for the group home and provides mitigation for 3 first row residences with noise

reductions of 13 dB. A second noise wall is proposed along the south side of S 320th Street near Military Road S. This wall provides noise reductions of 6 to 9 dB at nine impacted residences. The wall is 687 feet long, includes pedestrian access and ranges in heights from 5 to 8 feet. An impact was identified at the exterior of Fire Station 64, however, noise levels in the sleeping areas would be within the criteria.

An additional noise wall is also recommended to replace the noise wall and berm removed as part of the project, east of Belmor Park and south of S 324th Street. Two options were proposed for this area and both include noise walls up to 18 feet tall. The traffic noise abatement package would include approximately 3800 feet of noise wall on the west side of I-5. It is also possible that some of the old noise wall could be salvaged reducing the new wall requirements by approximately 300 feet in length. Due to the likely possibility of a new Sound Transit light rail alignment through this same area, further consideration will be necessary before a final package can be finalized. However, it is clear that a new noise wall will meet WSDOT requirements and be constructed as part of the project.

Report Layout

The report provides a complete project description in Section 1, with analysis requirements and an introduction to traffic noise in Sections 2 and 3. Section 4 provides a summary of all applicable regulations. Section 5 discusses the affected environment and Section 6 has noise monitoring results and noise model validation. Sections 7 through 9 provide the results of the modeling process and Section 10 summarized the modeled noise levels and identifies noise impacts. Section 11 is the noise abatement and section 12 covers construction noise.

Appendix A provides report references and Appendix B has a detailed introduction to acoustics. Traffic data used in this analysis is provided in Appendix C, and photos of the noise monitoring sites are in Appendix D. Additional information on shared exterior uses and parks along with a map of the Belmor Park are in Appendices E and F.

Conclusion

Construction of the Federal Way City Center Project will result in a large number of noise impacts due to the removal of an existing noise wall and berm. However, with the recommended noise abatement measures, or similar abatement packages, it is clear that the majority of noise impact could be mitigated. In fact, with traffic noise abatement, there are no new residual noise impacts and the only residences with noise levels above the traffic noise abatement criteria are multi-family homes located on South 336th Street, near the I-5 overpass. Due to the S 336th Street overpass, traffic on S 336th Street, and driveways for local access, no reasonable or feasible noise abatement was available for the noise impacts in this area.

Additional coordination with Sound Transit may be necessary depending on the location of the proposed south light rail maintenance base. Construction of a maintenance base south of the City Center Project would include a new light rail alignment along the west side of the adjacent to the ramps from S 324th Street to southbound I-5. In this case, a package that

combines noise mitigation for I-5 traffic and link light rail operations using a pair of noise barriers may be the best solution. Although this project is not yet permitted it will likely be planned and permitted before the City Center Project and therefore is considered in this analysis. Limited discussion on this is included under Noise Abatement in section 11.

1. INTRODUCTION AND PROJECT DESCRIPTION

This noise technical report was prepared for City of Federal Way to document the potential traffic noise impacts and traffic noise abatement associated with the City Center Access Project, hereafter referred to as "the project." The project will provide improved multimodal mobility and access for regional and local trips while protecting the interstate system by providing congestion relief along S 320th Street and expanded multimodal facilities across Interstate 5 (I-5). The project will consist of the following project elements:

- Modification of the S 320th Street interchange by adding braided ramps and access at S 324th Street.
- Construction of a new two-lane bridge over I-5 at S 324th Street with an extension of S 324th Street from 23rd Avenue S to Weyerhaeuser Way S, and a widened S 324th Street from SR 99 to 23rd Avenue S.
- Improvements to S 320th Street west of I-5 to add HOV lanes.
- Nonmotorized improvements along 23rd Avenue S, S 320th Street, and S 324th Street.

1.1. Project Purpose

The City of Federal Way initiated the City Center Access Project to determine what transportation system changes are needed to preserve future mobility in the City Center. The Federal Way City Center Core is designated as one of 29 regional growth centers identified in the PSRC's Vision 2040. The purpose of the Federal Way City Center Access project is to improve the economic vitality of the City Center and to improve the quality of life for people who work, play, and live in the City by increasing multimodal mobility and access to regional and local trips while protecting the integrity of the interstate system. Access and mobility are limited by congestion issues along S 320th Street between Pacific Highway S and Military Road, including to and from I-5, and by the lack of multimodal facilities across Interstate 5 (I-5).

1.2. Existing Conditions and Project Need

The City Center is served by S 320th Street and is bounded by S 312th Street on the north, S 324th Street on the south, I-5 on the east, and 11th Place S and 14th Avenue S on the west. The City's Comprehensive Plan identifies development of the City Center to include a mix of uses, such as the Performing Arts and Events Center, a public park, and a mix of high-density residential, commercial, office, educational, and civic uses. Access between I-5 and the land uses surrounding the City Center is primarily via the S 320th Street interchange with direct HOV access at the S 317th Street interchange that serves the Federal Way Transit Center. Sound Transit's Link Light Rail Transit (LRT) is being extended to Federal Way, with a station opening in the City Center currently scheduled in 2024. LRT is planned for extension to Tacoma in 2030.

1.3. Proposed Project

The S 324th Street Interchange Alternative 2I (Grade Separated Ramps + Roundabouts at S 324th Street) was identified as the alternative that best meets the Purpose and Need of the project. Alternative 2I was recommended to the Federal Way City Council in November 2019 based on the results of alternatives analysis screening. The City Council agreed to move forward with Alternative 2I.

Below is a description of the elements included in the Preferred Alternative (the project). This description is based on the preliminary design and is subject to change as design progresses.

1.3.1. Access Modifications

The project includes a modified interchange at S 320th Street, with braided ramps and new access at S 324th Street. There are no new gore points along I-5, but the existing gore points north and south of the S 320th Street interchange will be relocated. The northbound off-ramp gore will move 2,100 feet south, the northbound on-ramp gore will move 150 feet north, the southbound off-ramp gore will move 550 feet north, and the southbound on-ramp gore will move 2,200 feet south.

All on-ramps from S 320th Street and S 324th Street will be metered and will not include HOV bypasses.

1.3.2. South 324th Street Roadway Improvements

The project includes a new two-lane bridge along S 324th Street, crossing I-5 and roundabouts at the ramp terminals. Both ramp terminals will have single-lane roundabouts with slip lanes in the northwest and southwest quadrants of the S 324th Street/I-5 southbound ramps intersection.

West of the new S 324th Street interchange, S 324th Street will be five lanes from SR 99 to 23rd Avenue S and four lanes from 23rd Avenue S to I-5 southbound ramps. There will be a two-lane roundabout at the S 324th Street/23rd Avenue S intersection. The project also includes intersection improvements at S 324th Street/SR 99 that will help manage westbound queues from the new interchange, including an additional southbound left-turn lane and an additional northbound left-turn lane.

The roundabout design at the S 324th Street/23rd Avenue S intersection has been reviewed by Sound Transit and Bonneville Power Administration (BPA). BPA's transmission tower relocations surrounding the intersection will be designed to accommodate the proposed Sound Transit TDLE and City Center Access project improvements.

East of the new S 324th Street interchange, S 324th Street will be three lanes from I-5 northbound ramps to Weyerhaeuser Way S, with a single-lane roundabout at S 324th Street/Weyerhaeuser Way S that will include a relocated access to the boat ramp.

1.3.3. South 320th Street Roadway Improvements

There are currently HOV lanes in both directions along S 320th Street between SR 99 and 20th Avenue S.

The project includes HOV lanes on S 320th Street in both directions between 20th Avenue S and Military Road to support future bus rapid transit (BRT) along S 320th Street included in the King County Metro long-range plan. Between 20th Avenue S and I-5 southbound ramps, a general-purpose lane in each direction will be converted to an HOV lane. Crossing I-5 between I-5 southbound ramps and I-5 northbound ramps, the S 320th Street bridge will be widened to include a new HOV lane in both directions and a lengthened left-turn lane for the I-5 southbound on-ramp. Between I-5 and Military Road, S 320th Street will be widened to accommodate the added HOV lanes.

1.3.4. Nonmotorized Improvements

The project includes nonmotorized improvements on both S 324th Street and S 320th Street. Between SR 99 and Weyerhaeuser Way, there will be a shared-use path on the north side of S 324th Street and a sidewalk on the south side of S 324th Street. There is potential for the shared-use path to connect to the BPA Trail in the future. A shared-use path on the west side of 23rd Avenue S between S 324th Street and S 320th Street is included. The S 320th Street bridge crossing I-5 will have a sidewalk on the north and south side. Between I-5 northbound ramps and Military Road S, there will be a sidewalk on the north and south side .

1.3.5. Design Compatibility

The project design accommodates the Sound Transit Federal Way Link Extension (FWLE) and Tacoma Dome Link Extension (TDLE) projects, BPA transmission tower relocations, and the future widening of I-5. The Sound Transit FWLE and TDLE WSDOT Compatibility Reports establish the WSDOT Compatibility Line, which the City Center Access project needs to adhere to. The roadway design incorporates input received from the City, WSDOT, and Sound Transit during design coordination meetings and submittal reviews.

Other design constraints and considerations include avoiding impacts to the existing bog, east of I-5, and the Tacoma Water transmission main, which crosses through the project area on 320th St, I-5 ramps and mainline, 23rd Ave, SR 99, and parallels 324th St. The project design minimizes impacts to the BP 14” Olympic Pipeline located on the east side of I-5, King County Metro Park and Ride, and adjacent development. Other utilities within the project area include Lakehaven Water and Sewer District, Comcast, CenturyLink, Puget Sound Energy Electric and Gas, and Zayo Communications.

1.3.6. Project phasing

The design and construction of the City Center Access improvements will likely need to be phased due to funding limitations. The following table summarizes the anticipated project phases . The noise analysis assumes all phases are complete and all potential project related noise impacts are identified. Project mitigation is designed assuming all phases of the Project are constructed.

Anticipated Project Phasing

	Local Street Improvements and Connections	Ramp and Interchange Improvements
Phase 1	• Construct new S 324th St between 23rd Ave S and I-5 southbound ramp intersections • Improve S 324th St and SR 99 intersection with added turn lanes	• Construct/revise I-5 southbound off ramps to S 320th St and S 324th St • Construct/revise on ramps from S 320th St and S 324th St to I-5 southbound
Phase 2	• Widen S 324th St between SR 99 and 23rd Ave S • Construct new S 324th St from I-5 southbound ramp intersection to Weyerhaeuser Way, including S 324th St bridge and Weyerhaeuser Way intersection	• Construct I-5 northbound off ramp to S 324th St • Construct portion of I-5 northbound off ramp to S 320th St
Phase 3A	• Replace S 320th St bridge over I-5 • Widen S 320th St from I-5 southbound ramp intersection to Military Rd • Restripe S 320th St to provide BAT lanes from SR 99 to southbound ramp intersection	• Reconstruct S 320th St loop ramp to I-5 northbound • Construct the remaining portion of I-5 northbound off ramp to S 320th St
Phase 3B	• Local improvements associated with this project are substantially complete	• Realign the I-5 northbound on ramp from S 320th St • Construct the I-5 northbound on ramp from S 324th St

Figure 1. Study Area with Proposed Improvements

Preliminary Design Improvements

1. Interchange at S 324th and modified interchange at 320th with braided ramps. All I-5 on-ramps will be metered.
2. 2-lane bridge along S 324th crossing I-5. Shared-use path on north side with potential future connection to BPA Trail. Sidewalk on south side.
3. Single-lane roundabouts at the ramp terminals with slip lanes in the northwest and southwest quadrants of S 324th/I-5 SB Ramps.
4. Additional SB left-turn lane and additional NB left-turn lane at S 324th/SR 99 to manage westbound queues from new interchange.
5. 5 lanes along S 324th from SR 99 to 23rd S. Shared-use path on north side and sidewalk on south side.
6. 2-lane roundabout at S 324th/23rd S.
7. 4 lanes along S 324th from 23rd S to I-5 SB Ramps.
8. 3 lanes along S 324th from I-5 NB Ramps to Weyerhauser. A shared -use path on the north side and sidewalk on the south side.
9. Single-lane roundabout at S 324th/Weyerhauser.
10. Road widening for HOV lanes to support future BRT from SR 99 to Military. Eastbound HOV will drop into existing right turn lane at Military.
11. Sidewalk on north and south side of S 320th bridge.
12. No improvements to S 320th St/SR 99 and S 320th/Military intersections.
13. Shared use path.

2. ANALYSIS REQUIREMENT

A Traffic Noise Analysis is required whenever a Type I project is federally funded or requires FHWA approval. A Type I project is a project that includes construction of a new highway or roadway, an increase in the number of traffic lanes, a substantial realignment (horizontal or vertical) of an existing highway, or significant changes to the existing topography around roadways. The proposed Project would include a new roadway, with a grade-separated roundabout bridge, and grade-separated ramps and, therefore, meets the requirements for a detailed noise impact and abatement analysis.

3. INTRODUCTION TO ACOUSTICS

Sound is any change in air pressure that the human ear can detect, from barely perceptible sounds to sound levels that can cause hearing damage. These changes in air pressure are translated to sound in the human ear. The greater the change in air pressure, the louder the sound. For example, a quiet whisper in the library creates a relatively small change in the room air pressure, whereas air pressure changes are much greater in the front row of a rock concert. When sounds are unwanted or disturbing, we classify it as noise.

Noise is measured in terms of sound pressure level. It is expressed in decibels (dB), which are defined as 10 Log(P^2/P^2ref), where "P" is the root-mean-square (RMS) sound pressure and "P_{ref}" is the reference RMS sound pressure of 2 x 10^5 Newtons per square meter.

The number of fluctuation cycles or pressure waves per second of a particular sound is the frequency of the sound. The human ear is less sensitive to higher and lower frequencies than to mid-range frequencies. Therefore, sound level meters used to measure environmental noise generally incorporate a weighing system that filters out higher and lower frequencies in a manner similar to the human ear. This system produces noise measurements that approximate the normal human perception of noise. Measurements made with this weighing system are termed "A-weighted" and are specified as "dBA" readings.

Several noise descriptors are used that take into account the variability of noise over time. The minimum noise level during a measurement period is denoted Lmin. The maximum noise levels (Lmax) that occur during an event, such as the passing of a heavy truck or the flyover of an airplane, can be useful indicators of interference with speech or sleep.

The equivalent sound level (Leq) is the level of a constant sound for a specified period of time that has the same sound energy as an actual fluctuating noise over the same period of time. It is an energy average sound level.

In summary, the noise level descriptors are defined as follows:

Symbol	Description
Leq	The average noise level (energy basis)
Lmin	The minimum noise level
Lmax	The maximum noise level

Noise levels decrease with distance from a noise source. For each doubling of the distance from a point source (such as an engine), noise levels decrease by 6 dBA because of the geometric divergence of the sound waves. Excess noise reduction (attenuation) can be provided by vegetation, terrain, and atmospheric effects that block or absorb noise.

For traffic noise, the level of noise reduction depends on the type of descriptor in use. The Leq noise level from a line source (such as a road) will decrease by 3 dBA for each doubling of distance (3 dB / DD) because of geometric divergence alone. However, the Lmax from individual vehicles on the road will decrease by 6 dBA / DD. In simple terms, the maximum noise levels (Lmax) decrease more rapidly with distance from the road than do the average noise levels (Leq).

It is important to understand how humans perceive noise and changes in noise levels. Subjectively, a 10-dBA change in noise level is judged by most people to be approximately a twofold change in loudness (e.g., an increase from 50 dBA to 60 dBA causes the loudness to double). A 3-dBA increase is a barely perceptible increase. Therefore, if traffic noise levels increase by 1 to 2 dB, the majority of people may not even notice the change in noise levels.

It is also important to understand the compatibility with land use based on area noise levels. For example, noise levels at night in a quiet rural area are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Daytime noise levels in a noisy urban area are frequently as high as 70 to 80 dBA.

Areas with PM peak hour traffic noise levels below 50 dBA Leq are typically found in quiet bedroom communities (rural and suburban) that are far from interstate or state highways, major arterial roadways, and urban areas. PM peak hour traffic noise levels from 50 dBA to 60 dBA Leq are typically found in quiet bedroom communities with arterial roadways nearby and primarily passenger traffic accessing the area (little or no truck traffic). Communities with traffic noise levels of 60 dBA to 67 dBA Leq are typically closer to urban areas and / or major arterial roadways where some truck traffic is present.

A more detailed section about acoustics, with mathematical formulas, is provided in Appendix B.

4. METHODOLOGY

This section provides a summary of the methods used for the Traffic Noise Analysis. In general, the methods follow the WSDOT policy and procedures for a traffic noise study as

published in the 2020 WSDOT Policy. Reference policies, manuals and guides used for this report are provided in Appendix A.

4.1. Regulatory Setting and Impact Criteria

The FHWA traffic noise impact criteria, against which the Project traffic noise levels are evaluated, are taken from Title 23 of the Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise. The FHWA criterion applicable for residences is an exterior hourly equivalent sound level (Leq) that approaches or exceeds 67 dBA. The exterior criterion for places of worship, schools, recreational uses, and similar areas is also 67 dBA Leq. The criterion applicable for hotels, motels, offices, restaurants / bars, and other developed lands is an exterior Leq that approaches or exceeds 72 dBA. There are no FHWA traffic noise impact criteria for retail facilities, industrial, warehousing, undeveloped lands that are not permitted for development, or construction noise. No traffic noise analysis is required for those uses for which no criteria exist. See Table 1 for the list of categories and impact criteria if one exists.

WSDOT considers a predicted sound level of 1 dBA below the NAC as sufficient to satisfy the condition of "approach," or approaching the NAC, required by FHWA for all land use categories. For example, where the NAC is 67 dBA for outdoor use at a residence, a noise level of 66 dBA is considered an impact. Receivers are also considered impacted when the worst hourly traffic noise is predicted to increase 10 dBA ("substantial increase") or more between the Existing and Build conditions. Impacts at places of worship, schools, and recreational areas (Category C properties) also occur at 66 dBA or higher in Washington. Hotel / motel, office building, and restaurant / bar impacts (Category E properties) occur at 71 dBA or higher. Table 1 summarizes the FHWA and the WSDOT traffic noise abatement criteria.

Table 1. Noise Abatement Criteria (NAC) by Land Use Category				
Activity Category	**Activity Criteria in hourly Leq (dBA)**		**Evaluation Location**	**Activity Description**
	FHWA NAC	**WSDOT NAC**		
A	57	56	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[1]	67	66	Exterior	Residential (single and multi-family units)
C[1]	67	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E[1]	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	--	--	--	Undeveloped lands that are not permitted

Notes:
1. Includes undeveloped lands permitted for this activity category

The primary FHWA category applicable to this analysis are FHWA Categories B, C, and E, which includes exterior noise levels at residential land uses (B), schools and parks (C), and hotels (E). Under FHWA policy, the noise impact criteria is applicable to frequently used exterior areas, for example, a back-yard deck or patio at a residence or along a path or viewing area at a park.

4.2. State Regulations and Local Noise Ordinances

Project operation and construction would take place in the city of Federal Way, located in King County. Both King County and Federal Way have their own local noise ordinances that would be applicable to the Project, in addition to the Washington Administrative Code.

The Washington Administrative Code (WAC) noise control regulation. WAC Chapter 173-60, Maximum Environmental Noise Levels, establishes maximum noise levels permissible in identified environments, including residential, commercial, industrial, and construction areas. However, WAC 173-60-110 provides that:

> *The department conceives the function of noise abatement and control to be primarily the role of local government and intends actively to encourage local government to adopt measures for noise abatement and control. Wherever such measures are made effective and are being actively enforced, the department does not intend to engage directly in enforcement activities.*

Hence, the rules governing noise levels that are contained in WAC Chapter 173-60 do not apply when a local noise ordinance is in effect. Therefore, the local noise ordinances would be applicable to the project construction. Since Federal Way has adopted portions of the WAC for purposes of their own noise ordinances, those WAC regulations are described below.

4.2.1.1. WAC Stationary Land Use Noise Criteria

For stationary land uses with noises originating from outside public roadways and rights-of-way, WAC Chapter 173-60 (Maximum Environmental Noise Levels) establishes three classes of property usage, called Environmental Designation for Noise Abatement (EDNA), and maximum allowable noise levels for each, as shown in Table 2.

Table 2. Washington State Noise Control Regulation

District of Source of Noise	District of Receiver of Noise (Maximum Allowable Sound Level in dBA[a])		
	Residential (EDNA Class A)	Commercial (EDNA Class B)	Industrial (EDNA Class C)
Residential (EDNA Class A)	55	57	60
Commercial (EDNA Class B)	57	60	65
Industrial (EDNA Class C)	60	65	70

[a] Between 10:00 p.m. and 7:00 a.m., the levels given above are reduced by 10 dBA for residential receiving property.

For example, the noise caused by a commercial property must be less than 57 dBA at the closest residential property line. From 10:00 p.m. to 7:00 a.m., the allowable maximum sound levels shown in Table 2 are reduced by 10 dBA at such a residential property line. The WAC contains short-term exemptions to the property line noise standards in Table 2 based

on the minutes per hour that the noise limit is exceeded. These exceedances are outlined in Table 3.

Table 3. Washington State - Exemptions for Short-Term Noise Exceedance	
Minutes Per Hour	**Adjustment to Maximum Sound Level**
15	+5 dBA
5	+10 dBA
1.5	+15 dBA

4.2.1.2. WAC Construction Noise Criteria

Generally, construction activities can be performed within the limits of the WAC regulations if the work is conducted during normal daytime hours (7:00 a.m. to 10:00 p.m.). If construction is performed during the nighttime, the contractor must still meet the WAC noise-level requirements presented in Table 2 or get a noise variance from the governing jurisdiction.

The WAC also contains a set of construction-specific allowable noise-level limits. These construction noise regulations are organized by type of noise and include general construction equipment; impulse equipment, such as jackhammers and pile-drivers; haul trucks; and safety alarms, such as back-up beepers.

Haul Truck Noise Criteria

Maximum permissible sound levels for haul trucks on public roadways are limited to 86 dBA for speeds of 35 miles per hour (mph) or less, and 90 dBA for speeds over 35 mph when measured at 50 ft (WAC, Chapter 173-62). For trucks operating within staging areas, the general construction equipment noise criteria would be used to determine compliance.

Noise Related to Back-up Alarms

Sounds created by back-up alarms are exempt from the allowable noise-level limits, except between 10:00 p.m. and 7:00 a.m. when "beep-beep" back-up alarms are essentially prohibited by the WAC in urban areas. During nighttime hours, other forms of back-up safety measures would need to be used and could include the use of smart back-up alarms, which automatically adjust the alarm level based on the background level, or switching off back-up alarms and replacing them with spotters. This criterion is included because, just like noise from construction activities, noise from back-up beepers would exceed the WAC nighttime criteria, even with the allowable exceedance, at distances up to 800 ft or more from the construction site.

4.2.1.3. King County

A small part of the project area, north of S 320th Street and east of South King County Fire Station 64, is located in unincorporated King County. Construction in this part of the project area would be required to follow the King County code. In Section 12.86.110 of its Code,

King County adopts by reference the maximum environmental noise levels set forth in the State rules, including those in WAC Chapter 173-60, but also includes noise levels for rural areas. However, rural levels are not applicable to this study. In addition, in Section 12.86.520, the County exempts sounds originating from heavy construction equipment between 7:00 a.m. and 7:00 p.m. on weekdays and 9:00 a.m. and 7:00 p.m. on weekends; sounds originating from impact type of construction equipment from 8:00 a.m. and 5:00 p.m. on weekdays and 9:00 a.m. and 5:00 p.m. on weekends; and all other sounds originating from construction sites and activities between 7:00 a.m. and 10:00 p.m. on weekdays and 9:00 a.m. and 8:00 p.m. on weekends. In Section 12.86.500, warning horns or sirens attached to motor vehicles are also exempt (King County Code Section 12.86.010).

4.2.1.4. City of Federal Way

For the majority of the project area, which is within the city of Federal Way, the local noise control ordinance would be applicable. The noise code is found in Section 7.10.050 of the city code, where the City of Federal Way adopts by reference the maximum environmental noise levels set forth in the State rules, including those in WAC Chapter 173-60. In addition, in Section 7.10.020, the City exempts sounds originating from construction sites and activities between 7:00 a.m. and 10:00 p.m. on weekdays and 9:00 a.m. and 8:00 p.m. on weekends. Warning horns or sirens attached to motor vehicles are also exempt (City of Federal Way Revised Code Section 7.10.020(1)).

4.3. Analysis and Modeling Procedures

The methodology used for a Type I traffic noise analysis is defined in the 2020 WSDOT Policy. A summary of the policy follows.

Projected traffic noise level conditions were calculated using the FHWA Traffic Noise Model (TNM). Noise emission levels used in the model were nationwide averages for automobiles, medium trucks, and heavy trucks provided by the FHWA and built into the TNM. Model input included traffic volumes, and vehicle type and speed information. The area was evaluated for noise-reducing effects of first-row structures and residences, existing outbuildings, roadway depressions, bridges and topography. Actual roadway width and average pavement type were used for existing and future conditions. The effects of signalized intersections and stop signs were also included where appropriate.

Traffic volumes and vehicle class percentages used for the modeled roadways were provided by Parametrix traffic engineers. The traffic data used for the analysis is provided in Appendix C. Vehicle speeds used are the current or proposed posted speeds. The PM peak traffic hour on weekdays has the highest total traffic volumes and, therefore, was used throughout the analysis to ensure the worst-case noise levels were predicted. Also, the traffic data assumes other planned and permitted roadway projects, including the FWLE Project, are completed, which could impact the transmission of noise.

The base model (existing conditions) has all acoustical elements of traffic noise in the area. This would include I-5, S 320th Street, highway 99, and other local roadways. Input to the

build model would also include the new bridge structure and safety features of the proposed S324th Street bridge over I-5. Traffic noise on elevated structures are slightly louder than the same traffic conditions for an at-grade roadway. The added noise is due to the bridge structure radiating noise caused by the vibration of vehicles on the structure, expansion joints used to allow for expansion and contraction of the structure, and the fact that noise from the bridge will have little to no ground effects, which also help to reduce traffic noise levels.

While bridges are louder in general, the traffic safety barriers along the side of the bridge can help reduce noise. These safety barriers, at a minimum typical height of 32 inches, were included in the noise modeling and any potential noise reduction is included in this study. Barriers like these already exist on I-5 over S 336th Street, on the S 320th Street bridge over I-5, and also on other parts of I-5 in the study area. Reductions of up to 3 dB or more can be achieved in some cases. The actual reduction will depend on the height of the bridge, height of the safety barriers and type of traffic, with the highest reduction from passenger vehicles and the lowest reduction from heavy trucks due to the low frequency noise and higher exhaust stack height.

4.4. Noise Study Area

The study area for traffic noise studies must be large enough to account for and include all potential noise sensitive properties within the Project construction limits that could experience traffic noise impacts with the proposed Project. For this Project, the study area includes all noise sensitive properties from approximately 2500 feet north of the I-5 overpass at S 320th Street at the north end of the Project corridor to the I-5 overpass at S 336th Place and Weyerhaeuser Way S at the south end. The study area also includes noise sensitive properties west of the intersection of S 320th Street and Military Road S at the east end of the corridor to the intersection of S320th Street and Pacific Highway S at the west end.

5. AFFECTED ENVIRONMENT

This section provides a summary of the land use in the project area, including planned and permitted developments and project related displacements.

5.1. Existing Land Uses

Land use in the Project area includes residences, commercial, recreational, hotels, churches, and undeveloped lands. The majority of sensitive land uses are west of I-5 and include single and multi-family residences, a residential group home, the Belmor Park mobile homes community, Calvary Lutheran Church, Cedar Grove Park, three hotels, and the Career Academy at Truman High School Campus. Sensitive land uses east of I-5 include Fire Station 64 and residences. Undeveloped lands east of I-5 are privately owned commercial properties. While there are number of visible walking trails in wooded areas west of Weyerhaeuser Way S they are on private property and not considered noise sensitive and, therefore, not included in this analysis.

Figure 1 is a of the Project corridor with the proposed design elements including roadway improvements. Land uses are shown on Figure 2 and Figure 3.

5.2. Zoning and Comprehensive Land Use Plan Design

A study of the Project area indicated that it is a mix of high intensity to low intensity commercial, residential, and developed lands. The FWLE is currently in final design, and construction of the trackway and retaining walls would have an effect on noise levels for residences located north of S 317th Street and east of 28th Avenue S. Because the alignment transitions from an at-grade to an elevated alignment, a large retaining wall would be constructed to the north of the S 317th Street roundabout, providing physical shielding from I-5 for many residences in this area. The most current FWLE design drawings were obtained from Sound Transit and used in this analysis (Noise and Vibration Technical Report, Sound Transit, 2021). More information on the proposed retaining walls and potential noise reduction are provided later in this report. There are no other planned or approved land use change or projects that would affect this noise study.

5.3. Planned and Permitted Projects

There are currently no planned or permitted projects that would affect this noise study. However, there are several residences located north of S320th Street, near the I-5 on ramps that have been removed in preparation for the construction of a construction vehicle dealership.

5.4. Displacements Due to Project Construction

There are partial displacements under the Project. Some of the residential manufactured home spaces at the northeast corner of Belmor Park will be removed to accommodate the new roundabout and structure over I-5. These units are at the corner of Winged Foot Way and Oakland Hills Boulevard, and the removal of these structures could potentially affect noise levels at residences that were shielded by the displaced structures.

In addition to the displacement in the Belmor Park, an earth berm and noise wall currently protecting residences along the west side of I-5 between S324th Street and S 336th Street would be removed for the widening of I-5 to accommodate the new ramps. It is possible that a portion of the wall could be left during construction, reducing the need for noise abatement in the area. However, because the part that could be left also includes an earth berm, two options for noise abatement were considered, one with the remaining wall portion, and a second assuming an entirely new noise wall, from S 324th Street continuously to the S 336th Street overpass. The location of the wall and berm to be removed are shown in Figure 3.

No other displacements are planned that would affect the transmission of noise, noise impacts, or noise abatement measures.

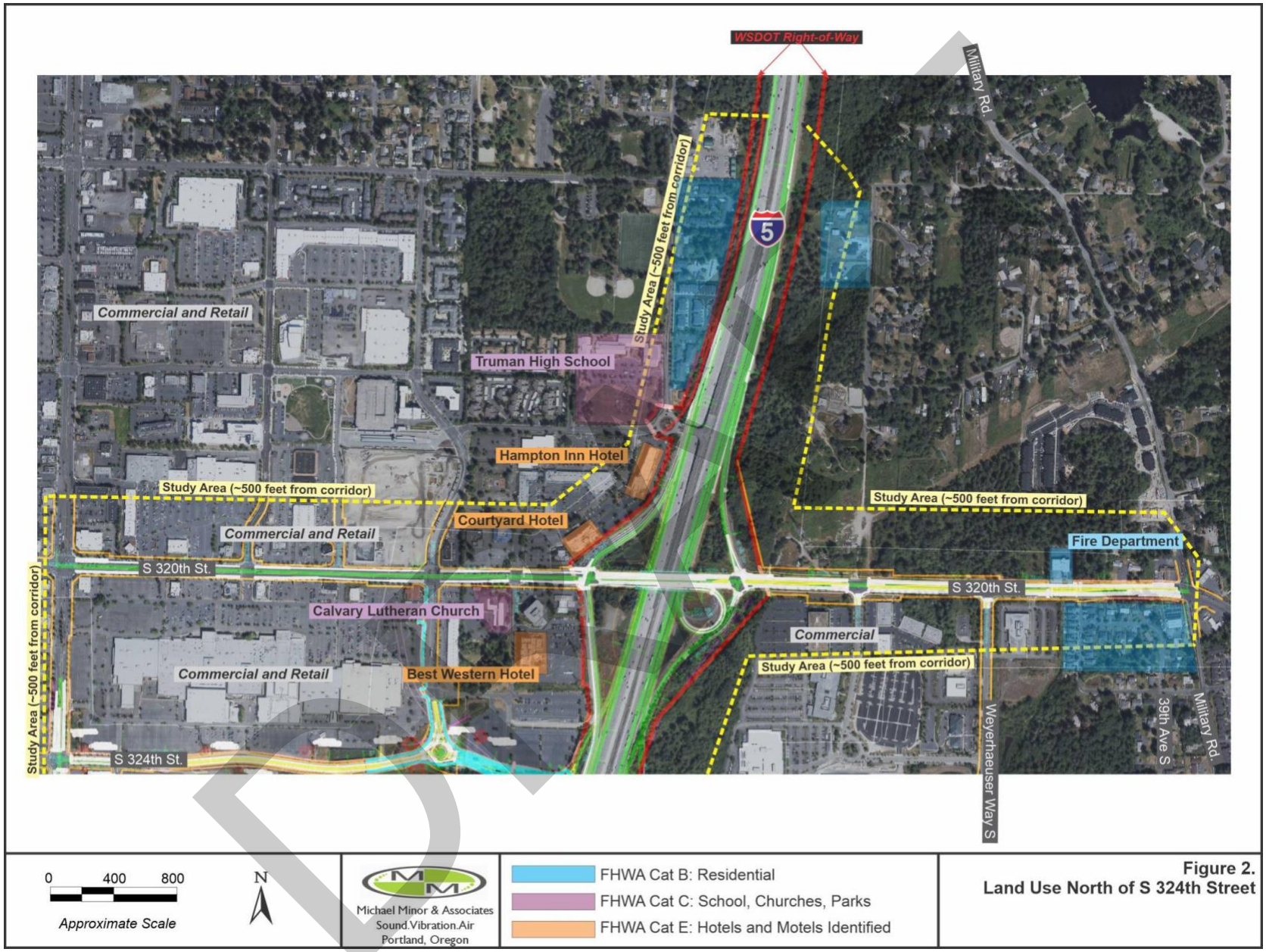


Figure 2.
Land Use North of S 324th Street

Figure 3.
Land Use South of S 324th Street

5.5. Noise Monitoring

On-site noise monitoring was performed at 6 locations throughout the Project study area. Figure 4 and Figure 5 provide an overview of the monitoring locations denoted M-1 through M-6 within the Project area. Detailed monitoring slides are provided in Appendix D.

The monitoring was performed on January 29, 2021. Noise measurements were taken in accordance with methods provided in the 2020 WSDOT Policy and in accordance with the American National Standards Institute (ANSI) procedures for community noise measurements. The equipment used for noise monitoring were Bruel & Kjaer Type 2238 Sound Level Meters. All meters were calibrated prior to and after the measurement period using a Bruel & Kjaer Type 4231 Sound Level Calibrator. Calibration varied by less than 0.1 dB during the measurement period. Complete system calibration is performed on an annual basis and the system meets or exceeds the requirements for an ANSI Type 1 noise measurement system.

All measurements taken included one-second Leq, Lmax and Lmin. Bruel & Kjaer Type 7820 Evaluation Software was used for data post-processing and calculations of the hour Leq noise levels presented in this report. All data is transfer and analysis is computer controlled and transferred using a computer interface, preventing any data editing or corruption.

5.5.1. Measurement Results

Noise Monitoring sites were located within the public right-of-way and on private properties. Noise levels ranged from 53.1 to 77.6 dBA Leq. Traffic on local roads and I-5were the primary noise sources at most of the monitoring locations, with additional noise coming from aircraft departing and arriving from SeaTac Airport. Secondary noise sources included typical neighborhood activities such as dogs barking, lawn maintenance, and children playing. The highest traffic noise measurement of 77.6 dBA Leq occurred at M-6 located adjacent to I-5. The lowest noise measurement of 53.1 was recorded at M-3 located at 3809 S 325th Street, which, as described later, was taken to assist in establishing the existing conditions in an area not near any major roadways. Table 4 provides a summary of the measured noise levels. A discussion of the measurements for specific areas follows the table.

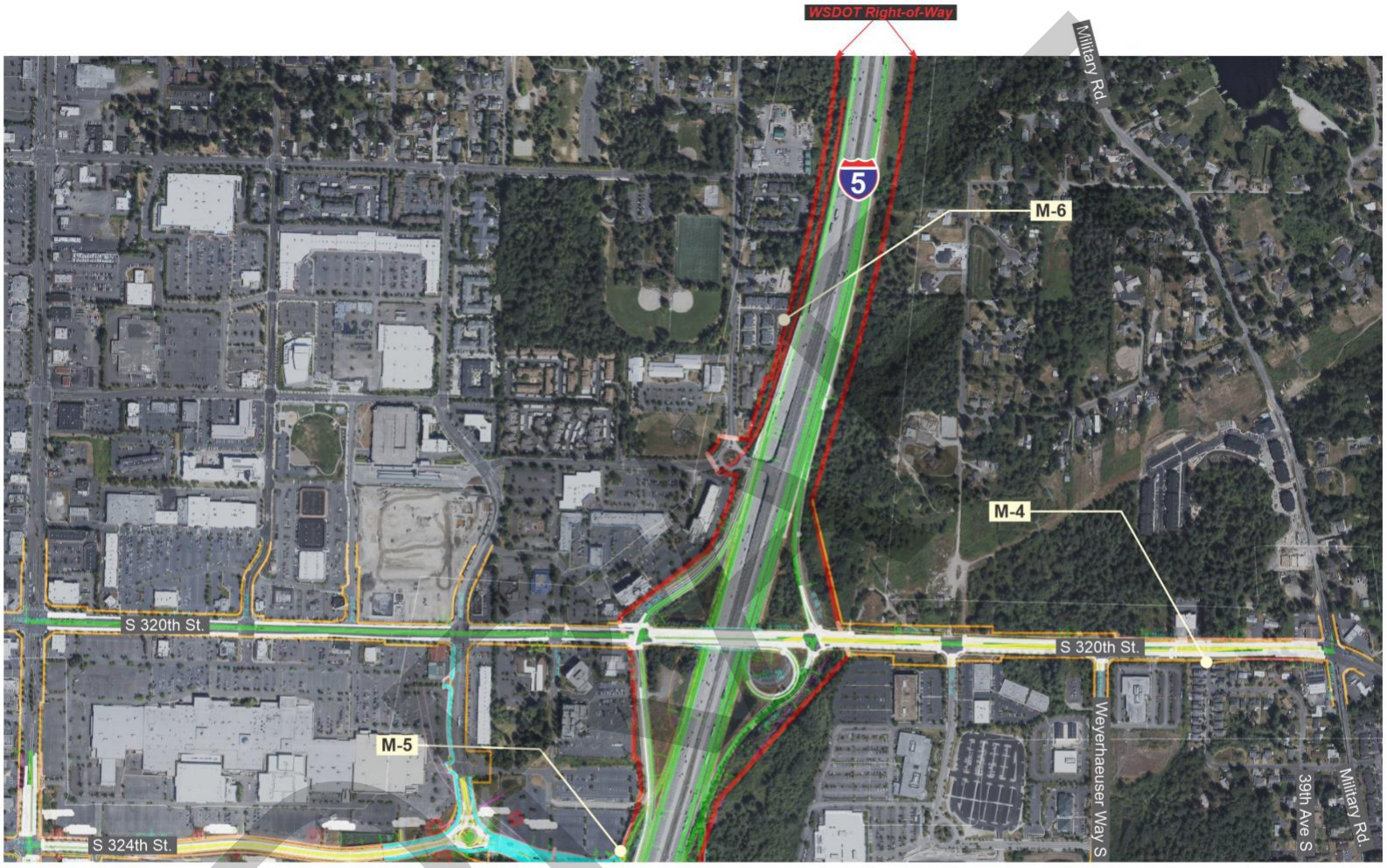


Figure 4.
Noise Monitoring and Traffic Count Site North of S 324th Street.

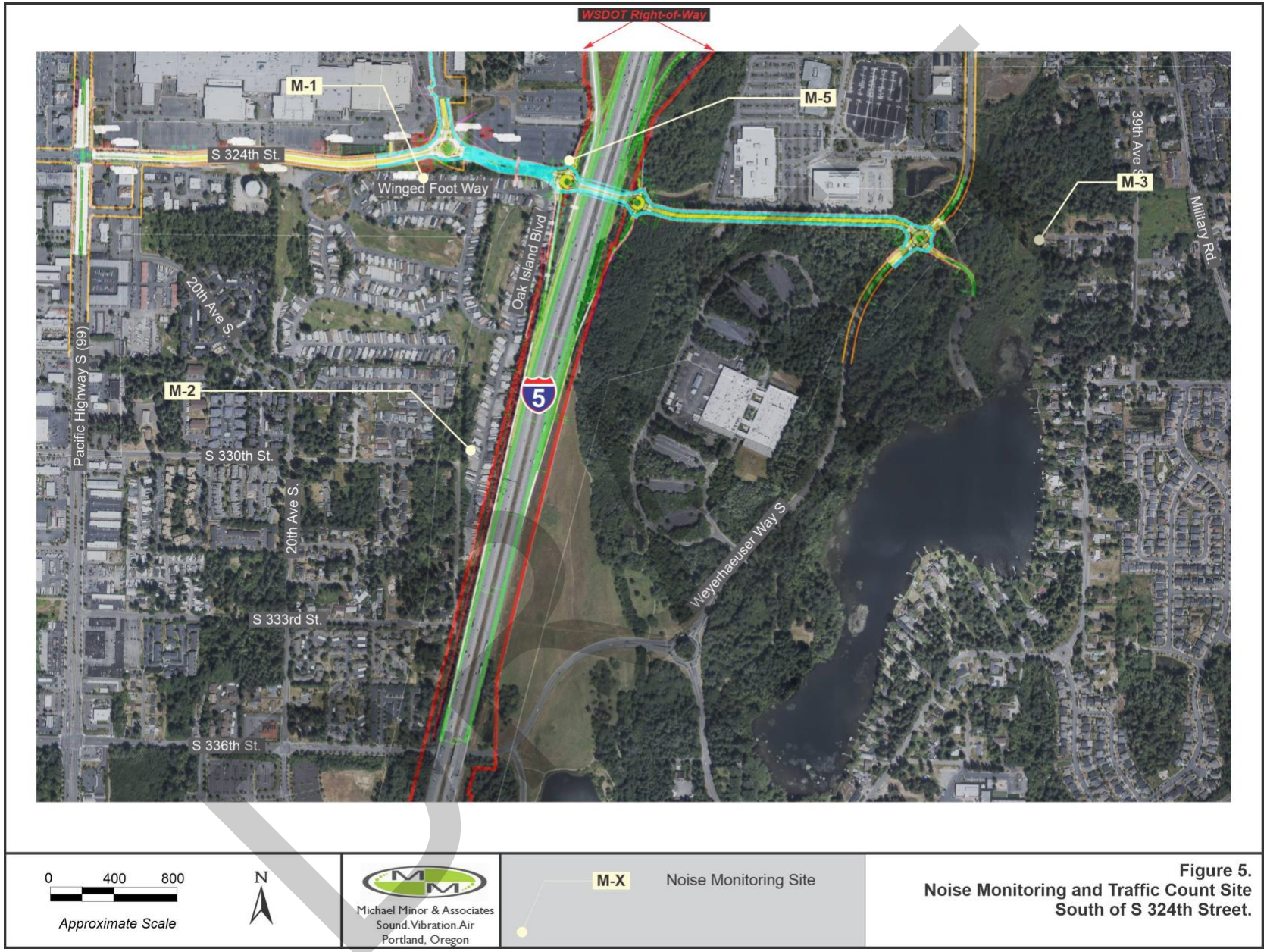


Figure 5.
Noise Monitoring and Traffic Count Site South of S 324th Street.

Table 4. Federal Way Noise Monitoring Results		
Site[1]	**Description or Address[1]**	**Noise Level[2]**
M-1	Belmor Park lot 189 on Winged Foot Way	55.0
M-2	Belmor Park between lots 308 and 311 on Winged Foot Way	64.1
M-3	3809 S 325th Street	53.1
M-4	32051 37th South Place	59.1
M-5	Park and Ride at South 322nd Street – I-5 Bus Entrance	74.7
M-6	31408 28th South Avenue – at dead end	77.6

Notes:
1. Monitoring sites are shown on Figure 4 and Figure 5.
2. All data is presented as an hourly Leq.

6. NOISE MODELING VALIDATION AND RECEIVERS

As previously described, the noise levels used for describing the existing and future conditions are taken from the FHWA TNM. This section describes the noise model validation results and selection of receivers used for modeling noise levels related to the Project.

6.1. Noise Model Validation

Traffic noise levels were modeled at five sites to test the agreement of calculated and measured noise levels. For model verification, the actual traffic counts and speeds as observed during the noise monitoring were used as input to the model. The five monitoring sites used for validation (M-1, M-2, and M-4 through M-6) are in areas where traffic noise was the dominating source and, thereby, could be used to validate the traffic noise model. A comparison of the five monitoring locations used for model validation is provided in Table 5.

Table 5. Measured vs. Modeled Noise Levels			
Receiver	**Measured**	**Modeled**	**Difference**
M-1	55.0	56	1
M-2	64.1	62.8	-1.3
M-4	59.1	59.2	0.1
M-5	74.7	72.7	-2
M-6	77.6	77.3	-0.3

The modeled and measured noise results agree within +/- 2 dBA at the five monitoring locations. Because a 2 dBA change in noise levels is barely perceptible to a person with average hearing, an agreement of +/- 2 dBA or less is considered acceptable deviation for modeled and measured noise levels.

Ambient Measurement Site M-3

Measurements were taken at site M-3 to establish background noise levels at the residential area just east of the proposed roundabout at Weyerhaeuser Way. The residences nearest to the proposed roundabout are on a dead end roadway, west of 39th Avenue SE, on South 326th Street SE. There is nothing except local traffic, and therefore, to establish the background noise levels at these residences, a terminal was installed for a 2-1/2 hour measurement session at 3809 S 325th Street. This is the residence nearest the roundabout and could be a candidate for a substantial increase impact. The sound level meter picks up all noise sources in the area and is a more accurate measurement of the existing background noise level than the noise level produced by the model, which would only include traffic noise. The main purpose for the measurement at M-3 was to establish a baseline for the existing noise levels to be used if the modeled noise levels were lower than the measured levels. Therefore, the measured noise was used in the existing, future no-build, and future build models when modeled noise levels in the area were less than 53 dBA Leq, the average measured Leq between 11:00 am and 1:30 pm.

6.2. Selection of Receivers

Noise modeling sites were selected to represent noise-sensitive areas within the Project area, where traffic noise impacts are most likely to occur. More specifically, the receiver locations were located in areas of frequent outdoor human use such as front yards, back yards, hotel and church entrances, and a park. In addition to receiver locations immediately adjacent to the Project roadways, modeled receiver locations were also extended beyond the distance where impacts can be modeled to verify that the full impacted area is captured. Figures 7 through 10 provide an aerial view of all Project noise modeling locations.

Traffic noise modeling was performed using the FHWA TNM. Existing and future traffic noise levels were predicted throughout the Project corridor at 81 locations representing 284 residences, three hotels, a church, a park, and a school. In several instances, one receiver location is used to represent a group of two or more neighboring residences expected to experience similar sound levels for both existing and future conditions and have comparable noise reductions if a noise barrier was constructed.

In order to provide a more detailed view of the modeling sites and aid in the discussion of existing and future noise levels, the corridor was divided into three segments:

- Segment A: Northwest, north of S 320th Street and west of I-5 to Pacific Highway S
- Segment B: East, east of I-5 to Military Road S
- Segment C: Southwest, south of S 320th Street and west of I-5.

Segment A noise modeling sites are denoted NW-1 through NW-17; Segment B modeling sites are denoted E-1 through E-13; and Segment C modeling sites are denoted SW-1 through SW-51. Figure 6 is an overview and identified the three segments. The figures also identify

front row receivers, which is necessary for noise abatement analysis, and receivers not considered front row are denoted second row+ receivers. Nosie modeling locations for each segment are described in detail below and identified in Figures 7 through 10.

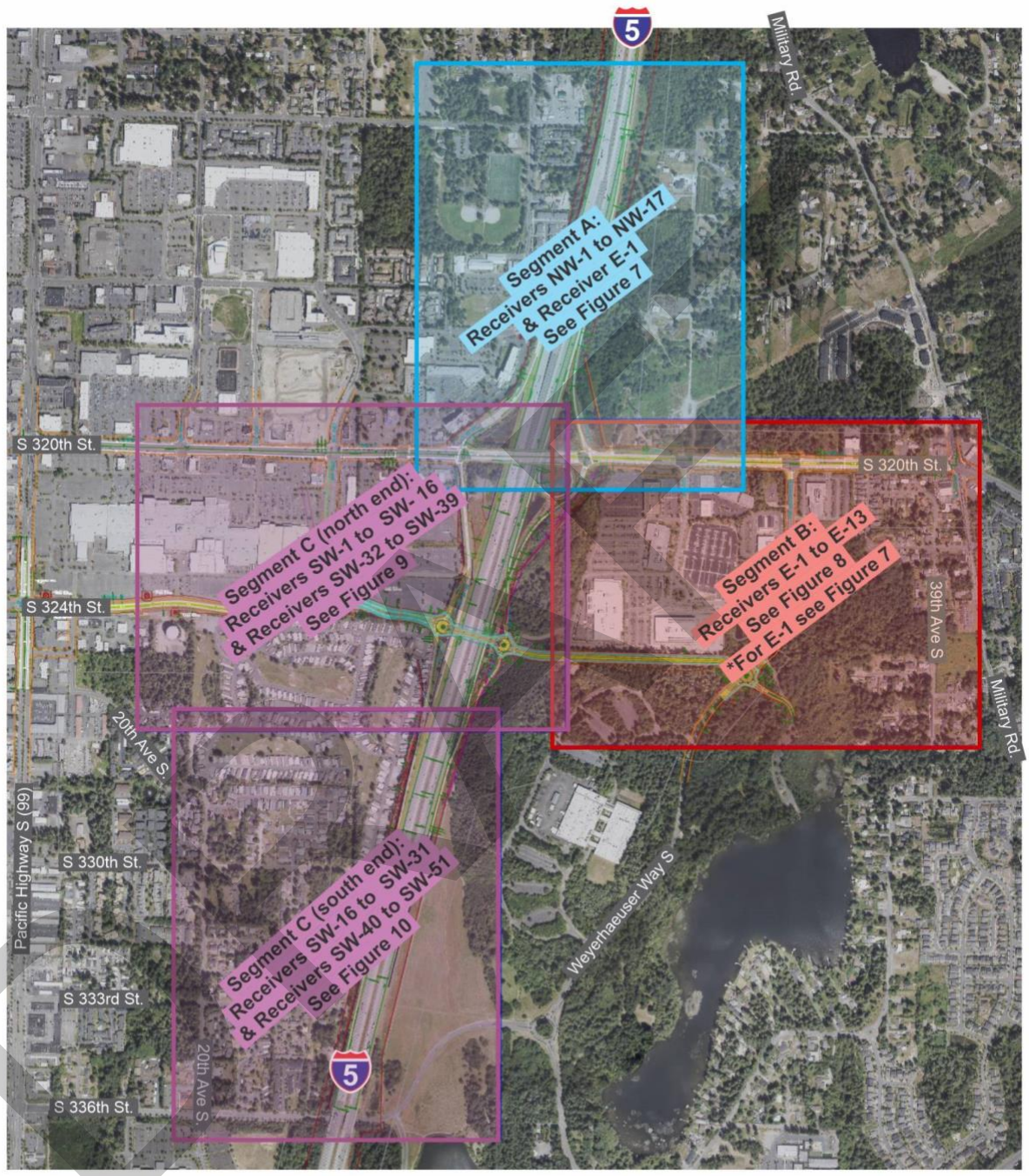


Figure 6.
Noise Analysis Segments

Modeling Sites Segment A: Northwest

There are 17 traffic noise modeling sites in Segment A: Northwest, west of I-5 to Pacific Highway South between S312th Street and S 320th Street. Modeling sites NW-1 through NW-10 and NW-13 through NW-17 represent 74 single and multi-family residences, including a residential group home, and one school along 28th Avenue S north of S 317th Street. Modeling sites NW-11 and NW-12 represent two hotels along Gateway Center Boulevard S north of S320th Street.

Modeling sites NW-1 through NW-16 are generally located as follows (see Figure 7):

- NW-1: One (1) first row receiver representing eight (8) residences at 31220 28th Avenue S.
- NW-2: One (1) first row receiver representing twelve (12) residences at 31220 28th Avenue S.
- NW-3: One (1) first row receiver representing one (1) residence at 31224 28th Avenue S.
- NW-4: One (1) first row receiver representing one (1) residence at 31228 28th Avenue S.
- NW-5: One (1) first row receiver representing two (2) residences at 31250 28th Avenue S.
- NW-6 through NW-8: Three (3) first row receivers representing ten (10) residences at 31408 28th Avenue S.
- NW-9 and NW-10: Two (2) first row receivers representing exterior uses at the 23-unit residential group home at 31524 28th Avenue S. Each receiver represents 3 residential equivalents.
- NW-11: One (1) first row receiver representing one (1) hotel use for the Hampton Inn at 31720 Gateway Center Boulevard S.
- NW-12: One (1) first row receiver representing one (1) hotel use for the Embassy Suites at 31910 Gateway Center Boulevard S.
- NW-13: One (1) second row receiver representing eight (8) residences at 31220 28th Avenue S.
- NW-14: One (1) second row receiver representing four (4) residences at 31250 28th Avenue S.
- NW-15 through NW-16: Two (2) second row receivers representing six (6) residences at 31408 28th Avenue S.
- NW-17: One (1) second row receiver representing one (1) school use for Career Academy at Truman High School Campus at 31455 28th Avenue S.

Modeling Sites Segment B: East

There are 13 traffic noise modeling sites in Segment B: East, east of I-5 to Military Road S. Modeling site E-1 represents one single family residence along 32nd Avenue South to the east of I-5. Modeling sites E-2 through E-3 represent two single family residences, including Fire Station 64, along the north side of S 320th Street to the east of I-5. Modeling sites E-4 through E-12 represent 19 single family residences on S 321st Street and 37th Place S, south of S 320th Street. Modeling site E-13 represents one single family residence east of Weyerhaeuser Way S along S 325th Street, nearest to the proposed roundabout.

Modeling sites E-1 through E-13 are generally located as follows (see Figure 8; for E-1 see Figure 7):

- E-1: One (1) first row receiver representing one (1) residence at 31323 32nd Avenue S.
- E-2: One (1) first row receiver representing one (1) residence at Fire Station 64 located at 3700 S 320th Street.
- E-3: One (1) first row receiver representing one (1) residence at 3801 S320th Street.
- E-4 through E-8: Five (5) first row receivers representing nine (9) residences on S 321st Street at 37th Place S.
- E-9 through E-12: Four (4) first row receivers representing nine (10) residences on S 321st Street at 37th Place S.
- E-13: One (1) first row receiver representing one (1) residence at 3809 S 325th Street, the same location as M-3 for background noise measurements.

Modeling Sites Segment C: Southwest

There are 51 traffic noise modeling sites in Segment C: Southwest, west of I-5 between S 324th Street and S 336th Street. Modeling site SW-1 represents one church and site SW-2 represents one hotel. Modeling sites SW-3 through SW-51 represent 204 single and multi-family residences and one park.

Modeling sites SW-1 through SW-51 are generally located as follows (see Figure 9 and Figure 10):

- SW-1: One (1) first row receiver representing one (1) sensitive land use for the Calvary Lutheran Church at 2415 S320th Street.
- SW-2: One (1) first row receiver representing one (1) hotel for the Best Western Inn at 32124 25th Avenue S.
- SW-3 through SW-20: Eighteen (18) first row receivers representing eighty-four (84) residences at Belmor Park at 2101 South 324th Street. Receivers SW-3 through SW-11 represent lots 183 through 255 along Winged Foot Way. SW-12 through SW-20 represent lots 256 through 305A along Oakland Hills Boulevard.
- SW-21 through SW-26: Six (6) first row receivers representing six (6) single family residences along 24th Avenue S between S330th Street and S333rd Street.
- SW-27 through SW-30: Four (4) first row receivers representing six (6) single family residences between S 333rd Street and S 3336th Street. Residences at these receivers are within 180 feet west of I-5.
- SW-31: One (1) first row receivers representing three (3) multi-family residences at the Greencrest Village Townhomes, 2210 S336th Street.
- SW-32 through SW-42: Eleven (11) second row receivers representing sixty-eight (68) residences at Belmor Park at 2101 S 324th Street. Receivers SW-32 through SW-36 represent lots 166 through 182, 206, and 332 through 336 along Winged Foot Way. Receivers SW-37 through SW-42 represent lots 330 along Winged Foot Way and lots 227 through 245 and 306A through 339 along Oakland Hills Boulevard.
- SW-43: One (1) second row receiver representing one (1) single family residence at 33003 24th Avenue S.
- SW-44: One (1) second row receiver representing one (1) single family residence at 2238 S 333rd Street.
- SW-45: One (1) second row receiver using a residential equivalence of 3.1 for Cedar Grove Park at 2224 S 333rd Street.
- SW-46 through SW-47: Two (2) second row receivers representing fifteen (15) multi-family residences at the King's Court Apartments, 2221 S 333rd Street.

- SW-48 through SW-51: Four (4) second row receivers representing nineteen (19) multi-family residences at the King's Court Apartments, 2221 S 333rd Street, and the Greencrest Village Townhomes, 2210 S 336th Street.

6.3. Residential Equivalents

Under WSDOT policy, residential equivalents are calculated for out-door use areas that are not associated with residential units. These residential equivalents are required and used during the noise abatement analysis for areas such as parks, schools, and churches. Equivalencies are calculated by usage factor, such as how often an area is used, and the number of people using the space. The residential equivalents are used for noise abatement calculations.

Parks, schools, and churches within the Project corridor all qualify for residential equivalencies. Residential equivalents were calculated only for the group home represented by receivers NW-9 and NW-10 and for the Cedar Grove Park. Residential equivalents were not predicted for the Career Academy at Truman High School or Calvary Lutheran Church, as they do not have a project traffic noise impact and no further noise abatement was proposed. See Appendix E for calculating residential equivalents.

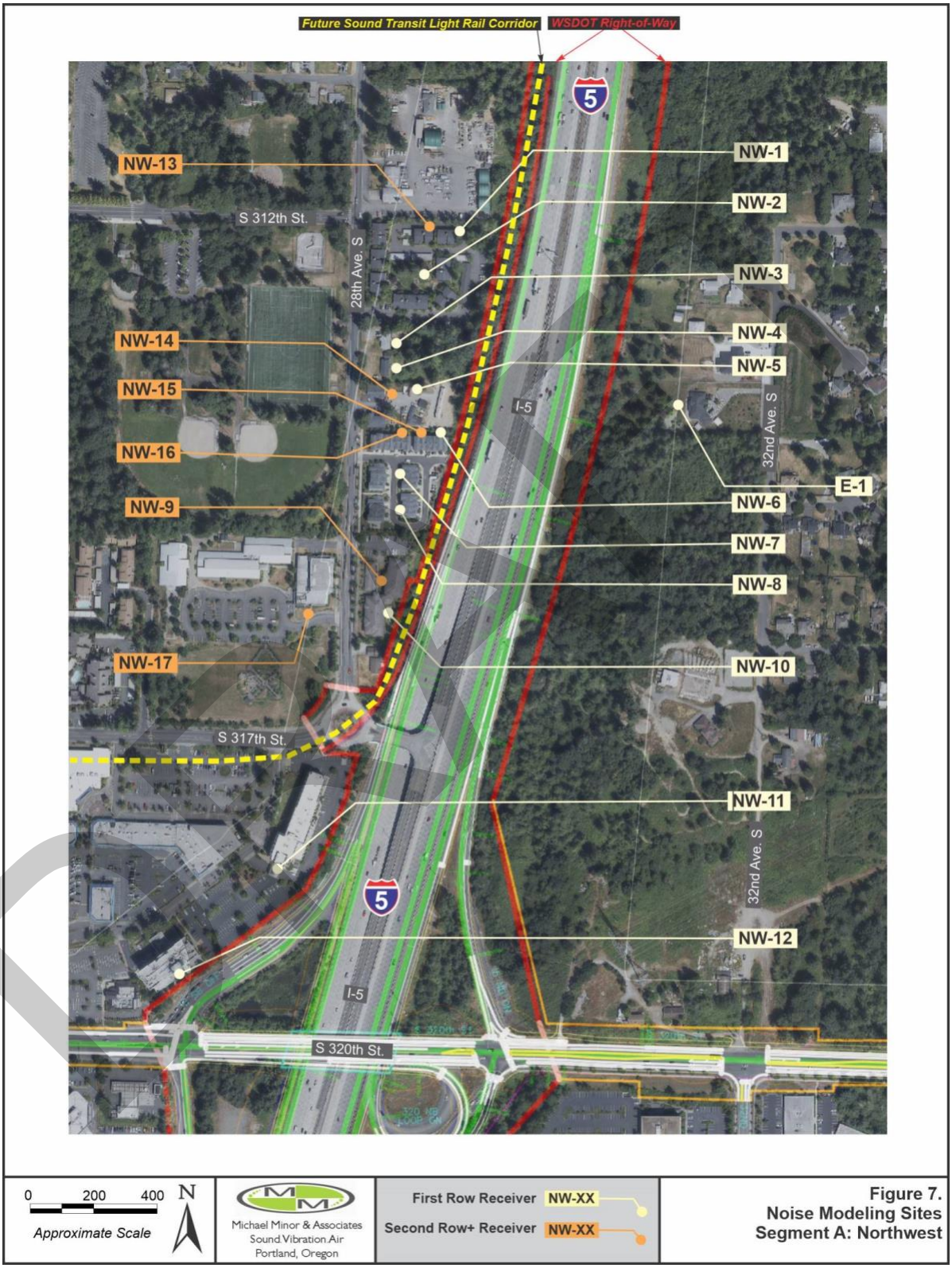


Figure 7.
Noise Modeling Sites
Segment A: Northwest

0 200 400

Approximate Scale

N

Michael Minor & Associates
Sound.Vibration.Air
Portland, Oregon

First Row Receiver E-XX

Second Row+ Receiver E-XX

Figure 8.
Noise Modeling Sites
Segment B: East

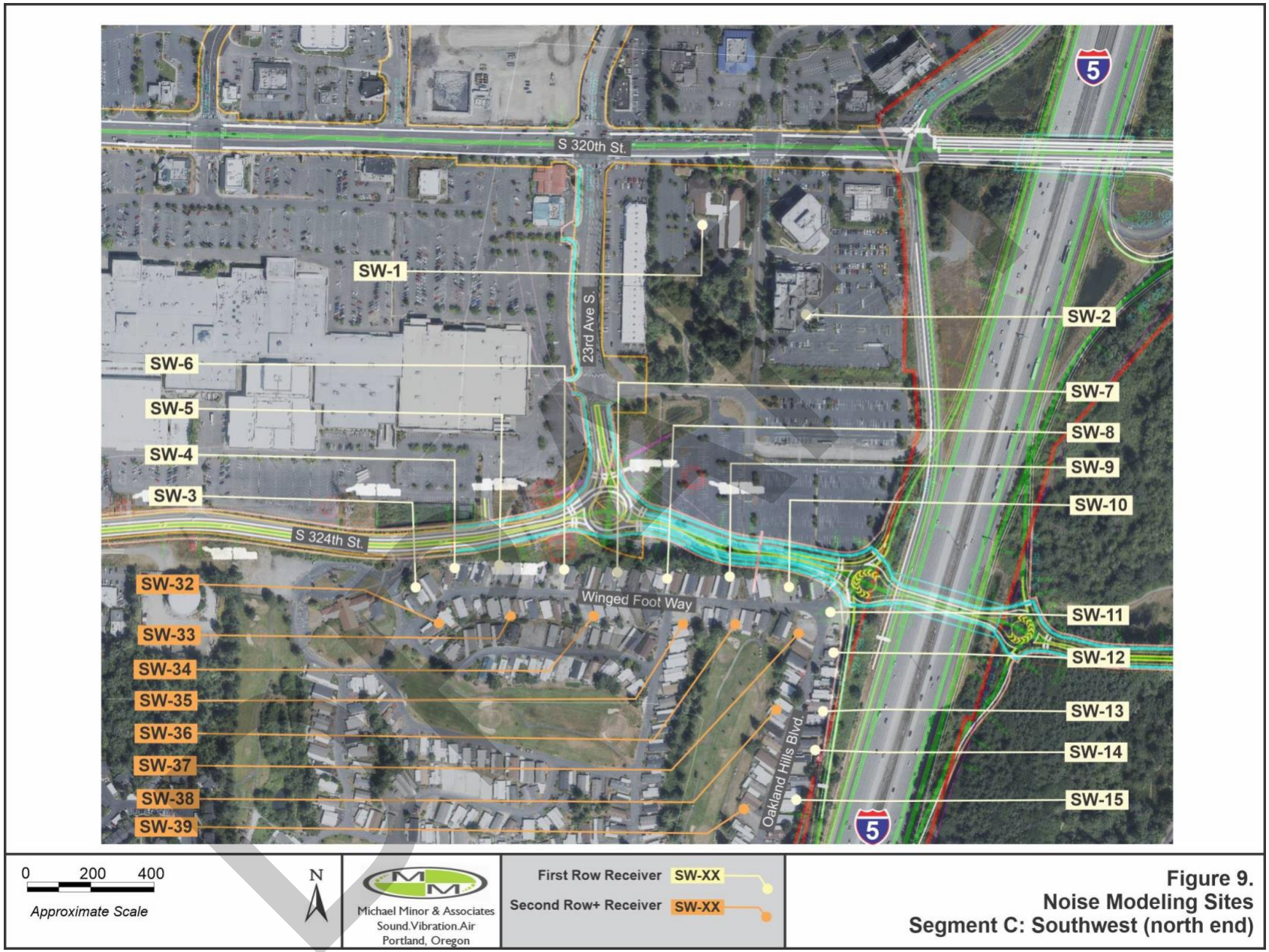


Figure 9.
Noise Modeling Sites
Segment C: Southwest (north end)

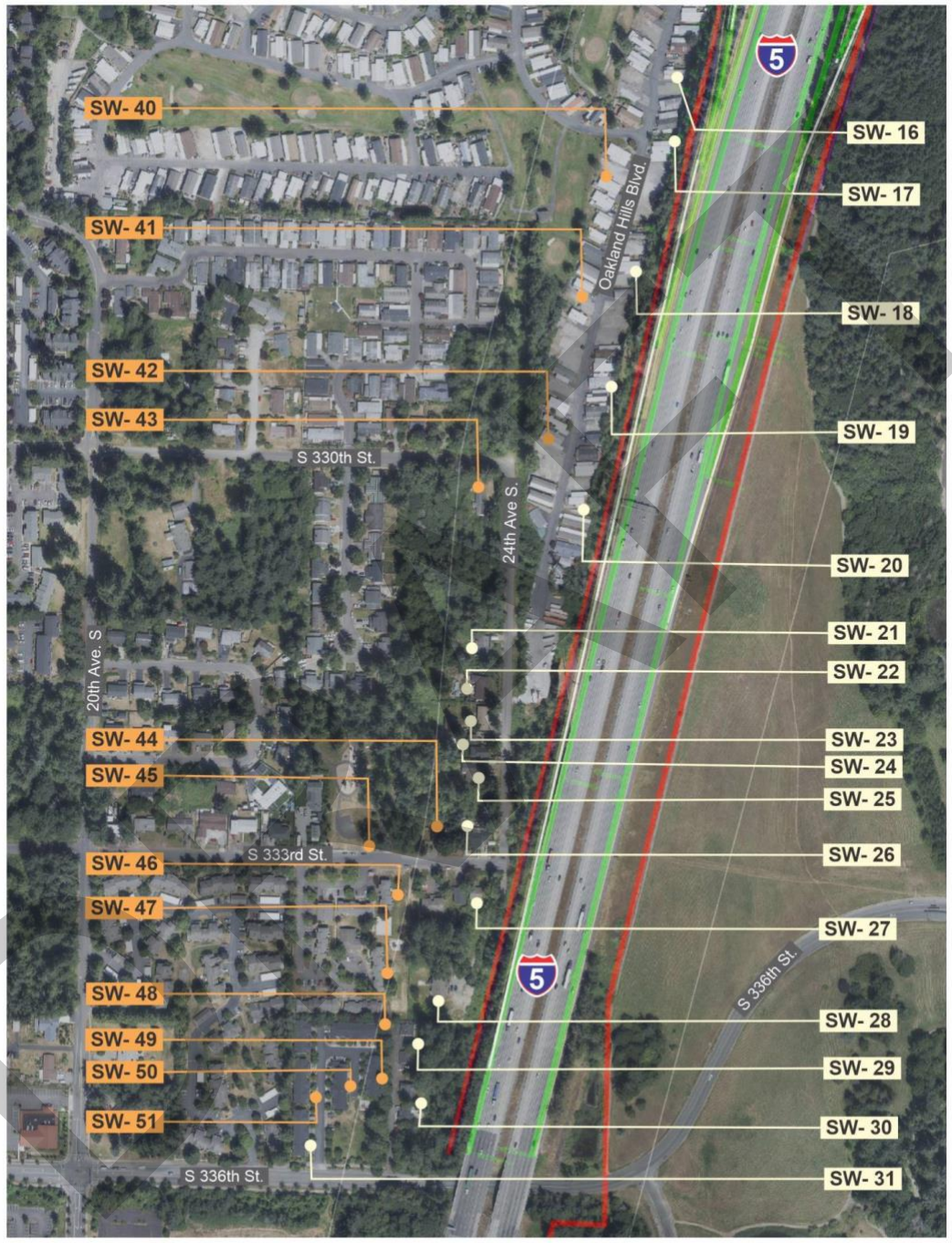


Figure 10.
Noise Modeling Sites
Segment C: Southwest (south end)

7. EXISTING ENVIRONMENT

This section provides the noise modeling results for the existing conditions (year 2017) PM peak traffic hour. Modeling was performed for 81 representative receiver locations shown on Figures 7 through 10. Overall, noise levels ranged from 46 to 75 dBA. However, because the lowest measured noise level was 53 dBA Leq the measured level was used at locations where the modeled noise levels were below 53 dBA Leq (see Section 6.1). 61 residences had noise levels meeting the WSDOT NAC. By definition, these are not considered "impacts" as impacts only occur under the Build scenario. Locations with levels exceeding the NAC are provided for informational purposes only.

The results of the existing conditions traffic noise analysis predictions for each of the 81 representative receivers are provided in the following sections and shown on Table 6.

7.1. Existing Traffic Noise Levels Segment A: Northwest

Existing noise levels for Segment A were modeled at 17 receivers (NW-1 through NW-17), representing 61 individual residences, two hotels, and a school. The existing levels ranged from 59 to 75 dBA Leq, with 51 sensitive uses meeting the WSDOT NAC but are not considered impacts under the existing scenario. High noise levels in this range are typical for uses close to a highway without mitigation. Second and third row receivers receive shielding from front row buildings thus reducing noise levels by 3 to 7 dB.

Receivers with noise levels at or above the WSDOT NAC include receivers NW-1 through NW-7, NW-10, and NW-13 through NW-16, all with high noise levels due to traffic from I-5. Table 6 provides a summary of the existing modeled traffic noise levels.

7.2. Existing Traffic Noise Levels Segment B: East

Noise levels in Segment B were modeled at 13 sites representing 23 residences (E-1 through E-13).Noise levels ranged from 53 to 67 dBA Leq. Five first row residences represented by E-6 through E-8 are predicted to meet the criteria for WSDOT NAC but are not considered impacts under the existing scenario. Although slightly below roadway grade, the high traffic volumes and close proximity to signalized intersection results in higher noise impacts at those five receivers. Note that receiver E-13 is located in a residential area with little to no traffic noise sources nearby, and therefore the modeled noise levels, which only include traffic noise, was lower than the measured noise levels, and at this location, the measured noise levels are presented whenever it is higher than the predicted traffic noise levels.

In Segment B receiver E-6 through E-8 all meet or exceed the WSDOT NAC. These are front row receivers along S 320th Street, just west of Military Road S. Table 6 provides a summary of the existing modeled traffic noise levels.

7.3. Existing Traffic Noise Levels Segment C: Southwest

Noise levels in Segment C were modeled at 51 sites representing 208.1 uses including residences, one park, one church, and one hotel (SW-1 through SW-51). Noise levels ranged from 55 to 68 dBA Leq. Four first row residences represented by SW-30 through SW-31 are predicted to meet the criteria for WSDOT NAC but are not considered impacts under the existing scenario. While many of the residences in this segment are in close proximity to the highway the lower noise levels here, rather than in Segment A, are a result of a 14-foot noise wall and earth berm along the highway from the existing park and ride parking lot to the bridge over S 336th Street. Because the noise wall ends when I-5 goes on structure to cross over S 336th Street, noise levels for SW-30 and SW-31 are higher noise levels than other receivers in this segment. Table 6 provides a summary of the existing modeled traffic noise levels.

8. FUTURE NO-BUILD ENVIRONMENT

This section provides the noise modeling results for the No-Build conditions using traffic volumes projected for the year 2045 with no changes to any of the roadways in the Project corridor. The same 81 noise modeling locations used to model the existing conditions were modeled for the No-Build Alternative PM peak hour traffic conditions. The TNM inputs include year 2045 traffic volumes and speeds prepared for this Project.

Based on the future projected traffic data for the year 2045 without the proposed Project, congestion, rerouting, and development have resulted in higher traffic volumes on some Project area roadways. As a result of this increase in traffic volumes, noise modeling has predicted increases in traffic noise levels at most locations when compared to the existing conditions. However, the Sound Transit FWLE project is assumed to be completed by 2045 with the inclusion of a noise wall along I-5 north of S 317th Street. The noise wall effectively reduces noises levels at most receivers in this area by -2 to -16 dB. Details on the noise reduction are provided under Segment A No-Build noise levels in the next section.

Under the No-Build alternative 17 uses were identified with noise levels that meet or exceed the WSDOT NAC. Again, these are not considered “impacts” as impacts only occur under the Build scenario. Locations with levels above the NAC are provided for informational purposes only. The reduction in impacts when compared to the existing conditions is due mainly to the retaining wall and trackway installation for the FWLE discussed below. Detailed modeled noise levels at each receiver are provided in the following sections and shown on Table 6.

8.1. No-Build Traffic Noise Levels Segment A: Northwest

Future 2045 No-Build traffic noise levels for the 17 receivers in Segment A are summarized in Table 6. Under the future No-Build Alternative noise levels range from -2 to -16 dB decrease or +1 to +2 dB increase. Noise reductions at 13 receivers is a result of construction of a noise wall related to the FWLE Project. The remaining the four receivers would have an

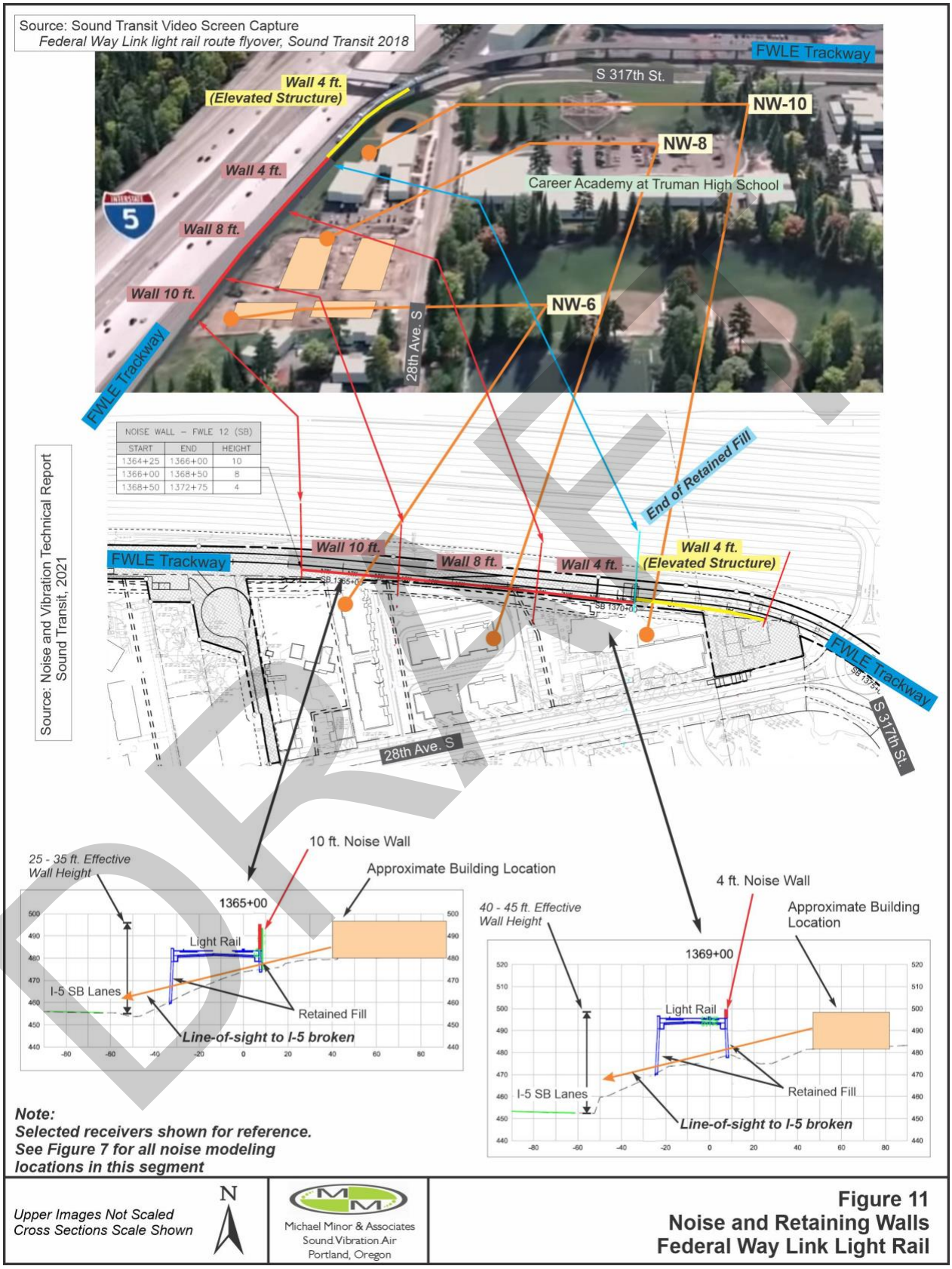
increase over existing conditions by 1 to 2 dB due to increased traffic volumes. Noise levels range from 56 to 73 dBA Leq, with receiver NW-10 predicted to exceed the WSDOT NAC.

The FWLE will install a trackway between I-5 and receivers NW-1 through NW-10 and NW-13 through NW-17. The light rail alignment will transition from an at-grade trackway, along the side of I-5 on to a retained fill, and then translation on to an elevated structure, traveling over the S 317th Street – 28th Avenue S roundabout. A retaining wall will be installed along the entire area north of the elevated structure to support the trackway, and at the same time, provide varying levels of acoustical shielding to residences in this area.

To transition the trackway from the side of I-5 to an elevated structure over the roundabout, the trackway will first need to transition to a large, retained fill section before making a final transition to a standard pillar supported elevated structure. The retained fill section for this transition will include retaining walls starting at 10 to 15 feet tall near NW-1, and gradually increase to 25 to 45 feet before the trackway converts to the elevated structure just north of NW-10. In addition, Sound Transit identified noise impacts from light rail operations at most of the receivers in this area, including many with traffic noise above the NAC. Therefore, the retained fill section also includes a noise wall between the light rail trackway and nearby receivers.

The FWLE noise walls range from 10 feet in the northern section (Near NW-6, NW-15), reduce to 8 feet, and then 4 feet as the trackway elevation above ground increases. The reduced size of the wall as the trackway elevation is increased is because most noise from light rail operations comes from the wheel rail interface, and therefore most elevated alignments can be fully mitigated with 4-foot noise walls.

To aid in the understanding of the noise reduction provided by the FWLE, Figure 11 was prepared. At the top of the figure is a screen capture of the FWLE light rail flyover, the center image is the most current design for the light rail through this area, and the bottom two figures are cross sections. This figure should aid in the understanding of the noise reductions provided by this configuration. The retained fill structure reduced traffic noise by 3 to 16 dBA at traffic noise modeling locations in this area.


Source: Sound Transit Video Screen Capture
Federal Way Link light rail route flyover, Sound Transit 2018
FWLE Trackway
S 317th St.
Wall 4 ft.
(Elevated Structure)
NW-10
NW-8
Wall 4 ft.
Career Academy at Truman High School
Wall 8 ft.
Wall 10 ft.
NW-6
28th Ave. S
FWLE Trackway
Source: Noise and Vibration Technical Report
Sound Transit, 2021
NOISE WALL – FWLE 12 (SB)
START END HEIGHT
1364+25 1366+00 10
1366+00 1368+50 8
1368+50 1372+75 4
End of Retained Fill
FWLE Trackway
Wall 10 ft.
Wall 8 ft.
Wall 4 ft.
Wall 4 ft.
(Elevated Structure)
FWLE Trackway
28th Ave. S
S 317th St.
25 - 35 ft. Effective
Wall Height
10 ft. Noise Wall
Approximate Building Location
1365+00
Light Rail
I-5 SB Lanes
Retained Fill
Line-of-sight to I-5 broken
40 - 45 ft. Effective
Wall Height
4 ft. Noise Wall
Approximate Building
Location
1369+00
Light Rail
I-5 SB Lanes
Retained Fill
Line-of-sight to I-5 broken
Note:
Selected receivers shown for reference.
See Figure 7 for all noise modeling
locations in this segment
Upper Images Not Scaled
Cross Sections Scale Shown
N
Michael Minor & Associates
Sound Vibration Air
Portland, Oregon
Figure 11
Noise and Retaining Walls
Federal Way Link Light Rail

8.2. No-Build Traffic Noise Levels Segment B: East

Future 2045 No-Build traffic noise levels for the 13 receivers in Segment B are summarized in Table 6. Under the future No-Build Alternative noise levels range from -1 dB to +3 dB. Only one receiver, E-1, would have a noise reduction. Noise levels range from 53 to 68 dBA Leq, with the same five residences identified in the existing conditions predicted to exceed the WSDOT NAC.

8.3. No-Build Traffic Noise Levels Segment C: Southwest

Future 2045 No-Build traffic noise levels for the 51 receivers in Segment C are summarized in Table 6. Under the future No-Build Alternative noise levels range from no change to +1 to +5 dB. The higher noise levels, over +2 dB, occur at Belmor Park receivers SW-3 through SW-8 and SW-32 through SW-33 along S324th Street where increased traffic volumes are predicted. The remaining receivers in this segment will see no change or +1 dB noise level increase. Noise levels range from 57 to 69 dBA Leq, with four new residences, in addition to the same five residences identified in the existing conditions, predicted to meet or exceed the WSDOT NAC.

9. FUTURE BUILD ANALYSIS

This section provides the noise modeling results for the Build Alternative. The same 81 noise modeling locations used to model the existing conditions were modeled for the Build Alternative PM peak hour traffic conditions. However, due to potential displacements of some of the Belmor Park properties (Segment C), the receivers will represent 289.1 sensitive land uses rather than 292.1. The TNM inputs include the Proposed build of the S 324th Street bridge, roundabouts, new ramps, bike lanes, sidewalks, and year 2045 traffic volumes and speeds prepared for this Project that could impact the modeling results.

The traffic data for the Build scenario includes several additional assumptions including increased development, extension of other planned roadways, and a notable increase in traffic when compared to the No-Build scenario. Therefore, the traffic noise levels for the Build Alternative are the worst-case noise levels for the year 2045.

Future Build Alternative traffic noise levels are predicted to range from 53 to 75 dBA Leq during the PM peak hour. There are 130.1 residences with noise levels that meet the WSDOT NAC. 24 of those residences would qualify for the substantial increase impact under the 2020 WSDOT policy with 10 to 13 dB increases over existing conditions. Compared to the No-Build Alternative conditions, the following sections provide the full results of the modeling and shown on Table 6.

9.1. Build Traffic Noise Levels Segment A: Northwest

Under the Build Alternative, noise levels in Segment A are predicted to range from 55 to 75 dBA Leq. Noise levels remain relatively the same as the future No-Build conditions with the

same residences at NW-10 exceeding the WSDOT NAC. Only one receiver, NW-12, would see a -1 dB noise reduction over the No-Build model. Again, the large noise reduction at most residences in this area is due to the installation of the FWLE retained fill tracked. Table 6 provides the results of the future Build Alternative traffic noise levels for Segment A with all Project noise impacts identified.

9.2. Build Traffic Noise Levels Segment B: East

Future Build Alternative traffic noise levels in Segment B are predicted to range from 53 to 69 dBA Leq. The noise model predicted five new impacts at E-2, E-4, and E-5 under the Build Alternative, in addition to the five impacts at E-6 through E-8 under the existing and no-build scenarios. Receivers E-4 through E-8 represent first row residences along South 321st Street and 37th Place South. Four new noise impacts at this location, E-4 and E-5, are a result of increased traffic volumes and roadway widening along S 320th Street near the Military Road S intersection. The new impact at E-2, which is Fire Station 64, is also a result of higher traffic volumes along South 320th near the Military Road S intersection. The modeling results for Segment B are provided in Table 6.

9.3. Build Traffic Noise Levels Segment C: Southwest

Future Build Alternative traffic noise levels in Segment C are predicted to range from 58 to 75 dBA Leq. The noise model predicted 108.1 new impacts over the no-build conditions. The increase in impacts within this segment is a combination of new conditions. First, the expansion of S 324th Street moves the roadway closer to homes at Belmor Park and removes some of the existing berm shielding homes closest to S 324th Street. The S324th Street expansion also includes a roundabout and an on-structure bridge over I-5, increasing both traffic volumes and transmission of noise. There will also be an I-5 on-ramp from the S 324th Street roundabout, due to the roadway widening the existing noise walls along I-5 South will have to be removed thus removing I-5 traffic noise shielding for residences and the park in this segment. The modeling results for Segment C are provided in Table 6.

10.NOISE LEVELS SUMMARY

Table 6 provides a full summary of 2017 Existing, 2045 No-Build Alternative, and 2045 Build Alternative noise levels for all receivers. The table also identifies locations that have noise levels which meet the WSDOT NAC, traffic noise impacts under the Build Alternative, and the change in noise levels between the existing, 2045 No-Build, and 2045 Build Alternatives.

Table 6. Traffic Noise Level Summary – All Segments										
Receiver[1]	Land Use[2]	Units[3]	Criteria (dBA Leq)[4]	Existing Conditions	No-Build Alternative		Build Alternative			
				Level (Leq dBA)[5]	Level (Leq dBA)[5]	Vs. Exist (in dB)[6]	Level (Leq dBA)[5]	Vs. Exist (in dB)[7]	No. of Impacts[8]	Vs. No-Build (in dB)[9]
NW-1	B	8	66	72	63	-9	64	-8	0	1
NW-2	B	12	66	69	61	-8	61	-8	0	0
NW-3	B	1	66	68	60	-8	60	-8	0	0
NW-4	B	1	66	68	60	-8	60	-8	0	0
NW-5	B	2	66	68	59	-9	59	-9	0	0
NW-6	B	2	66	75	59	-16	59	-16	0	0
NW-7	B	4	66	66	57	-9	57	-9	0	0
NW-8	B	4	66	63	57	-6	57	-6	0	0
NW-9	B	3	66	59	56	-3	56	-3	0	0
NW-10	B	3	66	73	73	0	73	0	3	0
NW-11	E	1	71	69	70	1	70	1	0	0
NW-12	E	1	71	68	69	1	68	0	0	-1
NW-13	B	8	66	70	62	-8	62	-8	0	0
NW-14	B	4	66	67	61	-6	61	-6	0	0
NW-15	B	2	66	71	57	-14	57	-14	0	0
NW-16	B	4	66	69	57	-12	57	-12	0	0
NW-17	C	1	66	59	61	2	61	2	0	0
E-1	B	1	66	61	60	-1	60	-1	0	0
E-2	B	1	66	64	65	1	69	5	1	4
E-3	B	1	66	62	63	1	65	3	0	2
E-4	B	2	66	62	63	1	66	4	2	3
E-5	B	2	66	63	65	2	67	4	2	2
E-6	B	2	66	66	68	2	69	3	2	1
E-7	B	2	66	66	68	2	69	3	2	1
E-8	B	1	66	67	68	1	69	2	1	1
E-9	B	1	66	59	60	1	62	3	0	2
E-10	B	1	66	59	61	2	63	4	0	2
E-11	B	3	66	57	58	1	60	3	0	2

Table 6. Traffic Noise Level Summary – All Segments										
Receiver[1]	Land Use[2]	Units[3]	Criteria (dBA Leq)[4]	Existing Conditions	No-Build Alternative		Build Alternative			
				Level (Leq dBA)[5]	Level (Leq dBA)[5]	Vs. Exist (in dB)[6]	Level (Leq dBA)[5]	Vs. Exist (in dB)[7]	No. of Impacts[8]	Vs. No-Build (in dB)[9]
E-12	B	5	66	56	58	2	59	3	0	1
E-13[10]	B	1	66	53	53	0	53	0	0	0
SW-1	C	1	66	64	65	1	64	0	0	-1
SW-2	E	1	71	67	67	0	67	0	0	0
SW-3	B	3	66	56	61	5	62	6	0	1
SW-4	B	3	66	58	62	4	63	5	0	1
SW-5	B	4	66	58	62	4	62	4	0	0
SW-6	B	4	66	56	59	3	63	7	0	4
SW-7	B	4	66	57	59	2	62	5	0	3
SW-8	B	4	66	57	59	2	61	4	0	2
SW-9	B	4	66	58	59	1	60	2	0	1
SW-10[11]	B	4,2	66	59	60	1	60	1	0	0
SW-11[11]	B	4,2	66	59	60	1	61	2	0	1
SW-12	B	5	66	61	62	1	63	2	0	1
SW-13	B	4	66	64	64	0	**74**	**10**	4	10
SW-14	B	5	66	63	63	0	**75**	**12**	5	12
SW-15	B	5	66	61	61	0	**74**	**13**	5	13
SW-16	B	4	66	60	61	1	**72**	**12**	4	11
SW-17	B	6	66	60	61	1	**70**	**10**	6	9
SW-18	B	7	66	65	65	0	**68**	3	7	3
SW-19	B	9	66	62	63	1	64	2	0	1
SW-20	B	5	66	61	61	0	62	1	0	1
SW-21	B	1	66	63	64	1	**69**	6	1	5
SW-22	B	1	66	61	62	1	**68**	7	1	6
SW-23	B	1	66	62	62	0	**69**	7	1	7
SW-24	B	1	66	63	64	1	**72**	9	1	8
SW-25	B	1	66	61	62	1	**70**	9	1	8
SW-26	B	1	66	61	62	1	**70**	9	1	8

Table 6. Traffic Noise Level Summary – All Segments										
Receiver[1]	Land Use[2]	Units[3]	Criteria (dBA Leq)[4]	Existing Conditions	No-Build Alternative		Build Alternative			
				Level (Leq dBA)[5]	Level (Leq dBA)[5]	Vs. Exist (in dB)[6]	Level (Leq dBA)[5]	Vs. Exist (in dB)[7]	No. of Impacts[8]	Vs. No-Build (in dB)[9]
SW-27	B	1	66	62	63	1	**71**	9	1	8
SW-28	B	1	66	62	62	0	**70**	8	1	8
SW-29	B	2	66	65	**66**	1	**72**	7	2	6
SW-30	B	2	66	**68**	**69**	1	**74**	6	2	5
SW-31	B	3	66	**68**	**68**	0	**69**	1	3	1
SW-32	B	4	66	55	57	2	58	3	0	1
SW-33	B	6	66	56	58	2	59	3	0	1
SW-34	B	7	66	58	59	1	60	2	0	1
SW-35	B	4	66	56	57	1	58	2	0	1
SW-36	B	3	66	56	57	1	59	3	0	2
SW-37	B	4	66	60	60	0	61	1	0	1
SW-38	B	8	66	61	62	1	**66**	5	8	4
SW-39	B	8	66	59	60	1	**68**	9	8	8
SW-40	B	8	66	62	63	1	**67**	5	8	4
SW-41	B	9	66	64	64	0	**66**	2	9	2
SW-42	B	7	66	62	62	0	64	2	0	2
SW-43	B	1	66	61	61	0	63	2	0	2
SW-44	B	1	66	62	63	1	**71**	9	1	8
SW-45[12]	C	3.1	66	61	62	1	**68**	7	3.1	6
SW-46	B	6	66	62	62	0	**69**	7	6	7
SW-47	B	9	66	62	63	1	**69**	7	9	6
SW-48	B	7	66	63	64	1	**69**	6	7	5
SW-49	B	5	66	64	65	1	**69**	5	5	4
SW-50	B	5	66	64	65	1	**67**	3	5	2
SW-51	B	2	66	65	**66**	1	**67**	2	2	1
Summary		**Minimum**		53	53	-16	53	-16	0	-1
		Maximum		75	73	5	75	13	9	13

Table 6. Traffic Noise Level Summary – All Segments

Receiver[1]	Land Use[2]	Units[3]	Criteria (dBA Leq)[4]	Existing Conditions	No-Build Alternative		Build Alternative			
				Level (Leq dBA)[5]	Level (Leq dBA)[5]	Vs. Exist (in dB)[6]	Level (Leq dBA)[5]	Vs. Exist (in dB)[7]	No. of Impacts[8]	Vs. No-Build (in dB)[9]
Substantial increase noise impacts with future noise levels 10 dB or more above existing =		**Total Meeting NAC**							**130.1**	
Substantial increase noise impacts with future noise levels 10 dB or more above existing = 24										

Notes:

1. All receivers are shown in Figures 7 through 10.
2. FHWA land use: See Table 1.
3. Number of dwellings represented by each receiver.
4. WSDOT traffic noise abatement criteria by land use type.
5. Predicted peak hour noise levels in dBA Leq for condition stated, taken from TNM version 2.5 with **bold red** typeface used to indicate noise levels that are equal to or greater than the NAC of 66 dBA Leq for Category B uses.
6. Change in noise: No-Build compared to existing conditions.
7. Change in noise: Build compared to existing conditions with **bold red** typeface used to indicate noise level increases of 10dB or greater (substantial increase impacts).
8. Number of uses predicted to meet or exceed the WSDOT NAC, either the level criteria or substantial increase criteria.
9. Change in noise: Build compared to No-Build for reference only.
10. Measured noise levels of 53 dBA Leq for receiver E-13 are presented as they are higher than the modeled traffic only noise levels, which would not reflect other non-traffic noise sources in the area. See Section 6.1.
11. Receivers SW-10 and SW-11 will have 4 units each under the Existing conditions but only 2 units each under the Build model due to displacements.
12. Number of units calculated using a residential equivalence. See Appendix E.

10.1. Noise Impact Summary

The following locations were identified with noise levels meeting the noise abatement criteria for WSDOT:

10.1.1. Noise Impact Summary, Segment A: Northwest

Due to the retained fill structure and noise walls being constructed as part of the FWLE , only one first row receiver, NW-10 representing 3 residential equivalents, and no second-row receivers, is predicted to have an impact, with future build noise levels of 73 dBA. Traffic noise at this receiver would come from increased traffic along I-5 and the HOV ramps.

10.1.2. Noise Impact Summary, Segment B: East

The following noise impacts predicted in Segment B would result from increased traffic along S320th Street and Military Road S, in addition to expanding S320th Street to include west and east traveling rapid transit lanes. Noise impacts at these locations range from 66 to 69 dBA.

Noise Impacts Segment B: East:

- E-2: Fire Station 64 located at 3700 S 320th Street, north of S 320th Street, however, noise levels in the sleeping areas of the fire station would be within the interior criteria (see Category D in Table 1).

- E-4 through E-8: Nine first row residences on S 321st Street at 37th Place S, south of S320th Street.

10.1.2. Noise Impact Summary, Segment C: Southwest

Noise impacts were identified at 29 of the 51 receivers in this segment. In the north end of the segment there were 10 receivers, representing 64 first and second row residences, with impacts at the Belmor Park. Noise impacts at Belmor Park are at residences parallel to I-5 where existing shielding, such as berms and noise walls, will be removed under the Project build conditions. Noise impacts at Belmor Park range from 66 to 75 dBA, 24 of those residences would qualify for the substantial increase impact under the 2020 WSDOT policy with 10 to 13 dB increases over existing conditions.

However, four first row receivers and two second row receivers also parallel with I-5 are not predicted to have noise impacts. At the north end of Belmor Park SW-11, SW-12, and SW-37 would be shielded by a berm and are below the new South 324th Street extension and the I-5 South elevated on-ramp. At the south end of Belmor Park, SW-19, SW-20, and SW-42 would receive shielding from an existing wall that is not expected to be removed under the Project build conditions. See Appendix F for a Belmor Park map.

Noise Impacts Segment C: Southwest:

- SW-13 through SW-17: Five first row receivers representing 31 Belmor Park residences at lots 261 through 285 along Oakland Hills Boulevard. Each receiver is predicted to have a substantial noise level increase. Noise levels would range from 70 to 75 dBA.

- SsW-18: One first row receiver representing 7 Belmor Park residences at lots 286 through 292 along Oakland Hills Boulevard. Noise level would be 68 dBA and not predicted to have a substantial increase due to partial shielding from a noise wall.

- SW-38 through SW-41: Four second row receivers representing 33 residences at lots 227 to 242 and 313 to 329 along Oakland Hills Boulevard. Noise levels would range from 66 to 68 dBA.

South of Belmor Park all first-row receivers (SW-21 through SW-31), representing 15 residences, and most second row receivers (SW-43 through SW-51), representing 36 residences and Cedar Grove Park, are expected to have noise impacts. Under the Project build conditions, the removal of an existing noise wall ranging from 14- to 20-feet tall would result in noise impacts in this area. Noise levels in the area would range from 67 to 75 dBA. Only SW-42, west of the southern end of Belmor Park, would not receive a noise impact due to shielding from an existing wall that will not be removed.

11.NOISE ABATEMENT ANALYSIS

In accordance with the current 2020 WSDOT Policy, when traffic noise impacts are identified, noise abatement measures must be considered for those developments that existed or have been issued a building permit prior to the date of public knowledge of the Project. This includes identifying noise abatement measures that are feasible and reasonable and that are likely to be incorporated into the Project. In addition, the noise analysis must also identify noise impacts for which no apparent solution is available and an explanation of why noise abatement was not recommended.

Whenever noise impacts are expected, noise abatement measures, including noise barriers and earthen berms, are evaluated. Construction of noise barriers between the roadways and the affected receivers would reduce noise levels by physically blocking the transmission of traffic-generated noise. Barriers can be constructed as walls or earthen berms. Earthen berms require more right-of-way than walls and are usually constructed with a 3-to-1 slope. Noise barriers should be high enough to break the line-of-sight between the noise source and the receiver. They must also be long enough to prevent significant flanking of noise around the ends of the barriers. Due to limited right-of-way within the study area, only noise walls were considered for noise abatement.

11.1. WSDOT Noise Abatement Criteria

For noise abatement to be recommended for inclusion with a project, the abatement must meet the feasibility and reasonability criteria set forth by WSDOT. Feasibility deals primarily with engineering considerations, such as whether substantial or meaningful noise level reductions can be achieved or whether there would be a negative effect on property access. Reasonableness assesses the practicality of the abatement measure based on a number of factors. Required factors are cost-effectiveness, consideration of the viewpoints of the property owners and residents of benefiting receivers, and noise abatement performance (noise reduction design goal). Details on the requirements are provided in the following sections.

11.1.1. Feasibility of Noise Abatement

In evaluating whether a particular noise abatement measure is feasible, WSDOT considered acoustic and engineering, and requires the following to occur for noise abatement to be feasible:

- Abatement must be physically constructible.
- A minimum of three (3) first row impacted receivers must obtain a minimum 5 dBA of noise reduction as a result of abatement (insertion loss), assuring that every reasonable effort will be made to assess outdoor use areas as appropriate.

In general, noise barriers are ineffective at reducing traffic noise levels when constructed along roadways that have uncontrolled access points (e.g., driveways and pedestrian access) due to the openings in the noise barrier required to accommodate access. These openings can allow sufficient noise onto the property, making it difficult if not impossible to meet the required noise reduction requirement for residences adjacent to the roadway. While noise abatement measures are considered for all project-related impacts, some noise barriers that would clearly not meet the feasibility criteria are evaluated qualitatively without extensive modeling efforts.

The noise abatement must be physically constructible as well to meet feasibility requirements. WSDOT also considers engineering factors when determining feasibility. Safety factors that should be considered in the feasibility assessment of noise abatement include: maintaining a clear recovery zone, redirection of errant vehicles, ensuring adequate sight distance, and fire/emergency vehicle access. The consideration of abatement may also include potential environmental impacts to wetlands, property access, placement of utilities and stormwater control facilities, and construction on steep slopes. Engineering considerations should be made in concert with the project engineering office.

11.1.2. Reasonableness of Noise Abatement

Once noise abatement is determined feasible, the abatement is evaluated for its reasonableness. Two primary criteria are used in considering the reasonableness of a particular abatement measure: cost-effectiveness and the WSDOT design goal achievement.

In areas where homes are scattered too far apart for noise barriers to be built at a reasonable cost, the noise abatement analysis is limited to qualitative discussion without extensive modeling efforts.

11.1.3. Cost Effectiveness

The cost of noise abatement sufficient to provide at least the minimum feasible noise reductions must be equal to or less than the allowable cost of abatement for each noise wall location analyzed. Based on current planning noise wall costs from 2020, the current average costs for Washington State for a Type I project are $51.61 per square foot of noise wall. These are the most current costs and values available from WSDOT (WSDOT 2020).

Either the barrier size or cost outlined in Table 7 below can be used to describe the reasonableness evaluation. However, a cost description must be included if there are non-standard additional costs, or costs that would not occur "but for" the barrier (e.g., additional foundation costs for steep slopes, unique drainage requirements). Additional cost estimates for abatement are added to the planning-level costs as part of the reasonableness evaluation.

Barriers are evaluated independently for feasibility and reasonableness, with some exceptions for barrier systems. On projects where noise barriers are considered for multiple locations, a feasibility and reasonableness evaluation will be done for each area independently.

Allowable costs are shown in Table 7 and are a function of the current planning-level barrier cost ($51.61 per square foot in 2020) multiplied by the allowable wall size for the receiver benefiting from the noise wall. The table shows the allowable costs for each receiver based on the predicted Build condition noise levels or sound level increases. Higher noise levels, or larger sound level increases, are allowed more money for abatement.

The cost evaluation used to determine WSDOT planning-level cost estimates for a standard noise wall includes the following:

1) Noise barrier construction labor and materials, including clearing and grubbing and the acquisition of property needed for the noise barrier;

2) Traffic management measures, as necessary only for the barrier construction;

3) A percent of the total project's workforce mobilization costs; and

4) Sales tax.

Table 7. Reasonableness Allowances			
Column A	**Column B**	**Column C**	**Column D**
Design Year Traffic Sound Decibel Level (dBA)	**Noise level increase as a result of the Project (dBA)[2]**	**Allowed Wall Surface Area Per Qualified Residence or Residential Equivalent**	**Allowed Cost Per Qualified Residence or Residential Equivalent[1]**
66		700 Sq. Feet	$36,127
67		768 Sq. Feet	$39,636
68		836 Sq. Feet	$43,146
69		904 Sq. Feet	$46,655
70		972 Sq. Feet	$50,165
71	10 (substantial, step 1) [3]	1,040 Sq. Feet	$53,674
72	11 (substantial, step 1)	1,108 Sq. Feet	$57,184
73	12 (substantial, step 1)	1,176 Sq. Feet	$60,693
74	13 (substantial, step 1)	1,244 Sq. Feet	$64,203
75	14 (substantial, step 1)	1,312 Sq. Feet	$67,712
76	15 (substantial, step 2)[4]	1,380 Sq. Feet	$71,222

Notes:

1. Current costs based on $51.61 per square foot constructed cost developed based current planning from 2020.
2. If the noise level increases 10 dBA or more as the result of the project (Column B), follow the allowed wall surface and cost for the level of increase in Column C in lieu of the total design year sound decibel level in Column A. For total highway related sound levels at 76 or more dBA or the project results in an increase of 15 or more decibels, continue increasing the allowance at the rate provided in this table unless circumstances determined on a case-by-case basis require an alternative methodology for determining allowance.
3. Step 1 is when the noise levels are 10 to 14 dBA over existing conditions traffic noise as a result of the transportation project.
4. Step 2 is when the noise levels are 15 or more dBA over existing conditions traffic noise as a result of the transportation project (or total highway related noise levels are between 76 and 79 decibels). Additional consideration for abatement may be considered under these circumstances.
5. Sq. Feet = square feet.

11.1.4. Design Goal Achievement

The minimum design goal for abatement is at least 7 dBA of reduction for one receiver. Noise walls cannot be recommended if they do not achieve the design goal. In addition to the design goal requirement, WSDOT will make a reasonable effort to achieve a 10 dBA or greater insertion loss (noise reduction) at the first row of receivers for all projects where abatement is recommended.

11.1.5. Other Considerations

A larger noise barrier than the minimum feasible and reasonable size shall be constructed when a barrier is highly cost-effective. A barrier is considered highly cost-effective when it reduces noise levels behind the barrier by 10 dBA, or more, for the majority of first-row receivers at less than 75 percent of the maximum reasonable cost allowed for abatement.

11.1.6. Summary of Abatement Requirements

In summary, in order to be recommended for construction, noise abatement must meet the three criteria:

1) **Feasibility:** At least three first-row receivers with noise impacts must have an insertion loss (noise reduction) of 5 dB or more.
2) **Reasonableness:** The total allowable cost or square footage (SF) for benefited receivers (using the allowable cost or SF from Table 7), must equal or exceed the costs or SF of the noise abatement measure (noise barrier).
3) **Design Goal:** At least one receiver must have a noise reduction of 7 dB (insertion loss of 7 dB or more).

For any considered noise abatement, these three criteria are reviewed, in order. If, for example, the Feasibility Criteria cannot be met, there will no comparison of the Reasonability or Design Goal criteria.

11.2. Noise Abatement Measures, Segment A: Northwest

Due the construction of the FWLE, virtually all noise impacts along this segment of the corridor were eliminated. The only remaining impacts is to the shared use at the group home and abatement for this location is described below.

11.2.1. Noise Abatement for Receiver NW-10

Noise impacts were identified at NW-10 representing residences at a group home along 28th Avenue S near the S317th Street and I-5 traffic circle on Segment A. The noise wall abatement analysis uses residential equivalents for the shared outdoor area on the east side of the building, which is entirely a front-line receiver. Noise Wall 1 was considered for the noise impact at this receiver location. Figure 12 shows the location of the wall on an aerial photo with the proposed roadway improvements and nearby receiver locations.

Because the wall is located near the Sound Transit retained fill structure, which will most likely be constructed before the City Center Project, it may be prudent, if possible, to have Sound Transit construct this wall during construction of the retained fill.

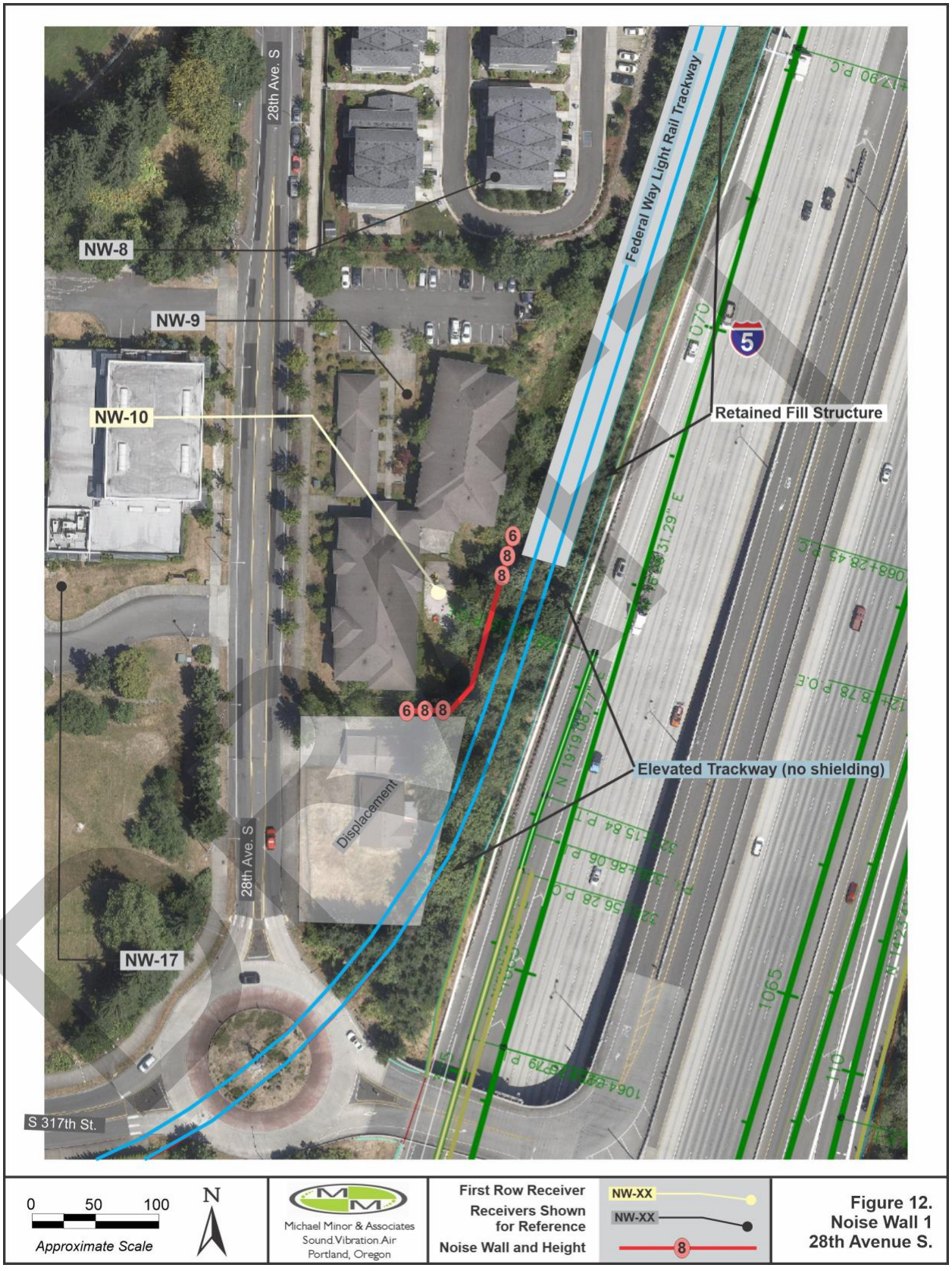


Figure 12. Noise Wall 1 28th Avenue S.

Noise Wall 1 has a total length of approximately 185 feet and is designed to provide noise abatement for the first row residences represented by receiver NW-10. The heights of the panels range from 6 to 8 feet, with a total area of 1,446 square feet (SF). Using the standard cost from WSDOT of $51.61 per square foot, the cost of the wall is $74,628.

The wall would meet WSDOT requirements for feasible noise abatement by reducing noise levels by 13 dB, meeting the necessary insertion loss requirement of at least 5 dB at all first row residences and a maximum insertion loss of at least 7 dB at all residences. The total allowable square footage of noise walls is 3,528 SF. Since the wall area is 1,446 SF, the wall meets WSDOT requirements for reasonable noise abatement and is recommended for inclusion with the Project. Table 8 summarizes the performance of the wall along with the cost and total square footage.

Table 8. Noise Wall 1: Abatement Considered for Receiver NW-10

Receiver Information			Abatement Noise Levels (dBA Leq) and Benefit				Wall Sq Ft and Cost	
Rec#[1]	Units[2]	First-Row[3]	Future Build[4]	Build with Wall[5]	Insertion Loss[6]	Benefited (>5 dB)[7]	Allowed $[8]	Allowed Sq Ft[9]
NW-10	3	Y	73	60	13	3	$706,233	13,684
Criteria Verification Noise Abatement Measure								
Requirement for at least three first-row impacts >5dB[10]							**3 of 3**	**Yes**
Requirement for reasonable noise abatement cost (Sq.-Ft)[11]			**Available Capital (SqFt) (from benefited receivers)**				**$182,079**	**3528**
			Wall Cost (SqFt)				**$74,628**	**1446**
			Available minus Cost > 0: Yes				**$107,450**	**2082**
Max insertion loss from abatement[12]							**13 >= 7**	**Yes**

Notes:

1. Receivers shown in Figure 12 with the noise wall evaluated.
1. Number of units with the same noise level.
2. First-row receivers are directly adjacent to the project roadway.
3. Future Build Noise levels from TNM.
4. Future Build noise levels with the noise wall evaluated from TNM.
5. Insertion loss, in decibels, of the noise wall evaluated.
6. Identifies receivers that are considered benefited under WSDOT policy (5 dB or more insertion loss).
7. Allowable cost per qualified residence from Table 7.
8. Allowable wall surface area per qualified residence from Table 7.
9. Insertion loss for three first-row receivers with impacts must be 5 dB or more.
10. Comparison of the allowable cost/sq. ft. to the actual cost/sq. ft. must be a positive number to meet criteria.
11. Maximum insertion loss, must be 7 dB or more.

Because the noise wall is both reasonable and feasible it is recommended to be considered for construction with the project. Due the close proximity to the retained fill from the FWLE project, coordination with Sound Transit may be prudent before finalizing the wall plans.

11.3. Noise Abatement Measures, Segment B: East

Impacts were identified on both sides of S 320th Street between the intersections with Weyerhaeuser Way S and Military Road S. Traffic noise abatement was considered for each areas with noise impacts as described below.

11.3.1. Noise Abatement at Receiver E-2

A noise impact was identified at E-2, Fire Station 64. Because the location of the sleeping quarters are located in the rear of the building, away from S 320th Street, noise levels inside the facility are predicate to meet the FHWA interior requirements for Category D uses of 52 dBA Leq (51 dBA Leq under WSDOT). This assumption is based on the exterior predicted noise level of 69 dBA and a conservative exterior to interior noise reduction of 20 to 25 dBA (minimal reduction of typical double pane windows), resulting in an interior noise levels of 44 to 49 dBA Leq, below the 51 dBA Leq WSDOT interior approach criteria.

11.3.2. Nosie Abatement at Receivers E-4 through E-8

Noise impacts were also identified at five receivers representing nine first row residences in Segment B. Receivers E-4 through E-8 are along 37th Place S and S 321st Street just south of S320th Street near the intersection of Military Road S. Noise Wall 2 was considered for the noise impacts at these receivers.

There is an existing pedestrian access to the neighborhood at the dead end of 37th Place S to the sidewalk and transit stop on S 320th Street. This access was maintained using a standard pedestrian access opening in the noise wall to maintain access, while still maintaining the necessary noise reduction. The access was designed with a 2 to 1 overlap of the opening to block most noise from being transmitted into the neighborhood through the pedestrian access opening. Figure 13 shows the location of Noise Wall 2 on an aerial photo with the proposed roadway improvements, nearby receiver locations and preliminary pedestrian access design.

Noise Wall 2 has a total length of approximately 678 feet and is designed to provide noise abatement for nine first row residences and ten second row residences represented by receivers E-4 through E-12. The heights of the panels range from 5 to 8 feet, with a total area of 5,316 square feet (SF). Using the standard cost from WSDOT of $51.61 per square foot, the cost of the wall is $274,359.

The wall would meet WSDOT requirements for feasible noise abatement by reducing noise levels by 7 dB at receiver E-5 through E-7 and a reduction of 6 dB at E-4 and E-8, meeting the necessary insertion loss requirement of at least 5 dB at three impacted first row residences and the required 7 dB insertion loss at six residences. The total allowable square footage of noise walls is 7,456 SF. Since the wall area is 5,316 SF, the wall meets WSDOT requirements for reasonable noise abatement and is recommended for inclusion with the Project. Table 9 summarizes the performance of the wall along with the cost and total square footage.

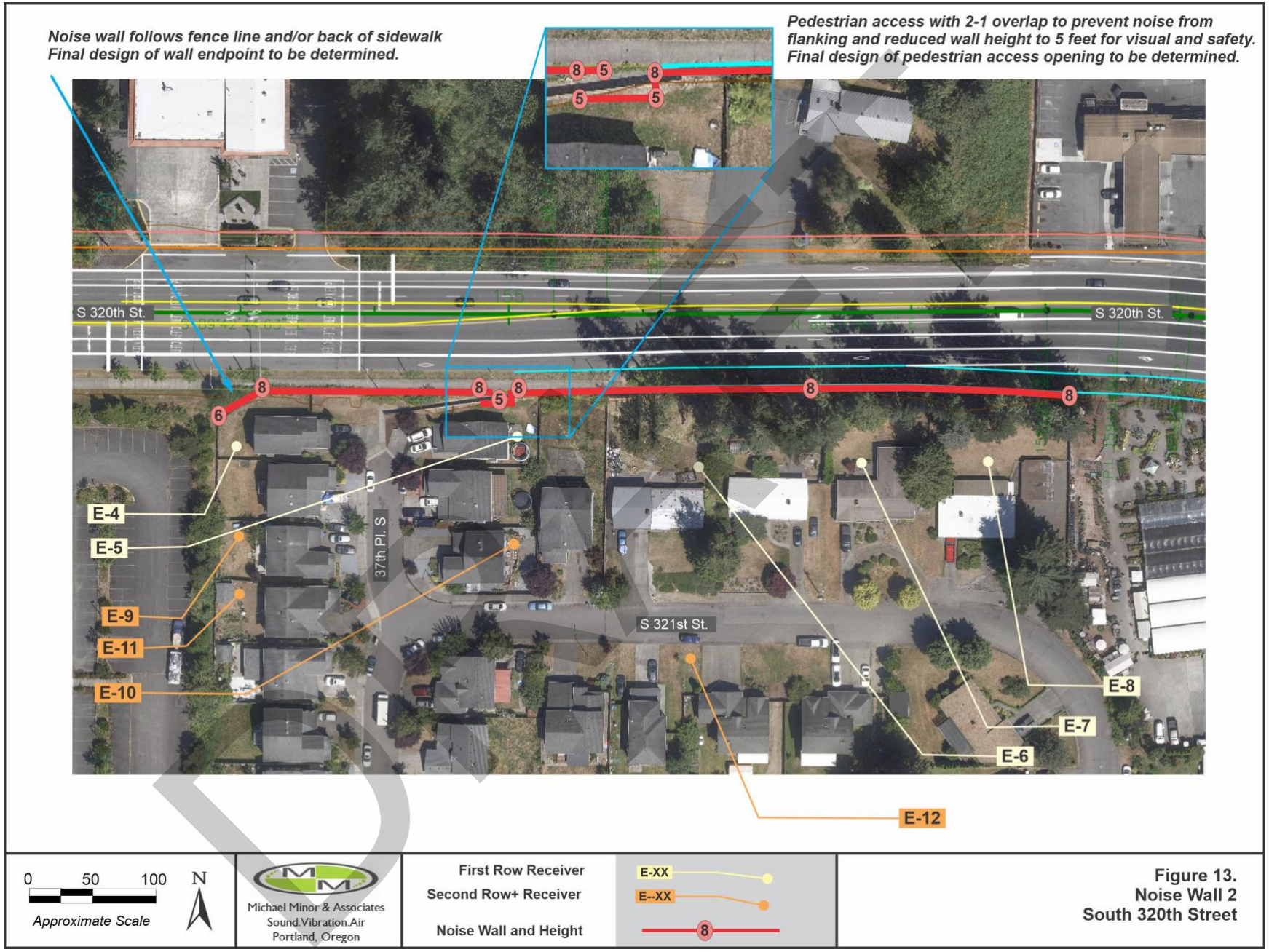

Noise wall follows fence line and/or back of sidewalk
Final design of wall endpoint to be determined.
Pedestrian access with 2-1 overlap to prevent noise from flanking and reduced wall height to 5 feet for visual and safety.
Final design of pedestrian access opening to be determined.
S 320th St.
S 320th St.
37th Pl. S
S 321st St.
E-4
E-5
E-9
E-11
E-10
E-8
E-7
E-6
E-12
0
50
100
Approximate Scale
N
Michael Minor & Associates
Sound.Vibration.Air
Portland, Oregon
First Row Receiver
Second Row+ Receiver
Noise Wall and Height
E-XX
E--XX
8
Figure 13.
Noise Wall 2
South 320th Street

Table 9. Noise Wall 2: Abatement Considered for Receivers E-5 through E-8								
Receiver Information			**Abatement Noise Levels (dBA Leq) and Benefit**				**Wall Sq Ft and Cost**	
Rec#[1]	**Units[2]**	**First-Row[3]**	**Future Build[4]**	**Build with Wall[5]**	**Insertion Loss[6]**	**Benefited (>5 dB)[7]**	**Allowed $[8]**	**Allowed Sq Ft[9]**
E-4	2	Y	**66**	60	6	2	$72,254	1,400
E-5	2	Y	**67**	59	8	2	$79,272	1,536
E-6	2	Y	**69**	60	9	2	$93,310	1,808
E-7	2	Y	**69**	60	9	2	$93,310	1,808
E-8	1	Y	**69**	63	6	1	$46,655	904
E-9	1	N	62	60	2	0	0	0
E-10	1	N	63	59	4	0	0	0
E-11	3	N	60	59	1	0	0	0
E-12	5	N	59	57	2	0	0	0
Criteria Verification Noise Abatement Measure								
Requirement for at least three first-row impacts >5dB[10]							**9 of 9**	**Yes**
Requirement for reasonable noise abatement cost (Sq.-Ft)[11]			**Available Capital (SqFt) (from benefited receivers)**				**$384,801**	**7,456**
			Wall Cost (SqFt)				**$274,359**	**5,316**
			Available minus Cost > 0: Yes				**$110,442**	**2,140**
Max insertion loss from abatement[12]							**9 >= 7**	**Yes**

Notes:

1. Receivers shown in Figure 13 with the noise wall evaluated.
1. Number of units with the same noise level.
2. First-row receivers are directly adjacent to the project roadway.
3. Future Build Noise levels from TNM.
4. Future Build noise levels with the noise wall evaluated from TNM.
5. Insertion loss, in decibels, of the noise wall evaluated.
6. Identifies receivers that are considered benefited under WSDOT policy (5 dB or more insertion loss).
7. Allowable cost per qualified residence from Table 7
8. Allowable wall surface area per qualified residence from Table 7.
9. Insertion loss for three first-row receivers with impacts must be 5 dB or more.
10. Comparison of the allowable cost/sq. ft. to the actual cost/sq. ft. must be a positive number to meet criteria.
11. Maximum insertion loss, must be 7 dB or more.

Noise Wall 2 for residences along 37th Place S and S 321st Street meets WSDOT criteria for reasonable and feasible noise abatement and therefore is recommended for inclusion with the project. Design issues to be reconciled, including wall end points and pedestrian access, will be further reviewed as project design moves forward.

11.4. Noise Abatement Measures, Segment C: Southwest

Overall, noise impacts were identified at 29 receivers representing 44 first row residences and 69 second and third row residences and a park in Segment C. Receivers SW-13 through SW-18 and SW-38 through SW-41 represent 64 residences at Belmor Park along Oakland Hills Boulevard parallel to I-5. Receivers SW-21 through 31 and SW-44 through SW-41 represent 48 residences and one park closest to I-5.

Traffic safety barriers, which can reduce some noise from passenger vehicles, are planned on the new S 324th Street overpass. These barriers along the new S 324th Street overpass and grading, required to allow the overpass to clear over I-5, was included in the analysis. The roundabout and safety barriers provide shielding for units in the north end of Belmor Park and prevent impacts in that area. Finally, the bridge over S 336th Street also has traffic safety barriers that were also included in the analysis of both walls.

The noise impacts in Segment C are due in part to the required removal of an existing noise wall and earth berm, currently providing noise abatement in this area. Based on the most current design drawings, it may be possible to keep the last 300 feet (approximately) of the existing noise wall near the S 336th Street overpass. Therefore, two forms of noise abatement were considered , first a complete replacement wall that would replace the entire wall with a new full-length wall located just off the shoulder of the planned ramps from the new S 324th Street roundabout ramps continuing to the S 336th Street overpass (Noise Wall 3A), and second option that merges and uses up to 300 feet of the noise wall that could be salvaged as defined by the design team (Noise Wall 3B).

Finally, because construction of the Link Light Rail alignment from Federal Way south is likely to be located between the new city center S 324th Street ramps and Belmor Park, a third noise wall option is provided. Under this scenario, the traffic noise wall would be combined with the light rail noise wall and retained fill structures near Belmore Park, and then separated into two noise walls where the light rail transitions to an elevated structure just south of Belmor Park. However, the design and selection of the final light rail alignment is not completed to the extent that would allow for a full analysis for the combined barrier systems. Therefore, no detailed noise analysis is provided for the combined barrier system, however, given the effectiveness of noise walls 3A and 3B, it is clear that a wall would meet WSDOT criteria for reasonable and feasible mitigation. The combination of the retaining wall and the light rail noise wall would reduce the overall requirements necessary for mitigation of traffic noise, resulting in a lower cost with similar noise reduction characteristics.

Figures 14 through 16 show the location of Noise Wall 3A and Figure17 shows the southern end and the changes between Noise Wall 3A and Noise Wall 3B. Both walls are shown on an aerial photo with the proposed roadway improvements and nearby receiver locations.

A final note, receivers SW-13 through SW-17 will have a10 dB substantial increase noise impacts in addition to exceed the 66 dBA Leq NAC. Therefore, the amount of square footage (cost) for reasonable abatement analysis will be taken from the column with the highest value

(see columns B, C and D in Table 7). For example, SW-14 has a 74 dBA Leq future noise level and a 12 dB increase; in this case the analysis would use the 74 dBA for allowance from Table 7, not the 12 dB increase amount, because the 74 dBA amount is higher (1,244 sq-ft versus 1,040 sq-ft). An analysis of the reasonableness and feasibility for Noise Wall 3A and Noise Wall 3B are provided in the following sections.

11.4.1. Noise Wall Option 3A: Complete Replacement Noise Wall

Under Noise Wall Option 3A, the assumption that some of the existing wall-berm could be salvaged was abandoned, and a completely new noise wall was considered. The new replacement wall starts just south of the new roundabout, and starting at 14 feet above local grade. The wall continues for 3,738 feet along the west side of the shoulder of the new on-ramps from the new S 324th Street roundabouts to the final merger near the S 336th Street overpass. The noise wall varies in height, reaching as high as 16 to 18 feet along I-5, and finally reducing to 14 feet, and then 12 feet at the S 336th Street overpass.

The wall has a calculated square footage of 53,176, and an estimated cost using WSDOT policy of $2,744,413. The wall provides benefit to 124.1 residences and a park, including 57 first row receivers with noise reductions of 5 to 12 dB, and up to 9 dB at some second-row receivers.

Table 10 provides a summary of the wall and benefit to receivers in the area. Some receivers in Belmor Park that did not have traffic noise impacts and received no noise reduction from the wall were not included in the table.

Table 10. Noise Wall 3B: One Wall Abatement Considered for Segment C								
Receiver Information			Abatement Noise Levels (dBA Leq) and Benefit				Wall Sq Ft and Cost	
Rec#[1]	Units[2]	First-Row[3]	Future Build[4]	Build with Wall[5]	Insertion Loss[6]	Benefited (>5 dB)[7]	Allowed $[8]	Allowed Sq Ft[9]
SW-9	4	Y	60	59	1	0	0	0
SW-10	2	Y	60	59	1	0	0	0
SW-11	2	Y	61	59	2	0	0	0
SW-12	5	Y	63	61	2	0	0	0
SW-13	4	Y	74	62	12	4	$256,812	4,160
SW-14	5	Y	75	63	12	5	$338,560	5,880
SW-15	5	Y	74	64	10	5	$321,015	6,220
SW-16	4	Y	72	63	9	4	$242,772	4,704
SW-17	6	Y	70	62	8	6	$322,044	6,240
SW-18	7	Y	68	61	7	7	$302,022	5,852
SW-19	9	Y	68	61	7	9	$388,314	7,524
SW-20	5	Y	72	63	9	5	$285,920	5,540
SW-21	1	Y	70	61	9	1	$50,165	972
SW-22	1	Y	69	61	8	1	$46,655	904
SW-23	1	Y	70	61	9	1	$50,165	972
SW-24	1	Y	72	63	9	1	$57,184	1,108
SW-25	1	Y	70	62	8	1	$50,165	972
SW-26	1	Y	70	62	8	1	$50,165	972
SW-27	1	Y	71	63	8	1	$53,674	1,040
SW-28	1	Y	70	62	8	1	$50,165	972
SW-29	2	Y	72	65	7	2	$114,368	2,216
SW-30	2	Y	74	69	5	2	$128,406	2,488
SW-31	3	Y	69	69	0	0	0	0
SW-32	4	N	58	57	1	0	0	0
SW-33	6	N	59	58	1	0	0	0
SW-34	7	N	60	59	1	0	0	0
SW-35	4	N	59	58	1	0	0	0
SW-36	3	N	59	59	0	0	0	0
SW-37	4	N	61	60	1	0	0	0
SW-38	8	N	66	61	5	8	$289,016	5,600
SW-39	8	N	68	60	8	8	$345,168	6,688
SW-40	8	N	67	59	8	8	$317,088	6,144
SW-41	9	N	66	59	7	9	$325,143	6,300
SW-42	7	N	67	60	7	7	$277,452	5,376

SW-43	1	N	**66**	59	7	1	$36,127	700
SW-44	1	N	**71**	63	8	1	$53,674	1,040
SW-45	3.1	N	**68**	62	6	3.1	$133,753	2,592
SW-46	6	N	**69**	62	7	6	$279,930	5,424
SW-47	9	N	**69**	63	6	9	$419,895	8,136
SW-48	7	N	**69**	64	5	7	$326,585	6,328
SW-49	5	N	**69**	65	4	0	0	0
SW-50	5	N	**67**	65	2	0	0	0
SW-51	2	N	**67**	65	2	0	0	0

Criteria Verification Noise Abatement Measure			
Requirement for at least three first-row impacts >5dB[10]		**57 of 73**	**Yes**
Requirement for reasonable noise abatement cost (Sq.-Ft)[11]	**Available Capital (SqFt) (from benefited receivers)**	**$5,912,402**	**113,064**
	Wall Cost (SqFt)	**$2,744,413**	**53,176**
	Available minus Cost > 0: Yes	**$3,176,988**	**59,888**
Max insertion loss from abatement[12]		**12 >= 7**	**Yes**

Notes:

1. Receivers shown in Figure 14 with the noise wall evaluated.
2. Number of units with the same noise level.
3. First-row receivers are directly adjacent to the project roadway.
4. Future Build Noise levels from TNM.
5. Future Build noise levels with the noise wall evaluated from TNM.
6. Insertion loss, in decibels, of the noise wall evaluated.
7. Identifies receivers that are considered benefited under WSDOT policy (5 dB or more insertion loss).
8. Allowable cost per qualified residence from Table 7.
9. Allowable wall surface area per qualified residence from Table 7.
10. Insertion loss for three first-row receivers with impacts must be 5 dB or more.
11. Comparison of the allowable cost/sq. ft. to the actual cost/sq. ft. must be a positive number to meet criteria.
12. Maximum insertion loss, must be 7 dB or more.

The replacement noise wall meets all WSDOT criteria, with a maximum noise reduction of 12 dB, benefiting 57 first row receivers with 5 dB or more of noise reduction, and required less than half of the total allowable square footage. Therefore, this wall is also recommended for further consideration and construction with the project.

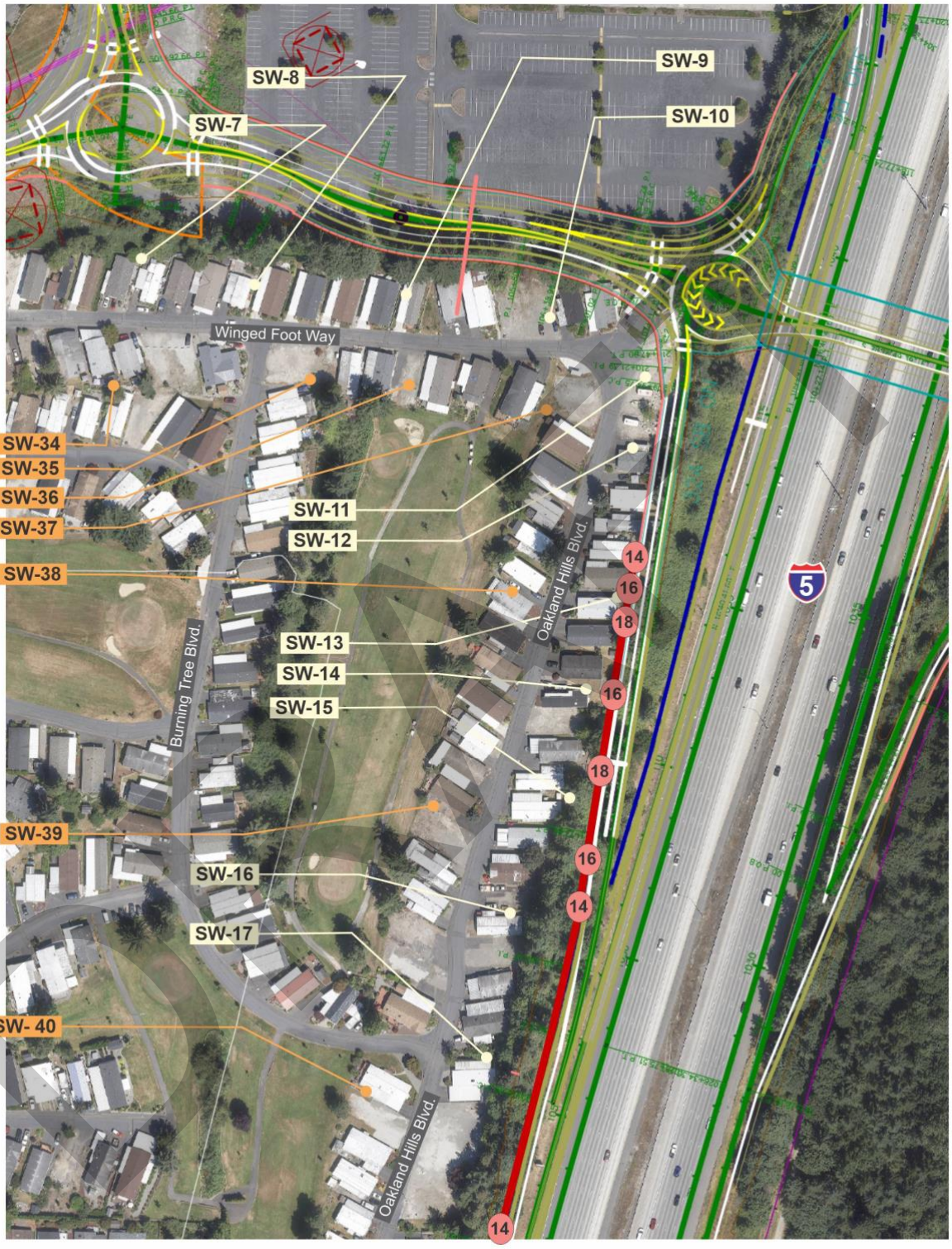


Figure 14.
Noise Wall 3A North End
Belmor to S 336th Street

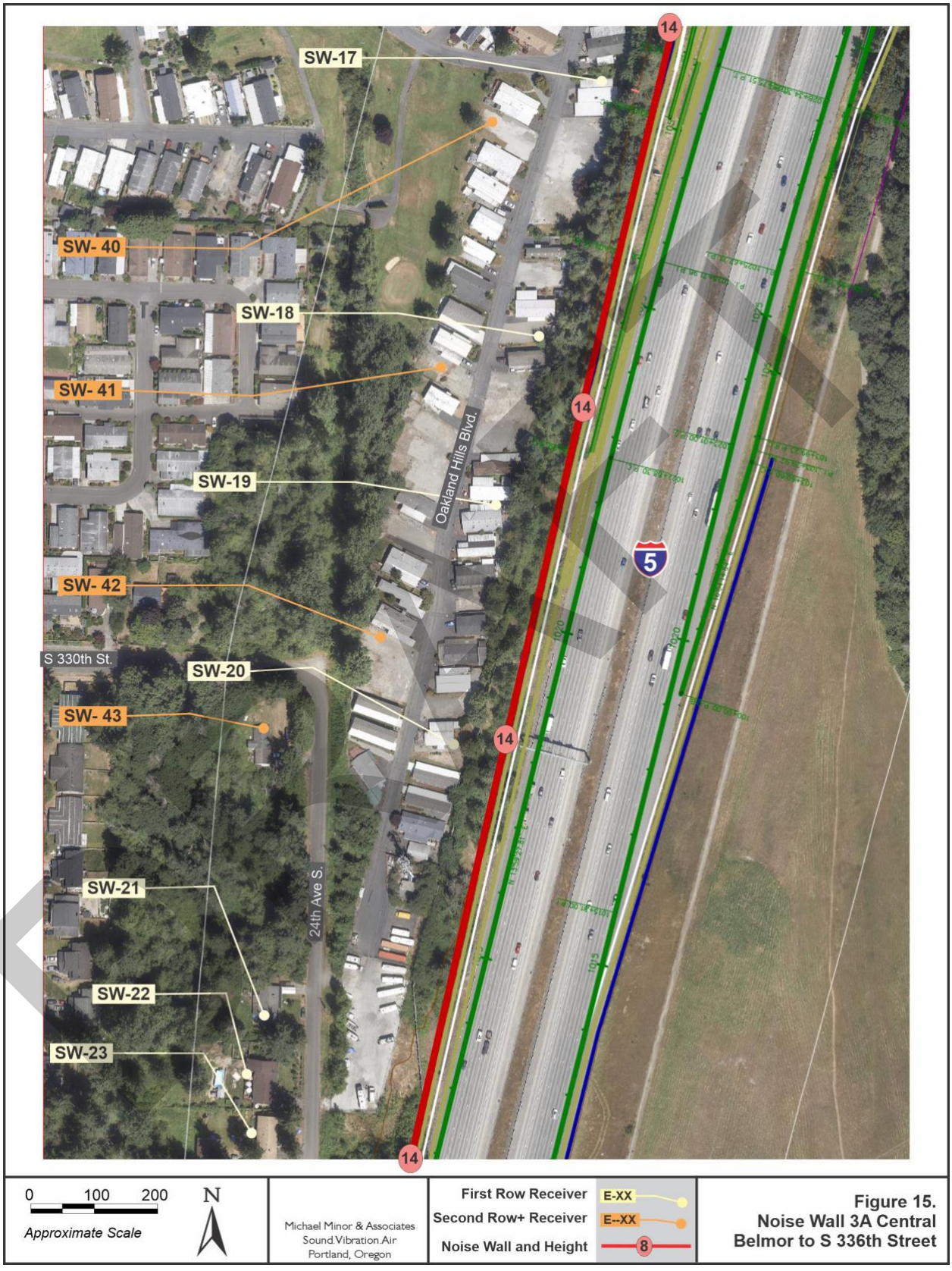


Figure 15.
Noise Wall 3A Central
Belmor to S 336th Street

Figure 16.
Noise Wall 3A South End
Belmor to S 336th Street

11.4.2. Noise Wall Option 3B: Partial Replacement Noise Wall

Noise Wall 3B is one wall similar to Wall 3A but incorporates the 300 feet of the current noise wall near S 336th Street. When calculating the cost of the wall, the remaining portion of the existing wall was not included, reducing the overall cost of this wall when compared to Noise Wall 3A, which is a full-length replacement. In addition, because of the length of the remaining wall, the new wall was evaluated for reasonable and feasible noise abatement with those receivers directly benefited by each part of the wall.

Noise Wall 3B, including the 300 feet of existing noise wall, is 3,778 feet in length, starting at 14 feet tall in the northern end, just south of the new roundabout, and varying in height between 12 and 18 feet, and finally reducing to around 14 feet as it was merged into the existing wall. The wall has a calculated square footage of 48,211, and an estimated cost using WSDOT policy of $2,488,170. The wall provides benefit to 124.1 residences, including 57 first row residences with noise reductions of 5 to 12 dB at first row, and up to 8 dB at some second-row receivers. Receivers behind the remaining 300 feet, including R-28 to R-31 and R-48 to R-50, were not considered as benefited even with reduction as they are protected by the remaining noise wall segment.

Table 11 provides a summary of the wall and benefit to receivers in the area. Some receivers in Belmor Park that did not have any impact and no noise reduction from the wall were not included in the table. Figure 17 shows the southern end of the wall and identifies the 300 feet that may be salvaged during construction.

Table 11. Noise Wall 3B North: Abatement Considered for Belmor Park								
Receiver Information			Abatement Noise Levels (dBA Leq) and Benefit				Wall Sq Ft and Cost	
Rec#[1]	Units[2]	First-Row[3]	Future Build[4]	Build with Wall[5]	Insertion Loss[6]	Benefited (>5 dB)[7]	Allowed $[8]	Allowed Sq Ft[9]
SW-9	4	N	60	59	1	0	0	0
SW-10	2	Y	60	59	1	0	0	0
SW-11	2	Y	61	59	2	0	0	0
SW-12	5	Y	63	61	2	0	0	0
SW-13	4	Y	**74**	62	12	4	$256,812	4,160
SW-14	5	Y	**75**	63	12	5	$338,560	5,880
SW-15	5	Y	**74**	64	10	5	$321,015	6,220
SW-16	4	Y	**72**	63	9	4	$242,772	4,704
SW-17	6	Y	**70**	62	8	6	$322,044	6,240
SW-18	7	Y	**68**	61	7	7	$302,022	5,852
SW-19	9	Y	**68**	61	7	9	$388,314	7,524
SW-20	5	Y	**72**	63	9	5	$285,920	5,540
SW-21	1	Y	**70**	61	9	1	$50,165	972
SW-22	1	Y	**69**	61	8	1	$46,655	904
SW-23	1	Y	**70**	61	9	1	$50,165	972
SW-24	1	Y	**72**	63	9	1	$57,184	1,108
SW-25	1	Y	**70**	62	8	1	$50,165	972
SW-26	1	Y	**70**	62	8	1	$50,165	972
SW-27	1	Y	**71**	63	8	1	$53,674	1,040
SW-28	1	Y	**70**	63	7	1	$50,165	972
SW-29	2	Y	N/A[13]	65	N/A[13]	N/A[13]	N/A[13]	N/A[13]
SW-30	2	Y	N/A[13]	**69**	N/A[13]	N/A[13]	N/A[13]	N/A[13]
SW-31	3	Y	N/A[13]	**69**	N/A[13]	N/A[13]	N/A[13]	N/A[13]
SW-32	4	N	58	57	1	0	0	0
SW-33	6	N	59	58	1	0	0	0
SW-34	7	N	60	59	1	0	0	0
SW-35	4	N	59	58	1	0	0	0
SW-36	3	N	59	59	0	0	0	0
SW-37	4	N	61	60	1	0	0	0
SW-38	8	N	**66**	61	5	8	$289,016	5,600
SW-39	8	N	**68**	60	8	8	$345,168	6,688
SW-40	8	N	**67**	59	8	8	$317,088	6,144
SW-41	9	N	**66**	59	7	9	$325,143	6,300
SW-42	7	N	**67**	60	7	7	$277,452	5,376

SW-43	1	N	**66**	59	7	1	$36,127	700
SW-44	1	N	**71**	63	8	1	$53,674	1,040
SW-45	3.1	N	**68**	62	6	3.1	$133,753	2,592
SW-46	6	N	**69**	63	6	6	$279,930	5,424
SW-47	9	N	**69**	63	6	9	$419,895	8,136
SW-48	7	N	N/A[13]	64	N/A[13]	N/A[13]	N/A[13]	N/A[13]
SW-49	5	N	N/A[13]	65	N/A[13]	N/A[13]	N/A[13]	N/A[13]
SW-50	5	N	N/A[13]	65	N/A[13]	N/A[13]	N/A[13]	N/A[13]
SW-51	2	N	N/A[13]	65	N/A[13]	N/A[13]	N/A[13]	N/A[13]

Criteria Verification Noise Abatement Measure			
Requirement for at least three first-row impacts >5dB[10]		**53 of 62**	**Yes**
Requirement for reasonable noise abatement cost (Sq.-Ft)[11]	**Available Capital (SqFt) (from benefited receivers)**	**$5,343,043**	**102,032**
	Wall Cost (SqFt)	**$2,488,170**	**48,211**
	Available minus Cost > 0: Yes	**$2,854,873**	**53,821**
Max insertion loss from abatement[12]		**9 >= 7**	**Yes**

Notes:

1. Receivers shown in Figure 14 with the noise wall evaluated.
2. Number of units with the same noise level.
3. First-row receivers are directly adjacent to the project roadway.
4. Future Build Noise levels from TNM.
5. Future Build noise levels with the noise wall evaluated from TNM.
6. Insertion loss, in decibels, of the noise wall evaluated.
7. Identifies receivers that are considered benefited under WSDOT policy (5 dB or more insertion loss).
8. Allowable cost per qualified residence from Table 7.
9. Allowable wall surface area per qualified residence from Table 7.
10. Insertion loss for three first-row receivers with impacts must be 5 dB or more.
11. Comparison of the allowable cost/sq. ft. to the actual cost/sq. ft. must be a positive number to meet criteria.
12. Maximum insertion loss, must be 7 dB or more.
13. Receivers R-28 to R-31 and R-48 to R-51 are protected by the remaining wall and therefore any benefit was not included in the reasonable calculations. Future noise levels are provided for information.

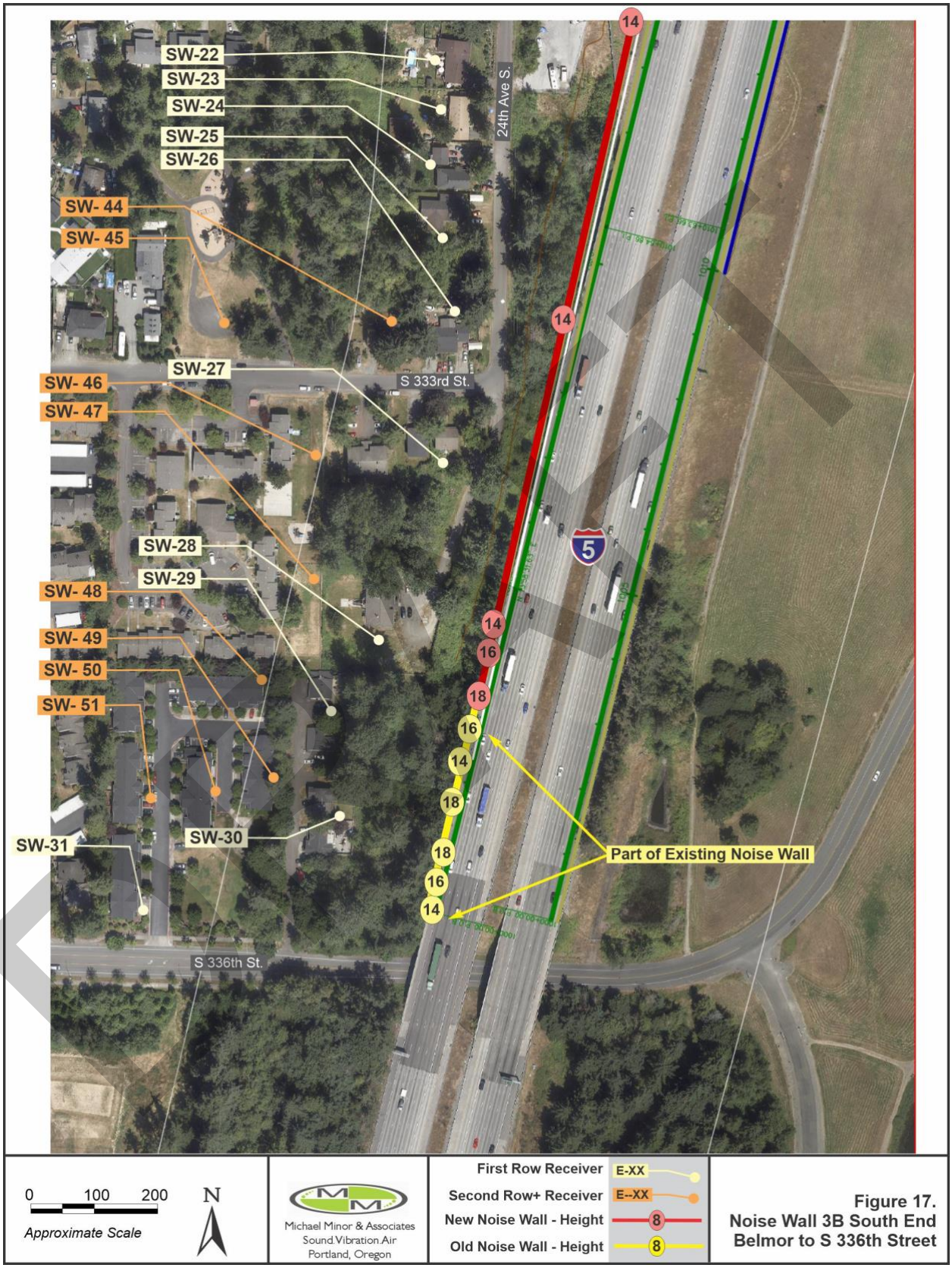


Figure 17.
Noise Wall 3B South End
Belmor to S 336th Street

11.1. Noise Wall 3: Additional Consideration

In addition to the two different noise walls presented for Segment C, the potential construction of a new Sound Transit maintenance facility could occur south of S 336th Street, approximately 1,000 feet south of Belmor Park. This would require installing a light rail alignment along the west side of I-5, generally between the Belmor Park and residential area to the south and the new I-5 ramps being constructed as part of this project.

Current plans call for the light rail to enter the northern part of Belmor Park on an aerial guideway, and then transitions to a retained fill. As the trackway proceeds south the retained fill transitions to at-grade and then, just north of S 336th Street, the alignment transitions back to an aerial structure, proceeding over S 336th Street.

Conceptual plans for a wall were discussed between the City Center design team and Sound Transit. Based on this discussion, a conceptual noise mitigation package was derived. The package would include increasing the heights of the light rail noise walls to also provide noise abatement for traffic noise from the City Center project. When the light rail transitions back to an aerial structure near S 336th Street, a new noise wall for traffic noise abatement would be required.

For reference, a graphic was prepared showing the conceptual noise mitigation package for this area. The walls, with the approximate location of the Link Light Rail are shown on Figures 18 and 19. Figure 18 shows the northern segment of this area, and includes most of Belmor Park. Figure 19 shows the southern segment, from Belmor Park to S 336th Street. The three types of noise walls, a combination of traffic and rail, rail only and traffic only, are displayed in different colors for easy identification.

Additional coordination with Sound Transit is currently underway, and once more detailed information is available, additional noise modeling will be required to finalize the wall heights. Given the reasonability and feasibility characteristics of the replacement walls (see Noise Walls 3A and 3B), it is assumed that the mitigation package will meet WSDOT criteria for noise abatement.

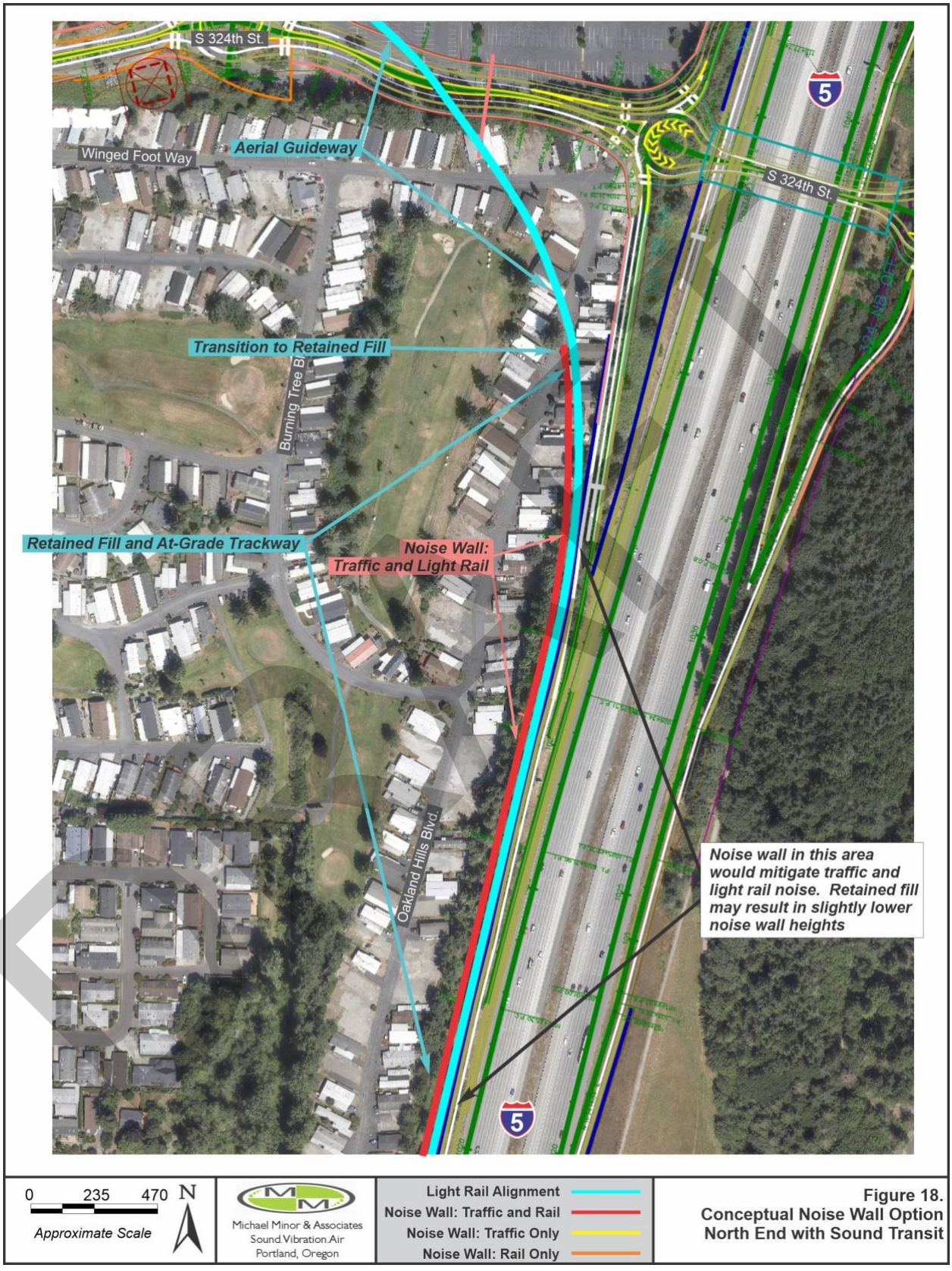


Figure 18.
Conceptual Noise Wall Option
North End with Sound Transit

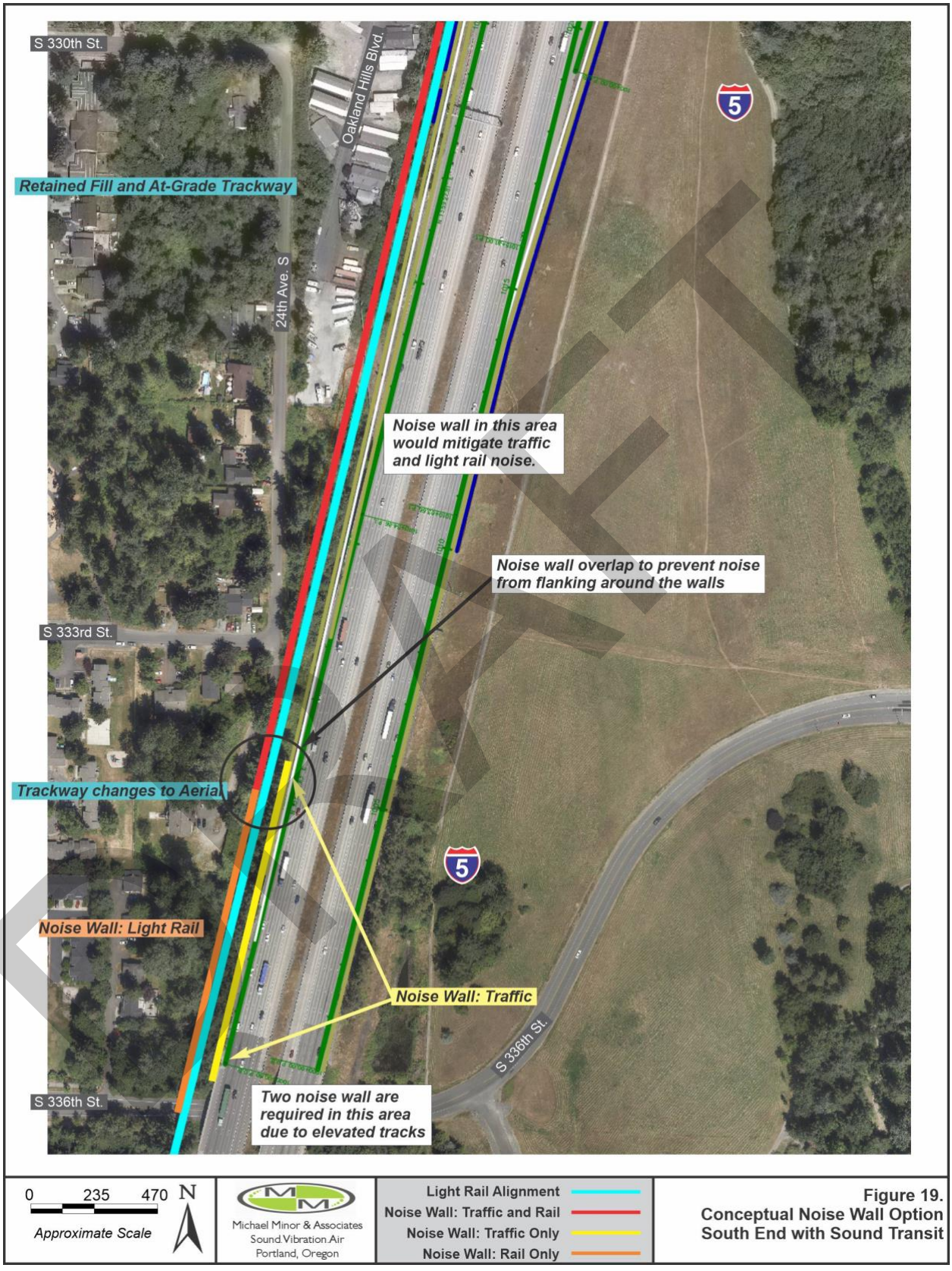


Figure 19.
Conceptual Noise Wall Option South End with Sound Transit

12.CONSTRUCTION NOISE ANALYSIS

Construction noise levels for the proposed Project improvements would result from normal construction activities. Noise levels for construction activities can be expected to range from 70 to 95 dBA at sites 50 feet from the activities. Table 12 lists equipment typically used for constructing this type of Project, the activities for which the equipment would be used, and the corresponding maximum noise levels under normal use measured at 50 feet.

Table 12. Construction Equipment List, Use, and Reference Maximum Noise Levels

Equipment	Typical Expected Project Use	Lmax dBA at 50 feet [a]
Air Compressor	Used for pneumatic tools and general maintenance	78-80
Backhoe	General construction and yard work	78–80
Compactor	Roadway surfacing	80-83
Concrete Pump	Pumping concrete	81-82
Concrete Saw	Concrete removal, utilities access	90
Crane	Materials handling, removal, and replacement	81-85
Excavator	General construction and materials handling	81-85
Haul Truck	Materials handling, general hauling	76-84
Jackhammer	Pavement removal	85-89
Loader	General construction and materials handling	79-80
Paving	Roadway paving	77-85
Power Plant	General construction use, nighttime work	70-73
Pump	General construction use, water removal	77-81
Pneumatic Tools	Miscellaneous construction work	85
Service Truck	Repair and maintenance of equipment	55-75
Tractor Trailer	Material removal and delivery	74-84
Welder	General project work	76

Notes:
[a] Maximum noise level measured at a distance of 50 feet under normal operation.
Source: FHWA RCNM User's Guide

The Project would include a combination of new road construction and upgrades to existing roadways. The existing roadway would be preserved to the largest extent possible and will follow the existing alignment and profile. In many areas, construction would include grinding the roadway and placing asphalt in the travel lanes and constructing planters and sidewalks adjacent to the roadway. In other places, construction of the roadway would include the removal of existing asphalt and concrete surfaces, clearing and grading of adjacent areas, and placing subgrade material to form a stable roadbed. New road surfaces would be primarily

asphalt and concrete. Fill would be required on both sides of the new S 324th Street bridge and construction of the bridge over I-5 would require nighttime construction for lane closures. The new bridge would likely be supported on driven piles or drilled shaft foundations.

12.1. Construction Noise Levels

Construction equipment could include, but is not limited to, cranes, backhoes, excavators, front loaders, pavement grinders, jack hammers, drilling rigs, pile drivers, trucks, and concrete pumping equipment. Staging areas would be located within the right of way and adjacent City-owned parcels where possible to allow for parking, large equipment storage, and material stockpiles.

Major noise-producing equipment in use during the site preparation phase would include saw cutters, concrete pumps, cranes, excavators, haul trucks, loaders, tractor-trailers, and vibratory equipment. Maximum noise levels could reach 82 to 88 dBA at the nearest noise sensitive areas (i.e., within 50 to 100 feet) for normal construction activities during this phase. Other less notable noise-producing equipment expected to be used during site preparation would be backhoes, air compressors, forklifts, pumps, power plants, service trucks and utility trucks.

During construction of the new bridge structure, the equipment needed would include cement mixers, concrete pumps, cranes, pavers, haul trucks and tractor-trailers. Cement mixers, cranes and concrete pumps would be required for construction of the supporting structures. Saw cutters, back-hoes, pavers, haul trucks and material deliveries on flatbed trucks are likely to be used to provide the final surface. Maximum noise levels from these activities would range from 82 to 88 dBA at 50 feet.

Following heavy construction, general construction would still be required, such as installation of signage as well as other miscellaneous activities such as roadway stripping. These less intensive activities are not expected to produce noise levels above 80 dBA at 50 feet except during rare occasions. Even then, noise levels from these activities would exceed 80 dBA at 50 feet only for short periods of time, during which combined maximum noise levels could reach 86 dBA Lmax at 50 feet.

12.2. Pile Driving

Although not expected to be needed for most of the corridor, the use of pile-driving of support piles or sheet piles may be required for construction of the new bridge or for retaining walls. Workers would install piles using a standard pile-drivers, which can produce an impact noise of 90 to 105 dBA depending on the type of piles being driven and the type of pile driver used. Alternative methods for pile installation could be considered, such as driving the piles using an auger instead of an impact driver. In addition, any pile-driving would be subject to the regulatory requirements of the local jurisdiction. Pile-driving at night is typically prohibited.

To provide an estimate of sound level versus distance for worst case pile driving, Figure 20 was prepared. The figure shows how pile driving would reduce with distance based on a reference level of 105 dBA at 50 feet.

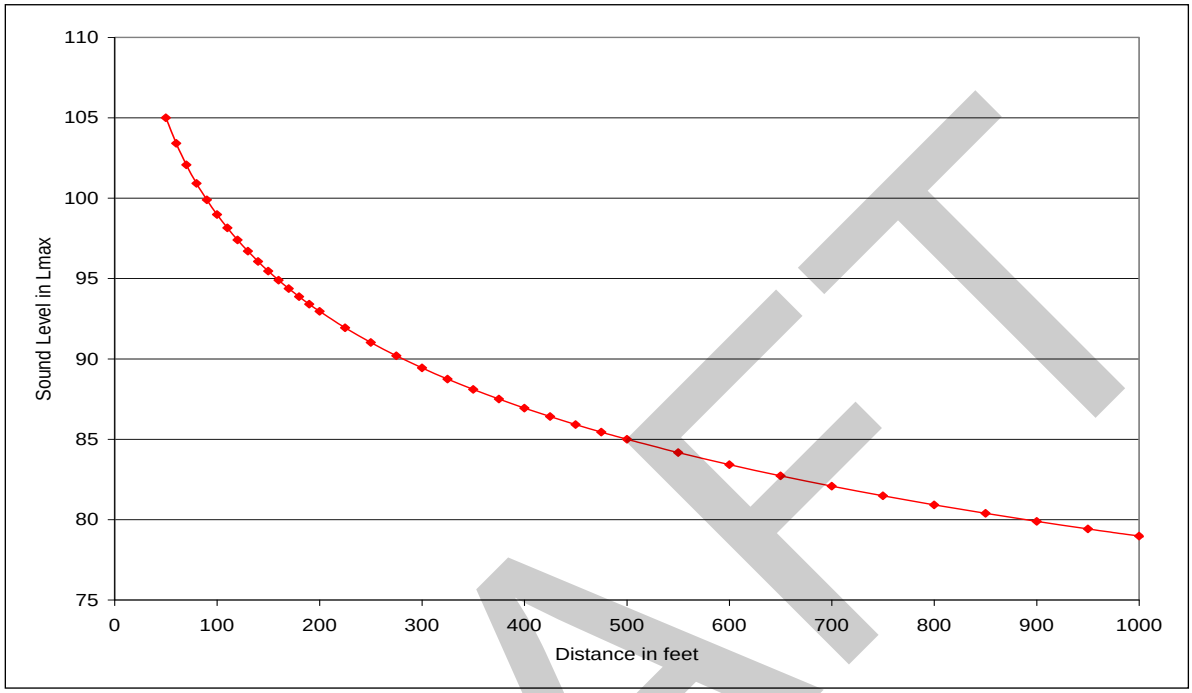


Figure 20. Pile Driving Noise Levels versus Distance.

12.3. Construction Noise Mitigation Measures

Construction noise levels, although temporary in nature, can be annoying. As described in Section 4.2 there are construction noise limitations imposed under Section 7.10.050 of the City of Federal Way Municipal Code and Section 12.86.520 of the King County Code. In Section 7.10.020 of the city code are exemptions for sounds originating from construction sites and activities between 7:00 a.m. and 10:00 p.m. on weekdays and 9:00 a.m. and 8:00 p.m. on weekends. In Section 12.86.520 of the county code are exemptions for sounds originating from heavy construction equipment between 7:00 a.m. and 7:00 p.m. on weekdays and 9:00 a.m. and 7:00 p.m. on weekends; sounds originating from impact type of construction equipment from 8:00 a.m. and 5:00 p.m. on weekdays and 9:00 a.m. and 5:00 p.m. on weekends; and all other sounds originating from construction sites and activities between 7:00 a.m. and 10:00 p.m. on weekdays and 9:00 a.m. and 8:00 p.m. on weekends. Work outside these hours would be required to meet the maximum allowable noise levels in Tables 2 and 3, or obtain a noise variance from the City of Federal Way or King County.

The following is a list of potential construction noise mitigation measures that could be included in the contract specifications:

- Require all engine-powered equipment to have mufflers that were installed according to the manufacturer's specifications.
- Require all equipment to comply with pertinent Environmental Protection Agency (EPA) equipment noise standards.
- Limit jackhammers, concrete breakers, saws, and other forms of demolition to daytime hours of within the City of Federal Way to 7:00 a.m. to 7:00 p.m. on weekdays, with more stringent restrictions on weekends, or in King County to 8:00 a.m. to 5:00 p.m. on weekdays, with more stringent restrictions on weekends.
- Minimize noise by regular inspection and replacement of defective mufflers and parts that do not meet the manufacturer's specifications.
- Install temporary or portable acoustic barriers around stationary construction noise sources and along the sides of the temporary bridge structures, where feasible.
- Locate stationary construction equipment as far from nearby noise-sensitive properties as possible.
- Shut off idling equipment.
- Reschedule construction operations to avoid periods of noise annoyance identified in complaints.
- Notify nearby residents whenever extremely noisy work would be occurring.
- Use non-pure tone back-up alarms or restrict the use of back-up beepers during evening and nighttime hours and use spotters. In all areas, Occupational Safety and Health Administration (OSHA) will require back-up warning devices and spotters for haul vehicles.
- Additional noise mitigation measures might be implemented as more details on the actual construction processes are identified.

Appendix A: References

City of Federal Way. Federal Way Revised Code, Chapter 4-05 Park Regulations. December 2020.

King County. King County Code, Chapter 12-86 Public Peace, Safety, and Morals. July 2015.

Sound Transit. Noise and Vibration Technical Report, Federal Way Link Extension (F200) Noise and Vibration – Technical Report, Rev 4 – 01/27/2021, Contract No. RTA/CN 0009-17, January 2021.

Washington State Department of Transportation. 2020 Traffic Noise Policy and Procedures. WSDOT March 2020.

Washington State Legislature. Washington Administrative Code, Chapter 173-60 Maximum environmental noise levels. December 2000.

U.S. Department of Transportation. FHWA Highway Traffic Noise Model User's Guide, Report No. FHWA-PD-96-009. Federal Highway Administration, Washington, D.C. January 1998.

U.S. Department of Transportation. FHWA Highway Traffic Noise Model User's Guide (Version 2.5 Addendum) Final Report. Federal Highway Administration, Washington, D.C. April 2004.

U.S. Department of Transportation. Roadway Construction Noise Model User's Guide, Final Report. Federal Highway Administration, Washington, D.C. January 2006.

Appendix B: Introduction to Acoustics

Sound is defined as any pressure variation that the human ear can detect, from barely perceptible sounds to sound levels that can cause hearing damage. The magnitude of the variations of the air pressure from the static air pressure is a measure of the sound level. The number of cyclic pressure variations per second is the frequency of sound. When sounds are unpleasant, unwanted, or disturbingly loud, we tend to classify them as noise.

Compared with the static air pressure, the audible sound pressure variations range from the threshold of hearing, a very small 20 μPa (20 x 10^{-6} Pascal), to 100 Pa, a level so loud it is referred to as the threshold of pain. Because the ratio between these numbers is more than a million to one, using Pascal to describe sound levels can be awkward. The "dB" measurement is a logarithmic conversion of air pressure level variations from Pascal to a unit of measure with a more convenient numbering system. This conversion not only allows for a more convenient scale, but is also a more accurate representation of how the human ear reacts to variations in air pressure. Measurements made using the decibel scale will be denoted dB.

The smallest noise level change that can be detected by the human ear is approximately 3 dB. A doubling in the static air pressure amounts to a change of 6 dB, and an increase of 10 dB is roughly equivalent to a doubling in the perceived sound level. Under free-field conditions, where there are no reflections or additional attenuation, sound is known to decrease at a rate of 6 dB for each doubling of distance. This is commonly known as the inverse square law. For example, a sound level of 70 dB at a distance of 100 feet would decrease to 64 dB at 200 feet, or 58 dB at 400 feet. The mathematical definition of sound pressure level in dB is listed below.

L_p (sound pressure level). The sound pressure in dB is 20 times the log of the ratio of the measured pressure, p, to the static pressure, p_o, where p_o is 20 μPa.

$$L_{pa} = 20Log_{10}\left(\frac{p}{p_o}\right)dB \quad (re\ 20\mu Pa)$$

In acoustic measurements where the primary concern is the effect on humans, the sound readings are sometimes compensated by an "A"-weighted filter. The A-weighted filter accounts for people's limited hearing response in the upper and lower frequency bands. Sound pressure level measurements made using the A-weighted filter are denoted dBA.

General Measurement Descriptors

- **Leq (equivalent continuous sound level).** The constant sound level in dBA that, lasting for a time "T," would have produced the same energy in the same time period "T" as an actual A-weighted noise event.

$$L_{eq} = 20Log_{10}\frac{1}{T}\int_{T}^{0}\left(\frac{p(t)}{p_o}\right)^2 dt$$

- **MaxPeak (maximum A-weighted sound level).** The greatest continuous sound level, in dBA, measured during the preset measurement period.
- **Lmax (maximum A-weighted RMS sound level).** The greatest RMS (root-mean square) sound level, in dBA, measured during the preset measurement period.
- **Lmin (minimum A-weighted RMS sound level).** The lowest RMS (root-mean square) sound level, in dBA, measured during the preset measurement period.

Statistical Noise Level Descriptors

Public response to sound depends greatly upon the range that the sound varies in a given environment. For example, people generally find a moderately high, constant sound level more tolerable than a quiet background level interrupted by high-level noise intrusions. In light of this subjective response, it is often useful to look at a statistical distribution of sound levels over a given time period. Such distributions identify the sound level exceeded and the percentage of time exceeded. Therefore, it allows for a more complete description of the range of sound levels during the given measurement period.

The sound level descriptor L_{xx} is defined as the sound level exceeded XX percent of the time. Some of the more common versions of this descriptor and their corresponding definitions are listed below:

- L01 The sound level is exceeded 1 percent of the time. This is a measure of the loudest sound levels during the measurement period. Example: During a 1-hour measurement, an L01 of 95 dBA means the sound level was at or above 95 dBA for 36 seconds.
- L50 The sound level is exceeded 50 percent of the time. This level corresponds to the median sound level. Example: During a 1-hour measurement, an L50 of 67 dBA means the sound level was at or above 67 dBA for 30 minutes.
- L90 The sound level is exceeded 90 percent of the time. This is a measure of the nominal background level. Example: During a 1-hour measurement, an L90 of 50 dBA means the sound level was at or above 50 dBA for 54 minutes.

Other commonly used L_{XX} values include $L_{2.5}$, $L_{8.3}$, and L_{25}. These correspond to the 5-, 10-, and 15-minute time levels for a 1-hour measurement period, respectively.

Typical Sound Levels

Table B-1 contains some common noise sources, their nominal maximum sound level in dBA, and the usual public response. The levels in this graph are comparable to the Lmax noise level descriptor. This graph would be useful when comparing the loudest noise produced with other familiar noise sources a person may have experienced.

Table B-1. Typical Maximum Sound Levels

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

Sources: Beranek (1988) and U.S. EPA (1971).

Appendix C: Traffic Data

I-5 PM Peak Hour Volumes (Vehicles Per Hour)

2017 Existing PM Peak Hour Volumes (Vehicles Per Hour)

I-5 Northbound	2:15pm								
Lane Type	Mainline	Ramp On from 317th	Mainline	Ramp On from 320th	Mainline	Ramp Off to 317th	Mainline	Ramp Off to 320th	Mainline
General Purpose	4,515	0	4,515	710	3,805	0	3,805	460	4,265
HOV	785	90	695	125	570	100	670	80	750

I-5 Southbound	2:15pm								
Lane Type	Mainline	Ramp off to 317th	Mainline	Ramp off to 320th	Mainline	Ramp on from 317th	Mainline	Ramp on from 320th	Mainline
General Purpose	7,140	0	7,140	1,120	6,020	0	6,020	500	6,520
HOV	1,260	195	1,065	200	865	75	940	90	1,030

2045 No-Build PM Peak Hour Volumes (Vehicles Per Hour)

I-5 Northbound	2:15pm								
Lane Type	Mainline	Ramp On from 317th	Mainline	Ramp On from 320th	Mainline	Ramp Off to 317th	Mainline	Ramp Off to 320th	Mainline
General Purpose	4,915	0	4,915	720	4,195	0	4,195	465	4,660
HOV	795	90	705	125	580	155	735	85	820

I-5 Southbound	2:15pm								
Lane Type	Mainline	Ramp off to 317th	Mainline	Ramp off to 320th	Mainline	Ramp on from 317th	Mainline	Ramp on from 320th	Mainline
General Purpose	8,375	0	8,375	1,325	7,050	0	7,050	800	7,850
HOV	1,480	310	1,170	235	935	85	1,020	140	1,160

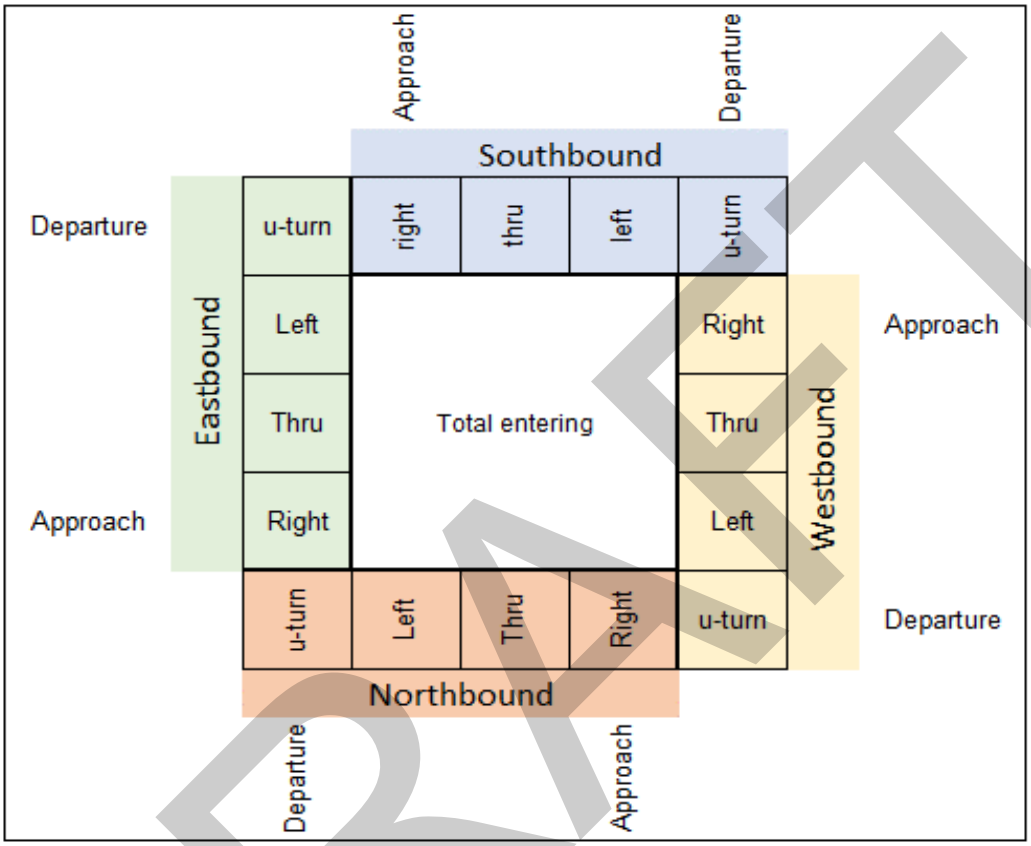
2045 Build PM Peak Hour Volumes (Vehicles Per Hour)

I-5 Northbound	2:15pm								
Lane Type	Mainline	Ramp On from 317th	Mainline	Ramp On from	Mainline	Ramp Off to 317th	Mainline	Ramp Off to 320th/324th	Mainline
General Purpose	4,915	0	4,915	720	4,195	0	4,195	465	4,660
HOV	795	90	705	125	580	155	735	85	820

I-5 Southbound	2:15pm								
Lane Type	Mainline	Ramp off to 317th	Mainline	Ramp off to 320th	Mainline	Ramp on from 317th	Mainline	Ramp on from 320th	Mainline
General Purpose	8,375	0	8,375	1,325	7,050	0	7,050	800	7,850
HOV	1,480	310	1,170	235	935	85	1,020	140	1,160

LEGEND

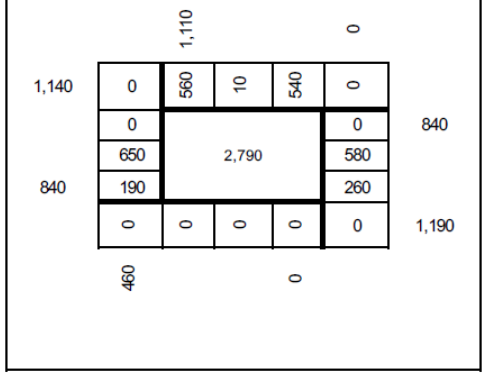
#	N-S Roadway
	E-W Roadway



2017 Existing PM Peak Hour Volumes (Vehicles Per Hour)

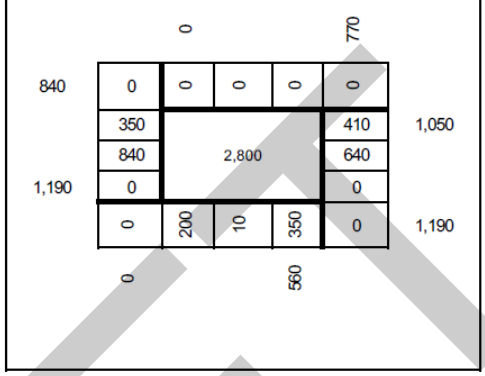
2017 Existing

1 I-5 SB Ramps / S 272nd Street

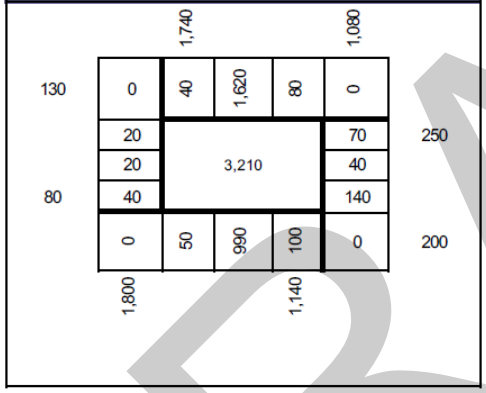


2017 Existing

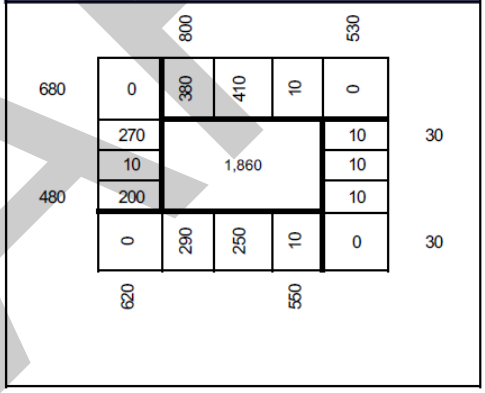
2 I-5 NB Ramps / S 272nd Street



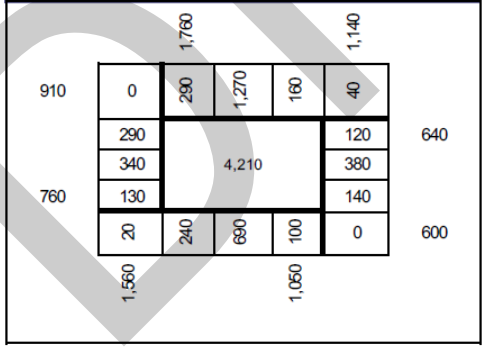
3 Pacific Highway S / S 304th Street



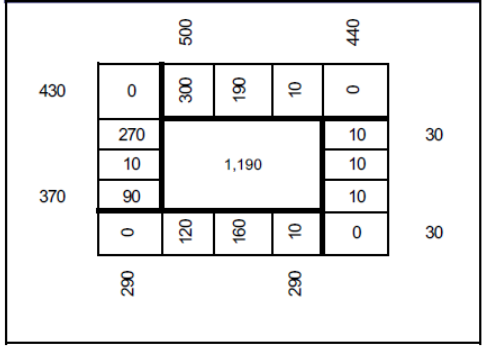
4 Military Rd S / S 304th Street



5 Pacific Highway S / S 312th Street

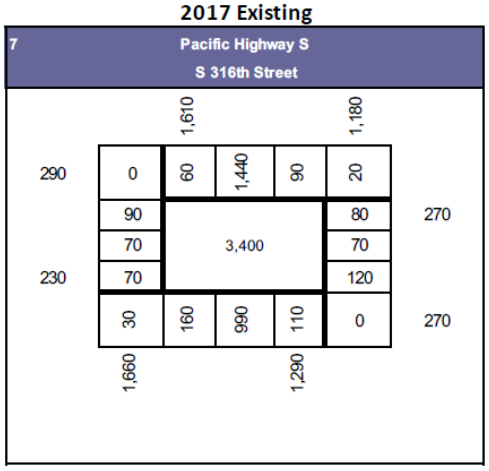


6 28th Avenue S / S 312th Street



2017 Existing PM Peak Hour Volumes (Vehicles Per Hour)

2017 Existing



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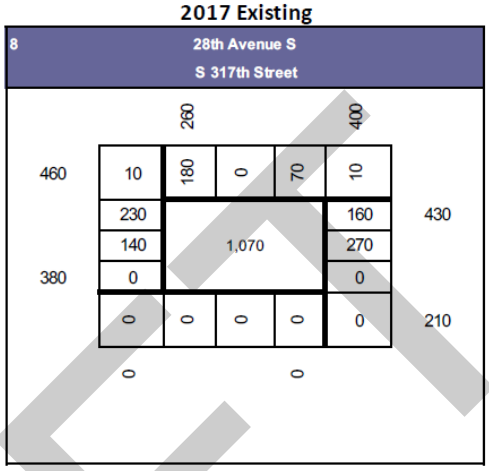
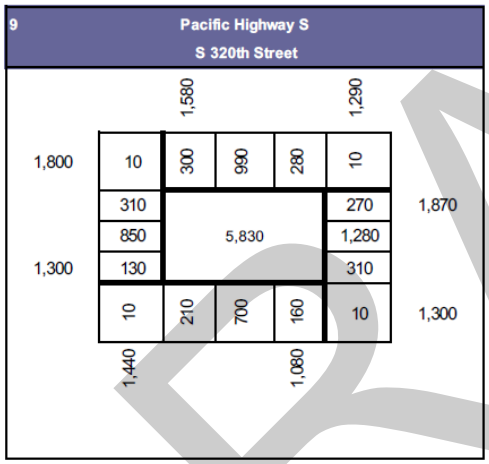
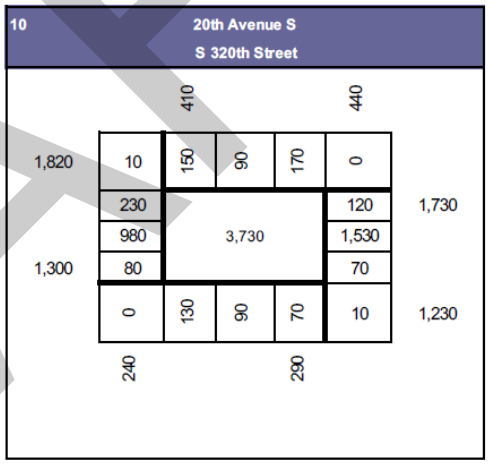
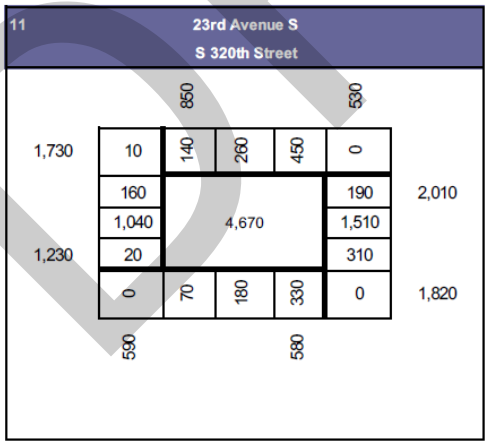
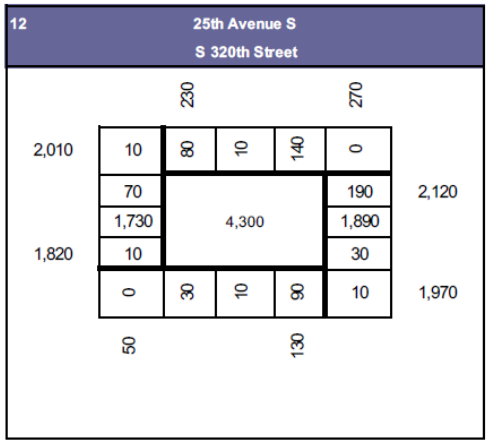




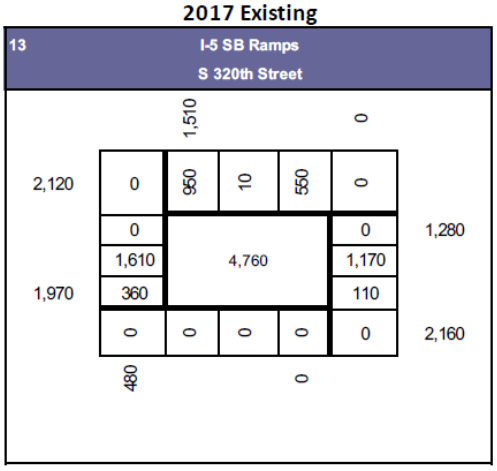






2017 Existing PM Peak Hour Volumes (Vehicles Per Hour)

2017 Existing



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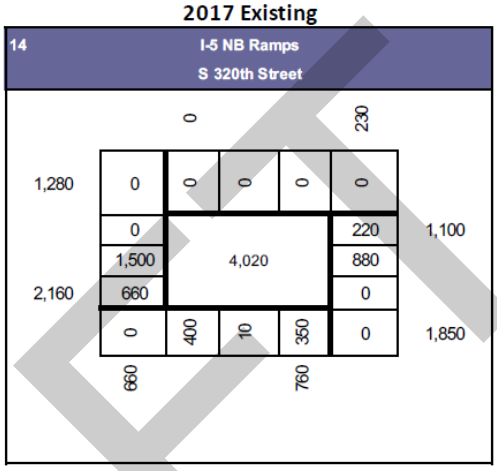
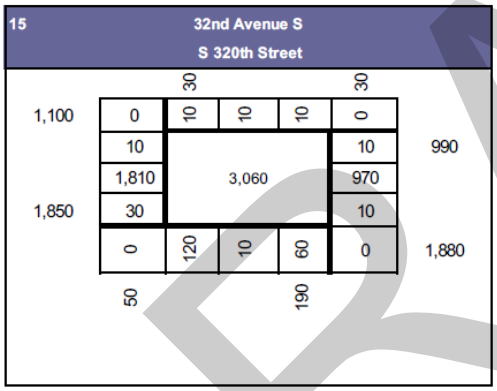
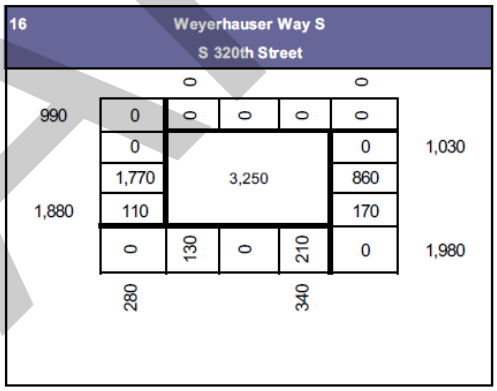
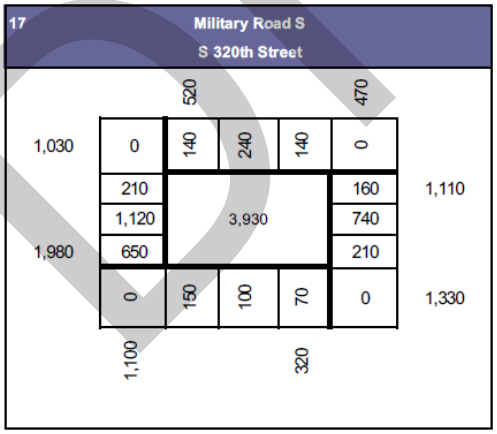
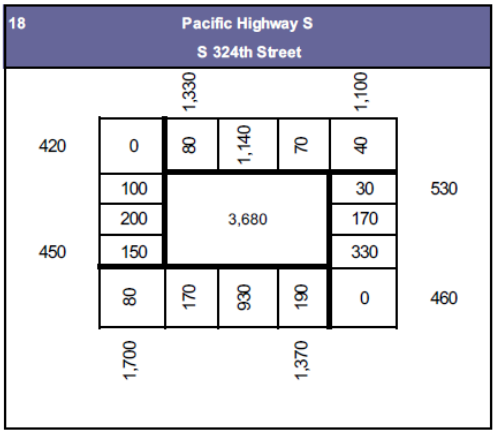




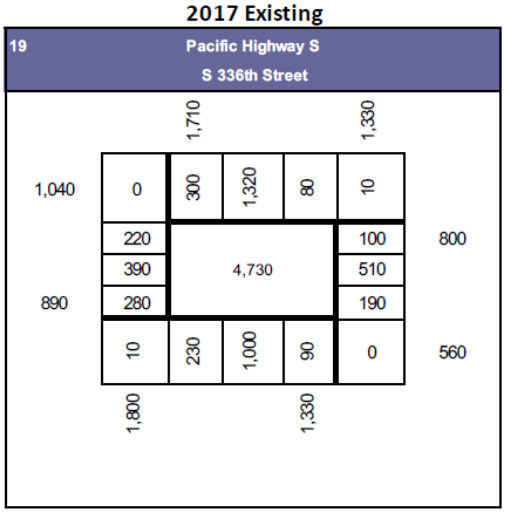




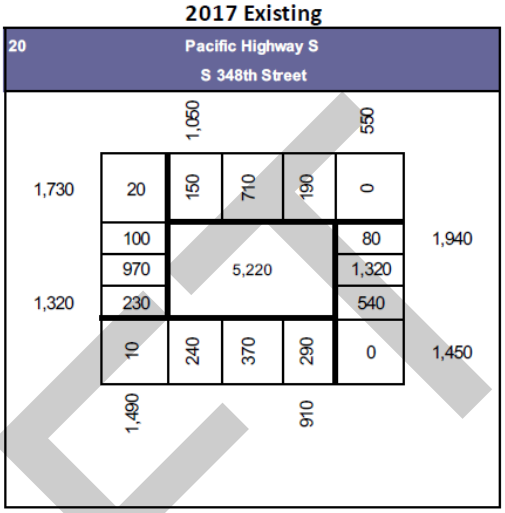


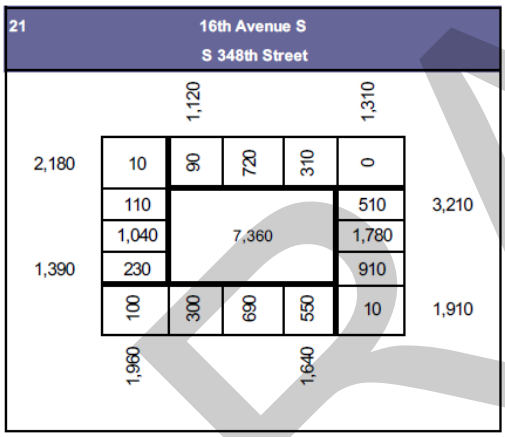
2017 Existing PM Peak Hour Volumes (Vehicles Per Hour)

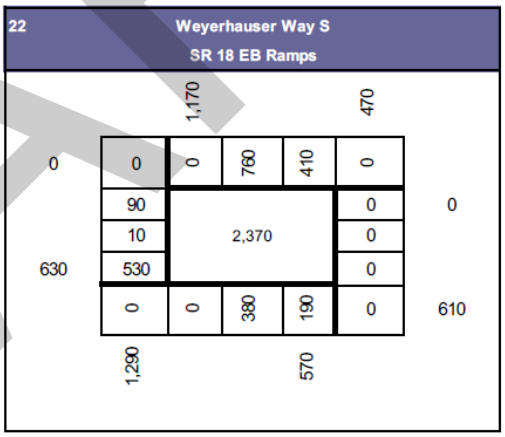
2017 Existing

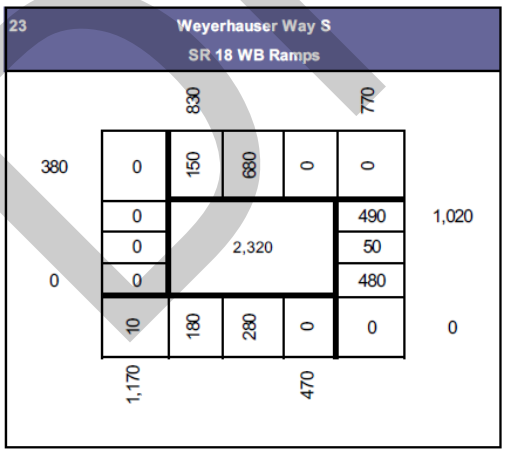


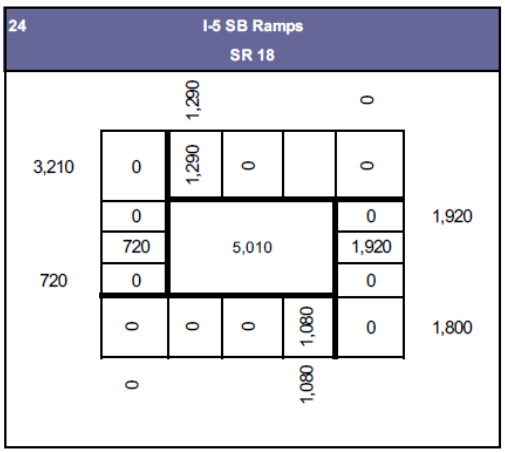
2017 Existing





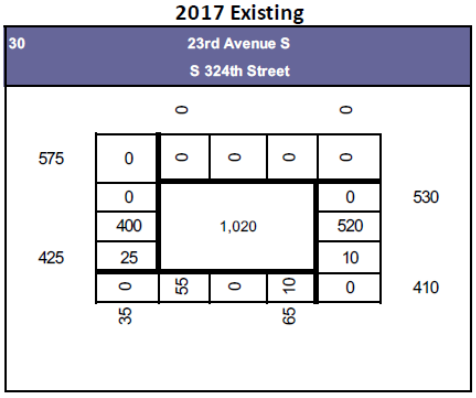






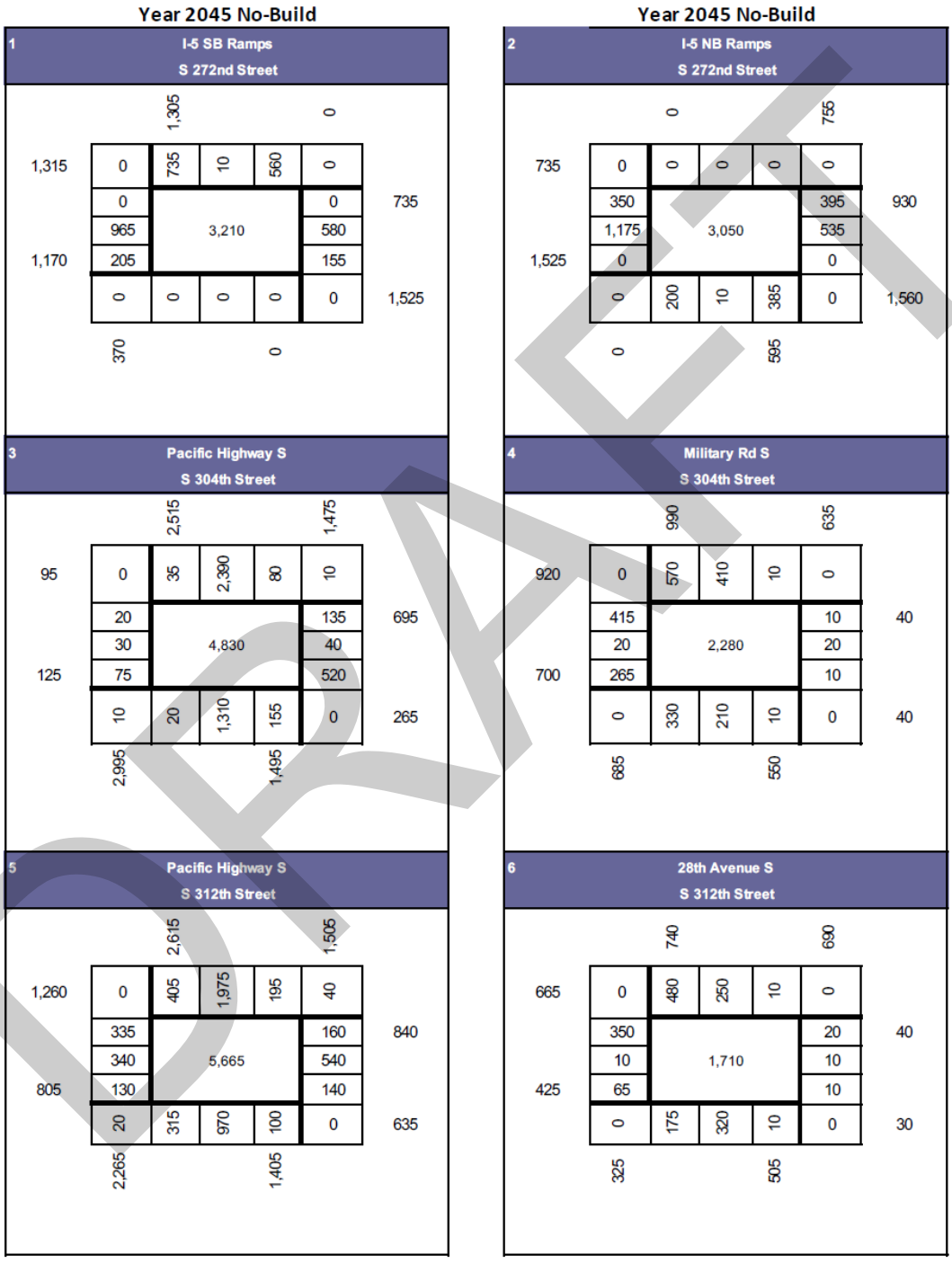
2017 Existing PM Peak Hour Volumes (Vehicles Per Hour)

2017 Existing



2017 Existing

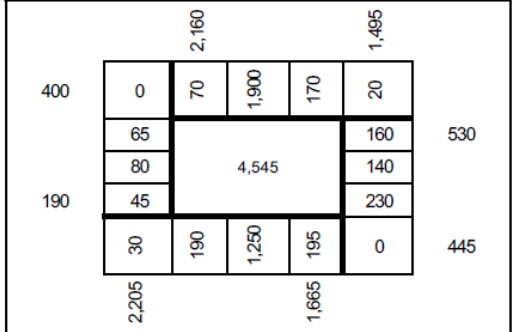
2045 No-Build PM Peak Hour Volumes (Vehicles Per Hour)



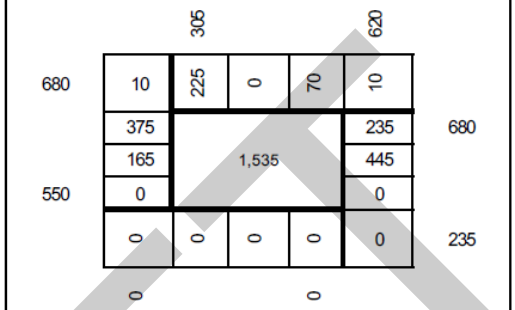
2045 No-Build PM Peak Hour Volumes (Vehicles Per Hour)

Year 2045 No-Build

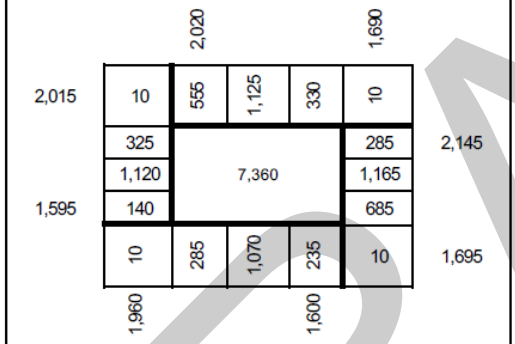
7 — Pacific Highway S & S 316th Street



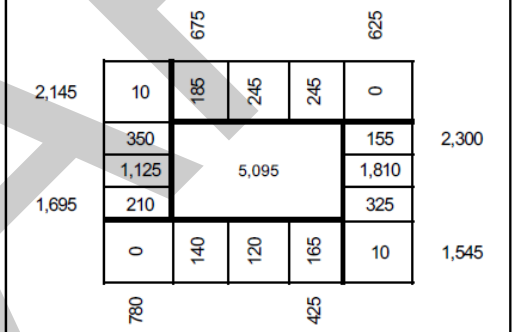
8 — 28th Avenue S & S 317th Street



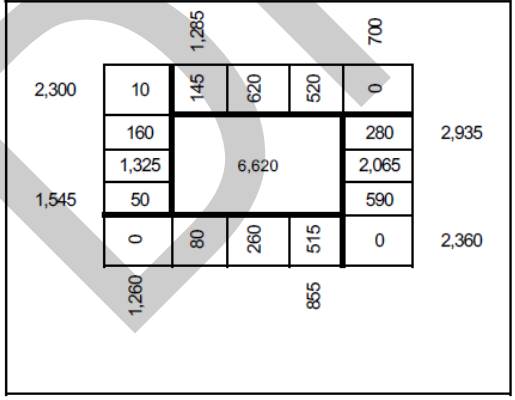
9 — Pacific Highway S & S 320th Street



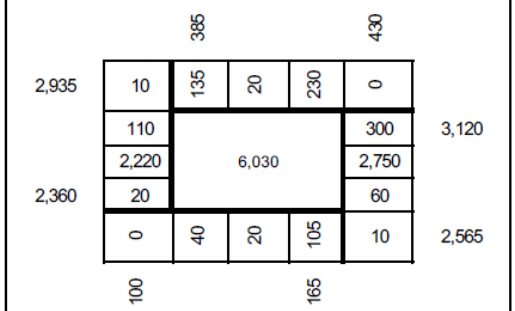
10 — 20th Avenue S & S 320th Street



11 — 23rd Avenue S & S 320th Street



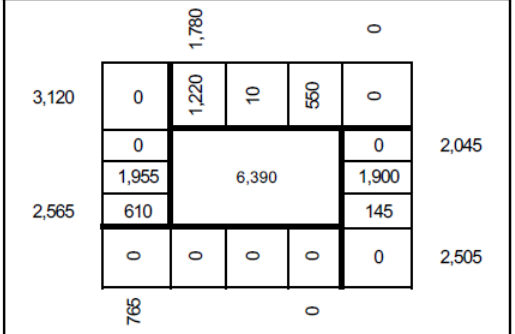
12 — 25th Avenue S & S 320th Street



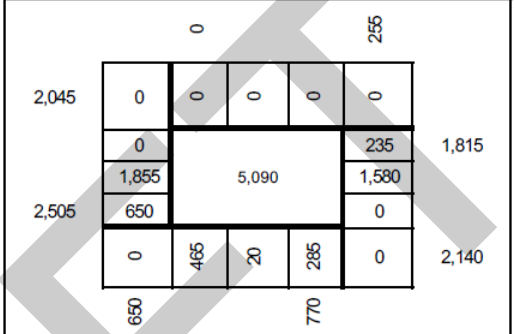
2045 No-Build PM Peak Hour Volumes (Vehicles Per Hour)

Year 2045 No-Build

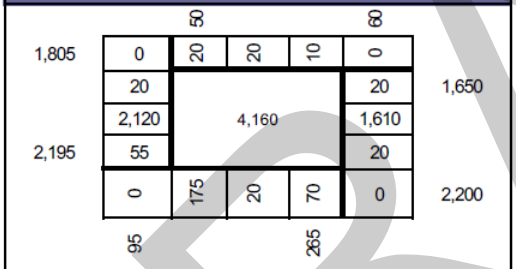
13 I-5 SB Ramps / S 320th Street



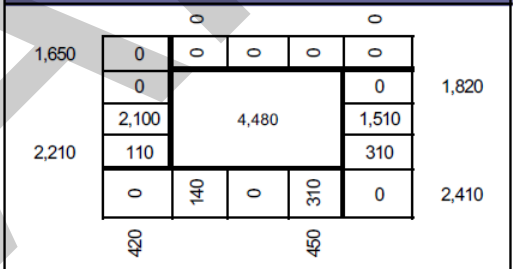
14 I-5 NB Ramps / S 320th Street



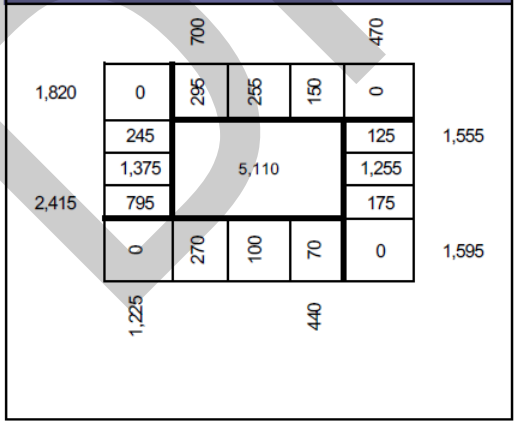
15 32nd Avenue S / S 320th Street



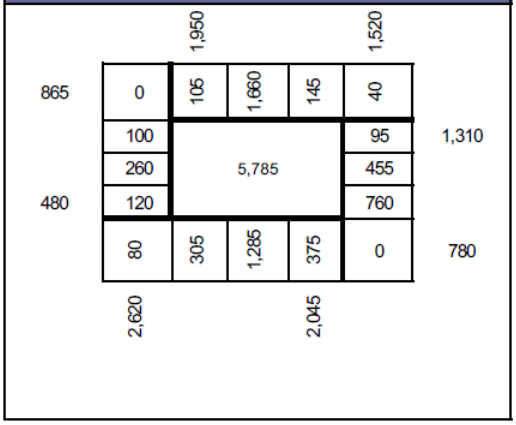
16 Weyerhauser Way S / S 320th Street



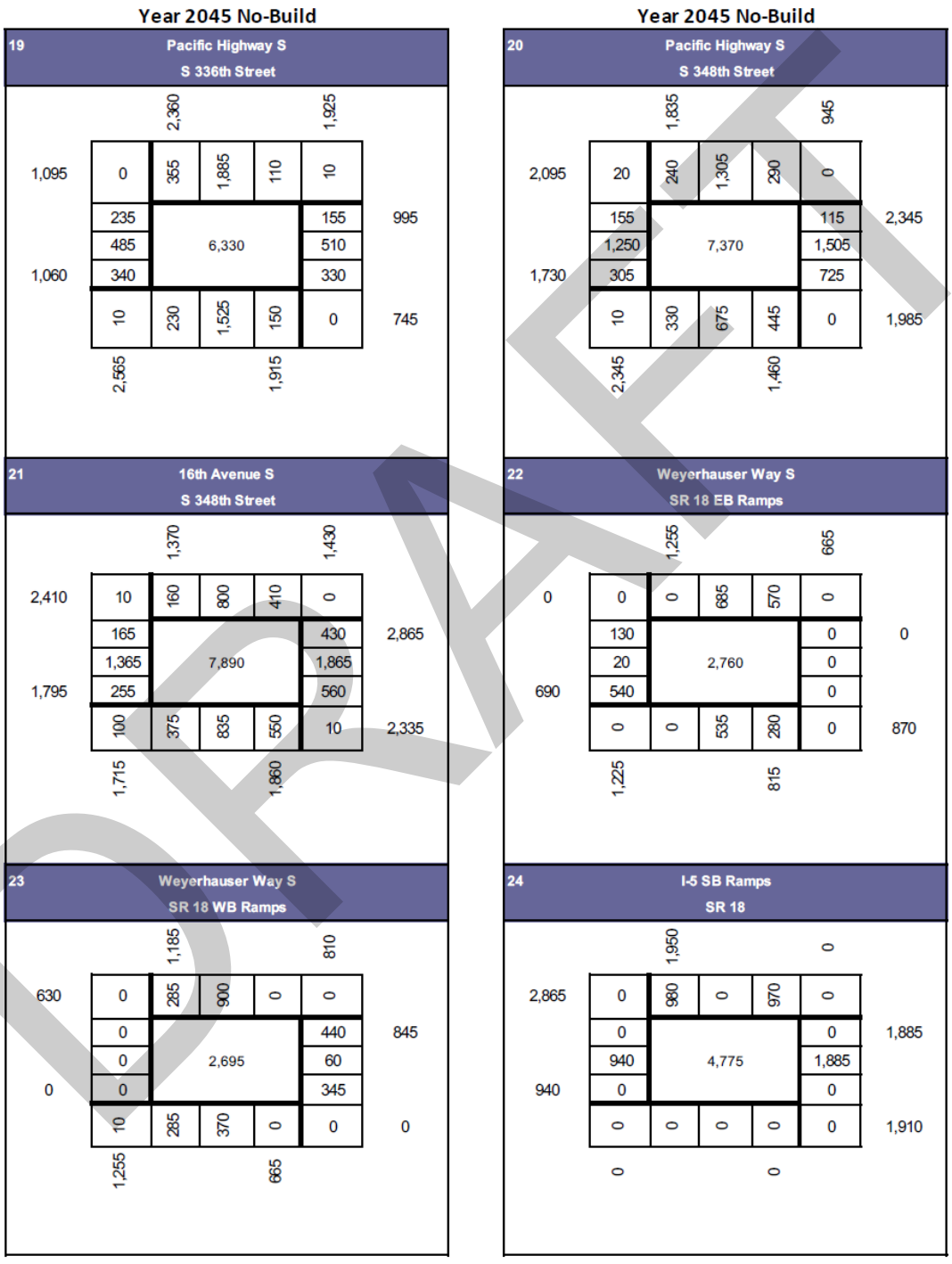
17 Military Road S / S 320th Street



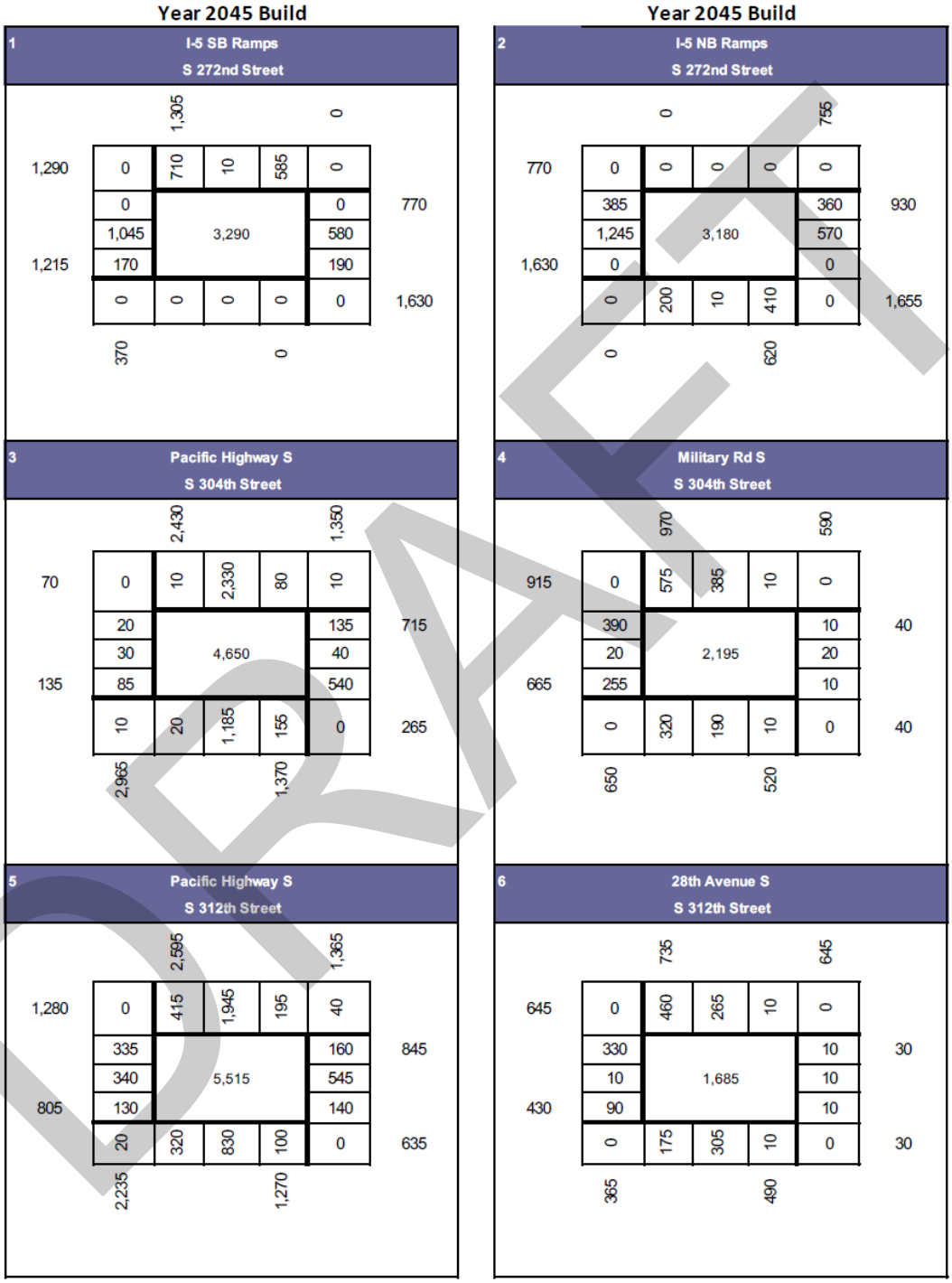
18 Pacific Highway S / S 324th Street



2045 No-Build PM Peak Hour Volumes (Vehicles Per Hour)



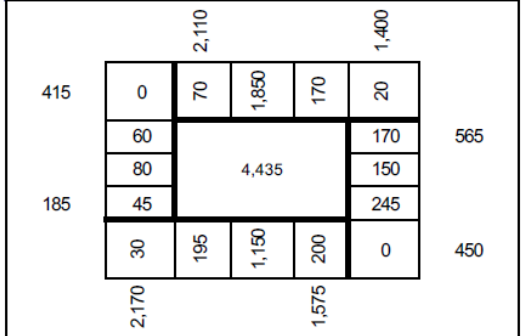
2045 Build PM Peak Hour Volumes (Vehicles Per Hour)



2045 Build PM Peak Hour Volumes (Vehicles Per Hour)

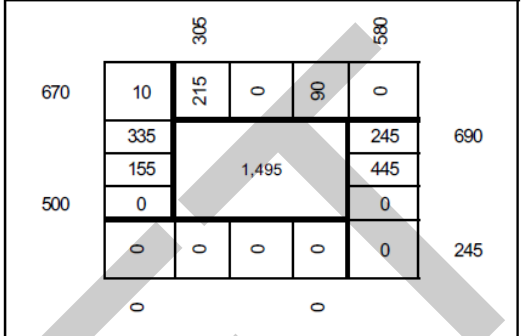
Year 2045 Build

7 Pacific Highway S & S 316th Street

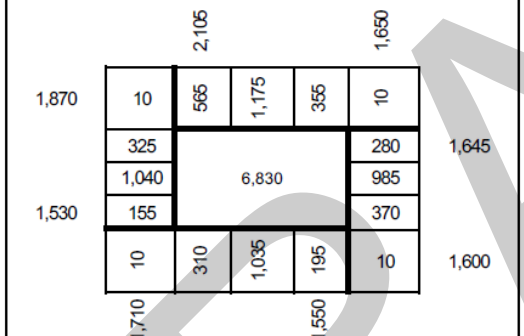


Year 2045 Build

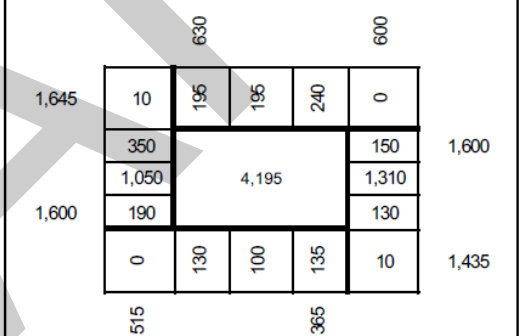
8 28th Avenue S & S 317th Street



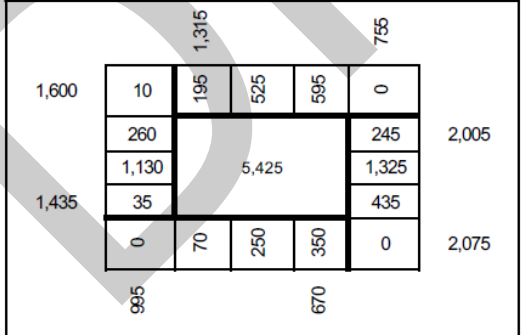
9 Pacific Highway S & S 320th Street



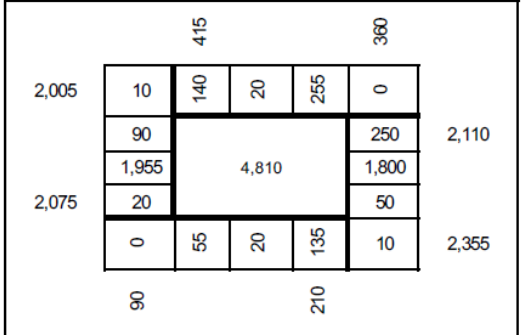
10 20th Avenue S & S 320th Street



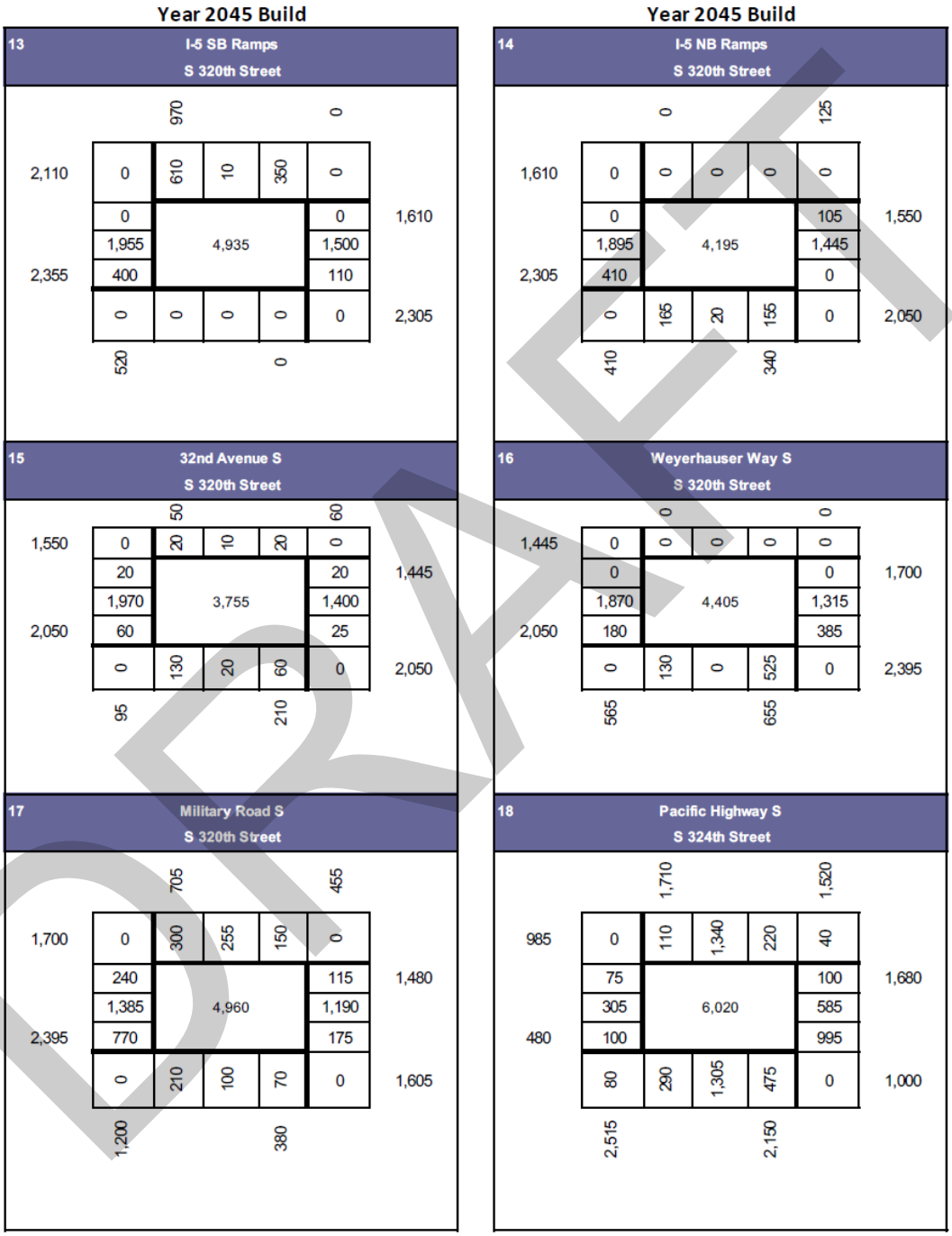
11 23rd Avenue S & S 320th Street



12 25th Avenue S & S 320th Street



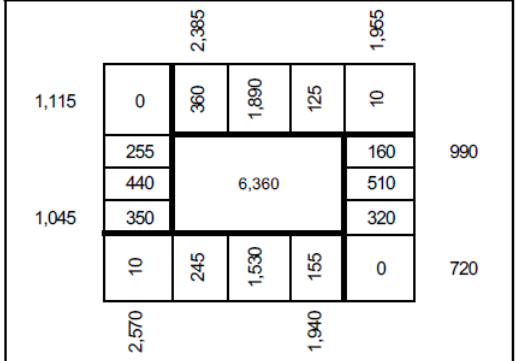
2045 Build PM Peak Hour Volumes (Vehicles Per Hour)



2045 Build PM Peak Hour Volumes (Vehicles Per Hour)

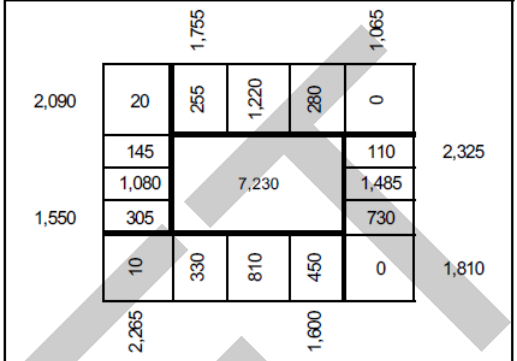
Year 2045 Build

19 Pacific Highway S / S 336th Street

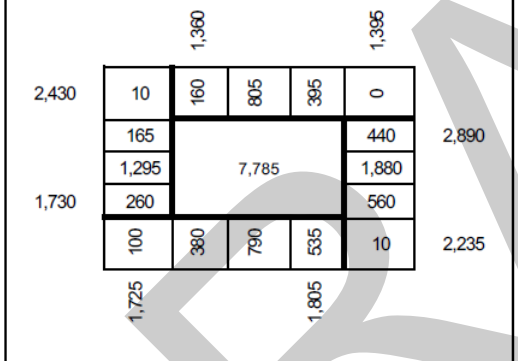


Year 2045 Build

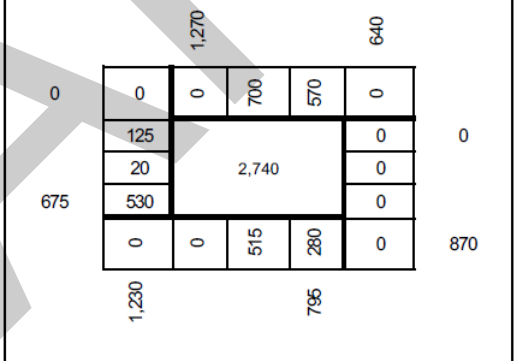
20 Pacific Highway S / S 348th Street



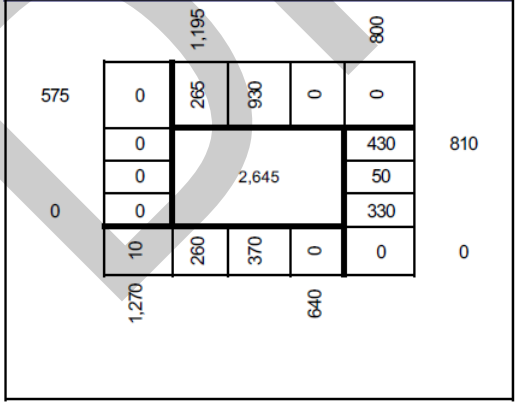
21 16th Avenue S / S 348th Street



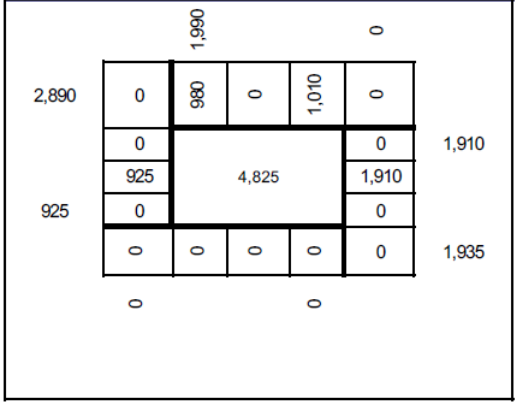
22 Weyerhauser Way S / SR 18 EB Ramps



23 Weyerhauser Way S / SR 18 WB Ramps



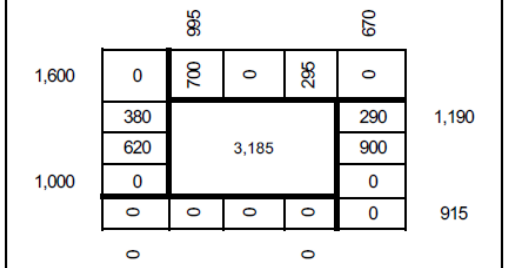
24 I-5 SB Ramps / SR 18



2045 Build PM Peak Hour Volumes (Vehicles Per Hour)

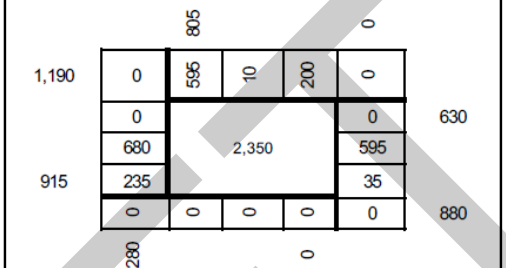
Year 2045 Build

30 — 23rd Avenue S / S 324th Street

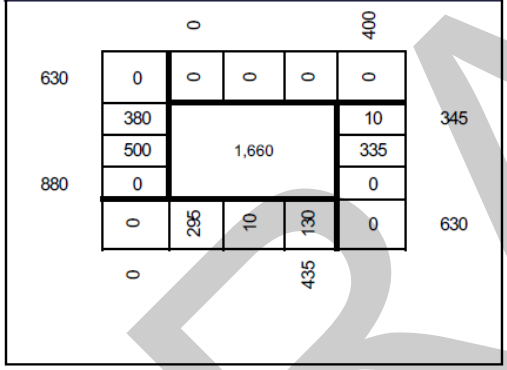


Year 2045 Build

31 — I-5 SB Ramps / S 324th Street



32 — I-5 NB Ramps / S 324th Street



Appendix D: Monitoring Slides

Photo 1: Aerial View

Photo 2: Looking Northwest

Photo 3: Looking Northeast

Photo 4: Looking Southwest

Monitoring Location M-1
Residences at the Belmor Park
Northwest corner of empty lot between lots
188 and 190, facing north

Michael Minor & Associates
Sound. Vibration. Air
Portland, Oregon

Detailed Noise Monitoring Site Photos
Federal Way City Center Access

Photo 1: Aerial View

Photo 2: Looking Northwest

Photo 3: Looking Southwest

Photo 4: Looking West

Monitoring Location M-2
Residences at the Belmor Park
Northwest corner of empty lot between lots
311 and 308, facing west

Michael Minor & Associates
Sound. Vibration. Air
Portland, Oregon

Detailed Noise Monitoring Site Photos
Federal Way City Center Access

Photo 1: Aerial View

Photo 2: Looking Southwest

Photo 3: Looking Southeast

Photo 4: Looking West

Monitoring Location M-3
Residences, 3809 S 325th Street
West corner of lot facing west

Michael Minor & Associates
Sound. Vibration. Air
Portland, Oregon

Detailed Noise Monitoring Site Photos
Federal Way City Center Access

Photo 1: Aerial View

Photo 2: Looking Northwest

Photo 3: Looking Northeast

Photo 4: Looking Southwest

Monitoring Location M-4
Residences, 32051 37th S Place
West corner of lot facing north

Michael Minor & Associates
Sound. Vibration. Air
Portland, Oregon

Detailed Noise Monitoring Site Photos
Federal Way City Center Access

Photo 1: Aerial View

Photo 2: Looking East

Photo 3: Looking West

Photo 4: Looking Southeast

Monitoring Location M-6
Residences, 31408 28th S Avenue
East corner of lot facing east

Michael Minor & Associates
Sound. Vibration. Air
Portland, Oregon

Detailed Noise Monitoring Site Photos
Federal Way City Center Access

Appendix E: Residential Equivalents and Supporting Information

The following pages contain the residential equivalent calculations. Data used for these calculations were obtained from the City of Federal Way and the United States Census Bureau. Supporting material is also included.

Residential Equivalent									
Group Home									
	Users/Hour	Hours/Day	Days/Week	Months of Year	Months/Year	Usage Factor	Avg House		Res Eqs
Peak	46.92	12	7	April-Sep	6	0.25	2.72		4.3
Off Peak	31.28	10	7	Oct, Nov, March	3	0.104166667	2.72		1.2
Winter	15.64	7	7	Dec-Feb	3	0.072916667	2.72		0.4
									5.9
						Receivers	2		3.0

Residential Equivalent									
Cedar Grove Park									
	Users/Hour	Hours/Day	Days/Week	Months of Year	Months/Year	Usage Factor	Avg House		Res Eqs
Peak	25	12	7	April-Sep	6	0.25	2.72		2.3
Off Peak	15	10	7	Oct, Nov, March	3	0.104166667	2.72		0.6
Winter	10	7	7	Dec-Feb	3	0.072916667	2.72		0.3
	Park hours from dusk till dawn per Federal Way Revised Code 4.05								3.1
	Numbers based on site visits and proximity to several multi-family residential structures					Receivers	1		3.1

Average Persons per Household for Federal Way

:

Weather and Climate:

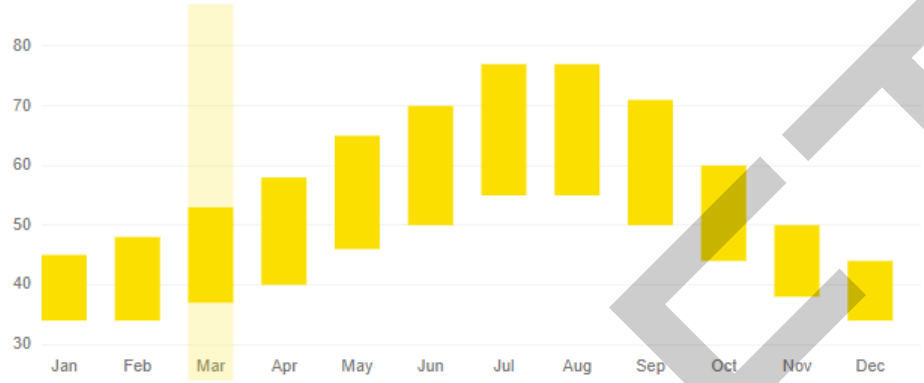
Weather history for Federal Way, Washington

Average temperature

March

53 / 37 °F | C

Record temps	71° / 24° F
Avg rainfall	5.61 in
Snow	1 days



Temperature | Rain | Snow

Current forecast · Radar map · Data from Weather Trends

Weather history for Federal Way, Washington

Average snowfall

March

1 days

Avg snowfall	0.37 in
Avg rainfall	5.61 in
Avg temps	53° / 37° F

Temperature | Rain | Snow

Current forecast · Radar map · Data from Weather Trends

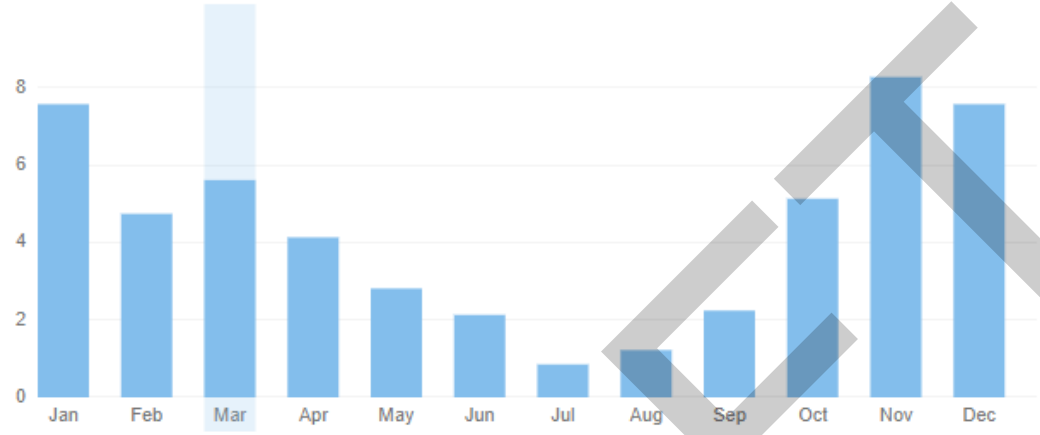
Weather history for Federal Way, Washington

Average rainfall

March

5.61 in | cm

Rain	27 days
Snow	1 days
Avg temps	53° / 37° F



Temperature | **Rain** | Snow

Current forecast · Radar map · Data from Weather Trends

Appendix F: Belmor Park Map