Appendix A

Noise and Vibration Technical Analysis

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South Tacoma Station Access Improvements

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Acronyms and Abbreviations

ADA	Americans with Disabilities Act
dB	Decibels
dBA	A-weighted decibel sound levels
EDNA	Environmental Designation for Noise Abatement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
Hz	Hertz
I-5	Interstate 5
in./sec.	inch(es) per second
Ldn	Day-Night Equivalent Sound Level
Leq	Equivalent Sound Level
Lv	Velocity in decibels
mph	miles per hour
PPV	peak particle velocity
RMS	Root Mean Square
ROW	Right-of-Way
SERA	South End Recreation & Adventure
VdB	Vibration Velocity Level
WAC	Washington Administrative Code

1 INTRODUCTION

The Central Puget Sound Regional Transit Authority's (Sound Transit) current Sounder Commuter Rail System includes two operating lines, Sounder North and Sounder South.

Sound Transit is planning to expand Sounder South rail capacity to meet future anticipated demand in King and Pierce Counties, Washington. In its capacity as lead agency, Sound Transit is reviewing this Project under the State Environmental Policy Act (SEPA). SEPA requires that project proponents identify possible environmental impacts that may result from government decisions, including impacts from noise. In addition, potential impacts from vibration are evaluated as an element of construction-related impacts.

The purpose of this memorandum is to summarize the results of the noise and vibration analysis for the South Tacoma Station Access Improvements Project (project). The analysis follows the methods for a general noise assessment as provided in the Federal Transit Administration (FTA) *Transit Noise and Vibration Impact Assessment Manual*, September 2018 (FTA Manual) (FTA 2018). In addition, because project construction is the main noise source, the maximum permissible sound levels from construction activities are governed by the City of Tacoma noise ordinance, found in Chapter 8.122 of the Tacoma Municipal Code and the Washington State Administrative Code (WAC), Chapter 173-60 (Maximum Environmental Noise Levels).

A project description and vicinity map follow along with an introduction to acoustics, regulatory information, methods of analysis, operational and construction analysis results and, where required, project mitigation measures.

2 PROJECT DESCRIPTION

The improvements included in this analysis are a result of the alternative analysis conducted in Phase 1 of the South Tacoma Station Access Improvements Project. The Phase 1 analysis identified two tiers of projects identified as Potential Improvements (herein titled Priority 1) and Possible Alternates (herein titled Priority 2). Three key criteria were used to identify Priority 1 and Priority 2 projects. These criteria were:

- Improves connections for underserved communities.
- Addresses a substantial travel barrier.
- Located within proximity of the station.

For the purposes of the environmental analysis, all Priority 1 and Priority 2 projects are included. The proposal consists of several individual improvements designed to improve access and connections to and from the South Tacoma Sounder Station. Sound Transit proposes to improve access to the South Tacoma Sounder Station and surrounding area by improving walking, bicycling, and bus facilities. Proposed improvements include new and updated sidewalks, Americans with Disabilities Act (ADA) compliant ramps, and bike lanes.

Figure 2-1 provides vicinity map with an overview of the study area with descriptions of the improvements outlined in the following sections.

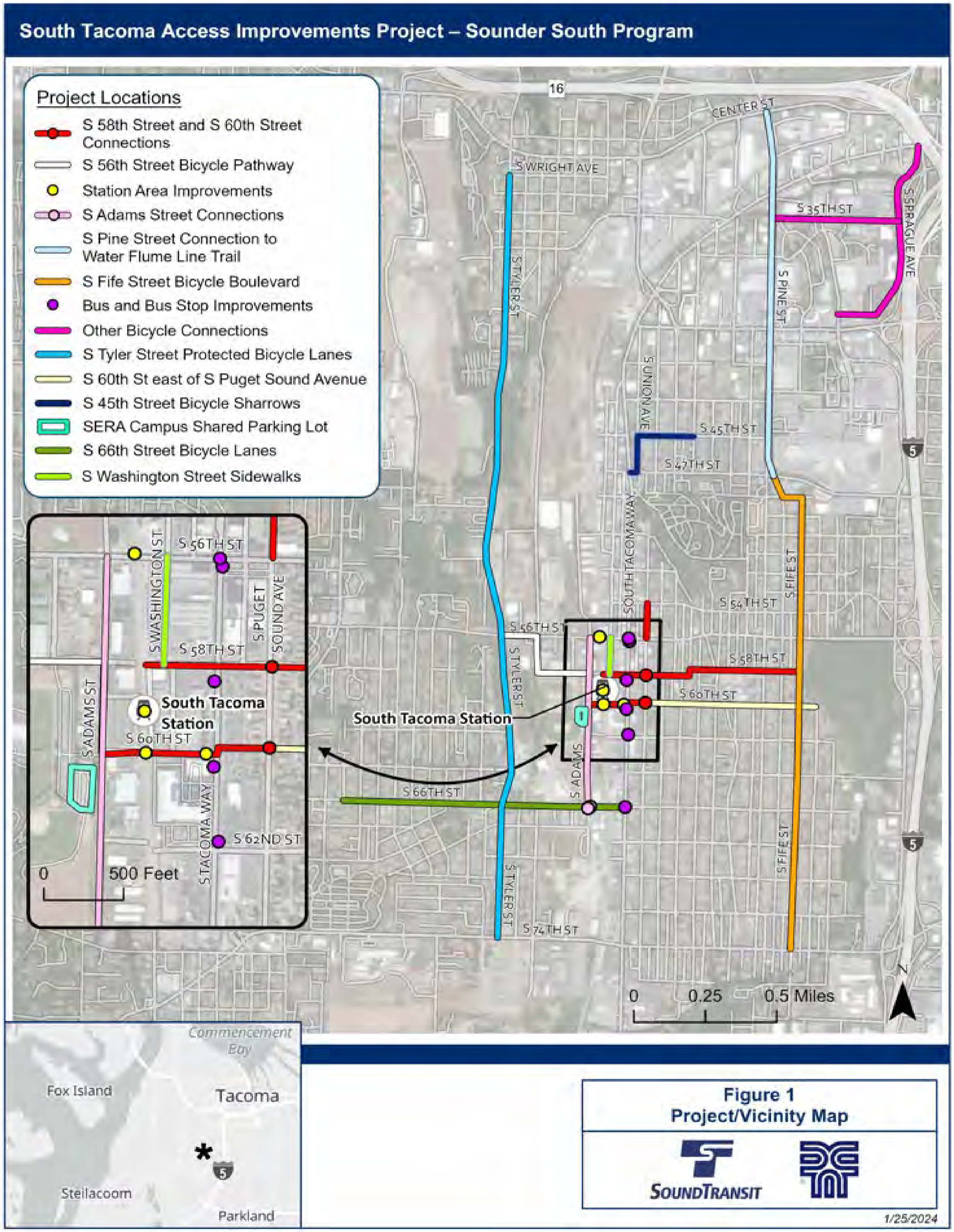


Figure 2-1 General vicinity map with an overview of proposed improvements

2.1 S 58th Street and S 60th Street Connections (A1, A27, A46, A24, A28, A56, A42, A54) – Priority 1

The improvements proposed within the S 58th Street and S 60th Street corridors would facilitate crossing South Tacoma Way (a principal arterial) and connect the station to neighborhoods to the east, the Water Flume Line Trail, Edison Elementary School, and Wapato Hills Park.
The improvements along S 58th Street include the following:

- Provide sidewalks on south side of S 58th Street from the station to South Tacoma Way, upgrade curb ramps, and mark crosswalks.
- Provide protected bike lanes on S 58th Street from the station to South Tacoma Way, including bike and pedestrian priority at the signal on South Tacoma Way.
- Improve bicycle and pedestrian crossings at the Puget Sound Avenue intersection with striping or other priority treatments and improve the crossing for pedestrians.
- Construct sidewalk, curb ramps, and bike boulevard improvements from S Lawrence Street to S Fife Street.

The improvements along S 60th Street include the following:

- Construct bike facilities on the north side of S 60th Street from S Adams Street to South Tacoma Way and transitioning to a bike boulevard to S Puget Sound Avenue.
- Provide a signalized pedestrian crossing at S 60th Street and South Tacoma Way and upgrade intersection crossing of S 60th Street and S Puget Sound Avenue to include pedestrian and bicycle safety treatments.
- Install curb ramps, gutter, lighting, and sidewalk on north side of S 60th Street between S Adams Street and South Tacoma Way. Include crossing at South End Recreation & Adventure (SERA) Campus entrance at S Adams Street and S 60th Street.

Additional elements that may be included along South Tacoma Way in the vicinity of S 56th Street and S 58th Street are installing station wayfinding, plantings trees along the curb line, and reducing the South Tacoma Way travel way width by providing parking in select locations.

This project grouping also includes extending the existing bike lanes on S Puget Sound Avenue to include the section between S 54th Street and S 56th Street and to include bicycle detection at S 56th Street/S Puget Sound Avenue.

2.2 S 56th Street Bicycle Pathway (A58) – Priority 1

A bicycle and pedestrian travel way would be constructed between S Tyler Street and the station to provide the ability for bicyclists and pedestrians to travel to the west and avoid S 56th Street between the station and S Madison Street. This facility includes:

- A shared sidewalk facility on S 56th Street between S Tyler Street and S Madison Street.
- A shared use path facility on S Madison Street between S 56th Street and northern boundary of the SERA Campus.
- Continue shared use path facility along northern edge of the SERA Campus between S Madison Street and S Adams Street. This path would tie into improvements on S 60th Street connecting S Adams Street and the station described in Section 1.1 above.

2.3 Station Area Improvements (A48, A55, E1, E2, E4, E7, E8, E9) – Priority 1

The station area improvements at South Tacoma Station are proposed to enhance access conditions for sight impaired, non-English-speaking, and disabled persons and to support non-motorized access. These include the following upgrades to the station:

- Provide parking for micromobility modes such as scooters and bicycles.
- Install a public address system.
- Provide additional security cameras with signage notifying that cameras are active located at the station and in the parking lot.
- Provide accessible wayfinding for sight impaired persons including brail for ticketing and tactile strips between platform and drop-off areas on S Washington Street.
- Provide signage for non-English-speaking persons.
- Provide a mini-high shelter (shelters designed for ADA access to transit) so riders with mobility needs for level boarding can wait closer to where they board the train.
- Improve non-motorized crossings at both at-grade crossings of S 56th Street and S 60th Street with sidewalk crossing arms and 4-quadrant crossing arms, additional warning signage, and other accessibility improvements.

In addition, ADA compliant curb ramps will be retrofitted/upgraded at 35 sidewalk locations within 0.5 mile of the station. Station area sidewalks will be constructed and improved within 0.5 mile of the station. The park-and-ride at S 60th Street, where riders wait while trains cross, will be provided with additional protection from the elements along the southern portion of the platform.

Wayfinding will be improved for traffic from the northeast to the station (via South Tacoma Way or via S Washington Street), from northwest, and from south (for drop-off rather than parking). Wayfinding will also be provided for non-motorized users from South Tacoma Way.

2.4 S Adams Street Connections (A23, A23A, A23B, A26, B2, B3) – Priority 1

Sidewalk and crossing improvements will be constructed on S Adams Street between S 56th Street and S 66th Street. Three options were developed for this corridor including:

- Add bike lanes and complete sidewalks on both sides of S Adams Street between S 56th and S 66th streets. This option would include crosswalks and ADA ramp upgrades at S Adams Street/S 60th Street and remove parking on one side of the street to accommodate the improvements within City right-of-way (ROW) (A23).
- Complete sidewalks on east side of S Adams Street and add shared use path on west side of street. This option would include crosswalks and ADA ramp upgrades at S Adams Street/S 60th Street, reduce vehicle lane widths and move western curb to the east to accommodate the improvements within the City ROW, and remove parking in limited areas (A23A).
- Complete sidewalks on both sides of S Adams Street and add shared use path on west side of street within Metro Parks ROW. This option would include crosswalks and ADA ramp upgrades at S Adams Street/S 60th Street, utilizing both City ROW and Metro Parks ROW to accommodate the improvements, and removes parking in limited areas (A23B).

- Provide signalized pedestrian crossing of S 66th Street at S Adams Street to facilitate transit access, bike connectivity, stripe crosswalks, and upgrade ADA ramps (A26).
- At the S Adams Street intersection with S 66th Street, provide improved passenger amenities, including shelter, pedestrian-scale lighting, and a bench (B2, B3).
- There are two options to replace parking removed with S Adams Street non-motorized improvements: (1) potential additional parking areas within existing City right of way on the north side of S 58th Street between S Durango Street and S Adams Street (Extra Parking Option 1) and (2) additional parking spaces in ROW on the east side of S Adams Street from S 64th Street to approximately 300 feet to the south (Extra Parking Option 2).

2.5 S Pine Street Connection to Water Flume Line Trail (A41.A) – Priority 1

S Pine Street provides a north-south connection between the station area and the employment center near the Tacoma Mall area. This project would construct bicycle lanes on S Pine Street from S Center Street to S 47th Street by removing through or turn lanes. S Pine Street turns into S Oakes Street approaching S 47th Street. These bicycle lanes would tie into the S Fife Street improvement described below.

2.6 S Fife Street Bicycle Boulevard (A40) – Priority 1

The project would include a bike boulevard on S Fife Street from S 48th Street to S 74th Street. At the north end, the corridor turns onto S 48th Street to S Oakes Street and on S Oakes Street between S 48th Street and S 47th Street, thus tying into the S Pine Street bicycle lanes described in Section 2.5 above.

The S Fife Street bicycle boulevard would include a pedestrian signal at S 56th Street and vehicle turn restrictions to safely support movement of bicyclists and pedestrians across the S 56th Street arterial.

2.7 Bus and Bus Stop Improvements (B5, B6, B7, B8, B10) – Priority 1

Pierce Transit Route 3 runs up South Tacoma Way from the Lakewood Transit Center and extends north through the project area serving the access improvements. A number of transit stops, ROW, and intersections in this area are proposed for improvements. These are described in more detail below.

The project will provide improved passenger amenities, such as shelter, bench, and pedestrian-scale lighting at South Tacoma Way intersections with S 56th, S 58th, and S 62nd streets. Intersection improvements along South Tacoma Way will also include transit signal priority at intersections along South Tacoma Way (S 56th Street, S 58th Street, and S 66th Street).

2.8 Other Bike Connections (A9, A37) – Priority 1

The project includes bicycle improvements along the following corridors:

- S Sprague Avenue – Would construct bike lanes on S 37th Street/S Sprague Avenue from South Tacoma Way to S Steele Street. This would provide a connection to the non-motorized crossing of Interstate 5 (I-5) at S 37th Street. (The nearest I-5 crossing for bicycles and pedestrians is half a mile to the north or south, and those crossings do not provide separation for bicyclists and pedestrians from vehicles.)

- S 35th Street Bike Lanes – Would construct bike lanes on S 35th Street between S Pine Street and S Sprague Street, connecting S Sprague Avenue and the S 37th Street crossing to the improved north-south S Pine Street corridor bike lanes.

2.9 Other Potential Improvements (A49, A50, E11) – Priority 1

Other potential improvements include the following:

- Leading Pedestrian Intervals at Signals – Upgrade signals to include leading pedestrian intervals at signalized intersections within 0.25 mile; include accessible pedestrian signals and no right turn on red (static or actuated signage).
- Bike Detection Intersection Upgrades – Include bike detection at select intersections along existing bike routes within 0.25 mile of station.
- Street Lighting Improvements – Install street lighting on priority roadways within 0.25 mile of the station.

2.10 S. Tyler Street Protected Bike Lanes (A43) – Priority 2

S Tyler Street serves as a primary north-south route for bikes adjacent to the station, to the north. The project would add horizontal and vertical protection to existing bicycle lanes from S 74th Street to S Wright Avenue by removing turn or through lanes.

2.11 S 60th Street east of S Puget Sound Avenue (A29) – Priority 2

The area east of S Puget Sound Avenue and bounded by S 56th Street, S Wapato Street, and S 66th Street includes approximately 0.5 square mile of residents and includes Edison Elementary School, Wapato Hills Park, and the Water Flume Line Trail. This improvement would add sidewalks and bike boulevard treatments on S 60th Street between S Puget Sound Avenue and S Prospect Street, providing for a connection from this area to and from the South Tacoma Station.

2.12 S Washington Street Sidewalks (A21) – Priority 2

The section of S Washington Street connecting the station to the north does not include sidewalks. This project would construct sidewalks on the western side of the street between S 56th Street and S 58th Street.

2.13 S 45th Street Bicycle Sharrows – Priority 2

Bicycle sharrows will be added to S 45th Street from S Union Avenue to S Lawrence Street, and extend along S Union Avenue to connect to the Water Flume Line Trail/S 47th Street/South Tacoma Way.

2.14 SERA Campus Shared Parking Lot (D1) – Priority 2

Improvements to existing parking at the SERA Campus will include expanding the existing SERA parking lot, located west of the South Tacoma Station, by an additional 50 parking stalls and improvements to parking, including parking management, to allow for shared parking. Project includes accessible connecting routes to and street crossing of S Adams Street.

2.15 S. 66th Street Bike Lanes (A4) – Priority 2

Add protected bike lanes and upgrade existing bike lanes to protected bike lanes on S 66th Street from S Orchard Street to S Puget Sound Avenue.

3 INTRODUCTION TO NOISE AND VIBRATION

This section introduces acoustics and vibration. It also includes discussion of the typical noise and vibration measurement descriptors that are used in this report to document the noise and vibration levels for the construction and operation of the proposed project.

3.1 Introduction to acoustics

What we hear as sound is a series of continuous air pressure fluctuations superimposed on the atmospheric pressure that surrounds us. The amplitude of fluctuation is related to the energy carried in a sound wave; the greater the amplitude, the greater the energy and the louder the sound. The full range of sound pressures encountered in the world is so great that it is more convenient to compress the range by using a logarithmic scale, resulting in the fundamental descriptor used in acoustics, the sound pressure level, in decibels (dB). When sounds are unpleasant, unwanted, or disturbingly loud, we tend to classify them as noise.

Another aspect of sound is the quality described as its pitch. Pitch is established by frequency, which is a measure of how rapidly a sound wave fluctuates as measured in cycles per second or Hertz (Hz). Most sounds are a composite of many individual frequencies. When a sound is analyzed, its energy content at individual frequencies is displayed over the frequency range of interest, usually the range of human audibility, from about 20 Hz to about 20,000 Hz. This display is called a frequency spectrum.

Sound is measured using a sound level meter with a microphone designed to respond accurately to all audible frequencies. The human hearing system does not respond equally to all frequencies. Low frequency sounds below about 400 Hz are progressively and severely attenuated, as are high frequencies above 8,000 Hz. To approximate the way humans interpret sound, a filter circuit with frequency characteristics similar to the human hearing mechanism is built into sound level meters. Measurements with this filter enacted are called A-Weighted Sound Levels, expressed in dBA.

Community noise is usually characterized in terms of the A-weighted sound level. Figure 3-1 Typical A-weighted sound levels illustrates the A-weighted levels of common sounds. When sounds exceed 110 dBA, there is a potential for hearing damage, even with relatively short exposures. In quiet suburban areas far from major freeways, the noise levels during the late-night hours will drop to about 30 dBA. Outdoor noise levels lower than this only occur in isolated areas where there is a minimum of natural noises such as leaves blowing in the wind, crickets, or flowing water.

Another characteristic of environmental noise is that it is constantly changing. The increase in noise level that occurs when a train passes is an example of a short-term change. The lower average noise levels during nighttime hours, when human activities are at a minimum, and the higher noise levels during daytime hours are daily patterns of noise level fluctuation. The instantaneous A-weighted sound level is insufficient to describe the overall acoustic "environment." A more useful descriptor is the Day-Night Equivalent Sound Level, Ldn, which is defined as the 24-hour equivalent sound level (Leq) but with a 10 dB penalty assessed to noise events occurring at night (defined as 10 p.m. to 7 a.m.). The effect of this penalty is that any event during the nighttime hours is equivalent to 10 events during the daytime hours. This strongly weights Ldn toward nighttime noise to reflect the fact that most people are more easily annoyed by noise during the nighttime hours, when background noise levels are lower and most people are sleeping.

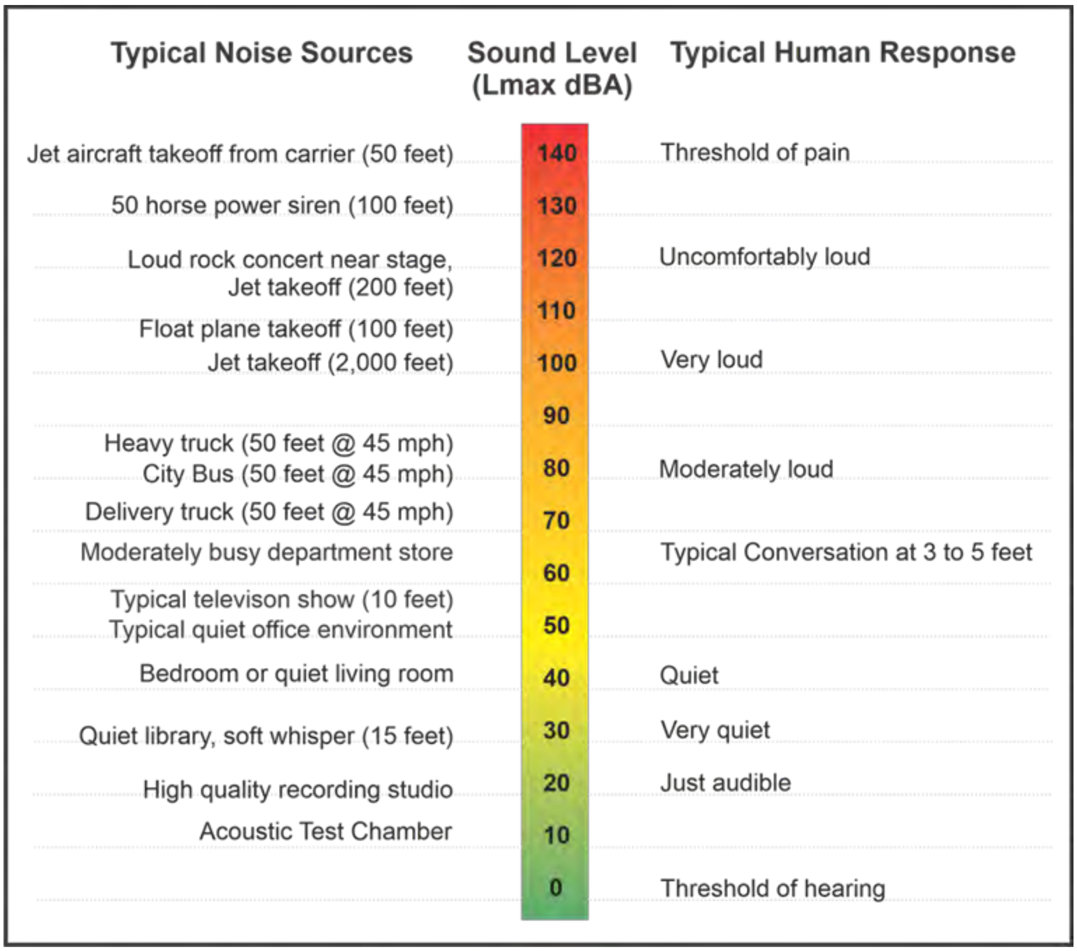
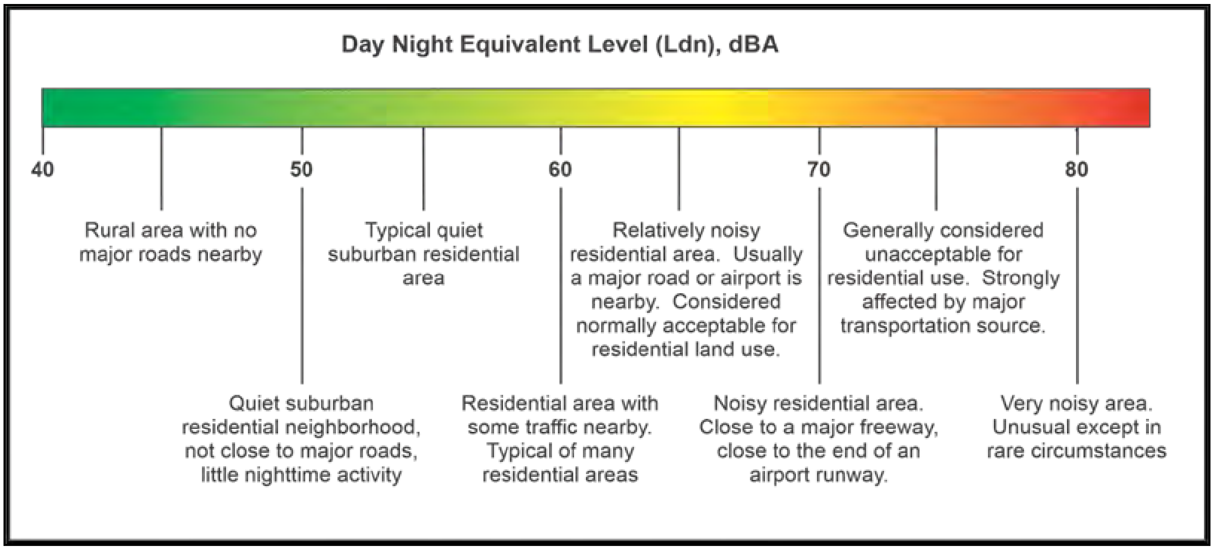


Figure 3-1 Typical A-weighted sound levels

Environmental impact assessments for high-capacity transit projects in the United States typically use Ldn to describe the community noise environment. Studies of community response to a wide variety of noises indicate that Ldn is a good measure of the noise environment. Efforts to derive measures that are better correlated to community response have not been successful, although there are still efforts in the acoustical community to develop improved measures.

Figure 3-2 shows typical community noise levels in terms of Ldn. Most urban and suburban neighborhoods will be in the range of Ldn 50 dBA to 70 dBA. An Ldn of 70 dBA is a relatively noisy environment that might be found at buildings on a busy surface street, close to a freeway or near a busy airport. It would usually be considered unacceptable for residential land use without special measures taken to enhance outdoor-indoor sound insulation. Residential neighborhoods that are not close to major sound sources will usually be in the range of Ldn 55 dBA to 60 dBA. If there is a freeway or moderately busy arterial nearby or any nighttime noise, Ldn is usually in the range of 60 dBA to 65 dBA.



Source: FTA 2018.

Figure 3-2 Typical Ldn levels

3.2 General rules related to community noise

Some general rules related to community noise are:

- A 3 dB change is the minimum most people can detect in most environments.
- Under free-field conditions, where there are no reflections or additional attenuations, a point sound source 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. However, traffic on a busy roadway is a line source, which reduces at approximately 3 dB for each doubling of distance.
- Sounds such as sirens, bells, and horns are more noticeable and more annoying than normal noise.
- A 10 dB increase in sound level is perceived as an approximate doubling of the loudness of the sound and represents a substantial change in loudness.

3.3 Decibel mathematics

An important factor to recognize is that noise is measured on a decibel scale and combining two noise sources is not achieved by simple addition. For example, combining two 60 dB noise sources does not give 120 dB (which is near the pain threshold), but yields 63 dB, which is lower than the volume at which most people listen to their TVs. For reference, if two noise sources are 10 dB apart, for example 50 dB and 60 dB, the sum of the two noise levels will simply be the louder of the two, in this case 60 dB. This is to say that for similar noise sources that are 10 dB apart in magnitude, a person would only be able to hear the louder of the two sources.

Examples of simplified decibel addition (Table 3-1), based on the difference between the two levels, are provided below for reference, to aid in the understanding of the total project noise and impact analysis presented in this report.

Table 3-1 Examples of simplified decibel addition

Difference between the two noise sources	Amount added to the higher of the two noise levels
0 to 1 dB	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

This information is important, because it is used to add the new noise (the noise related to the project) to the existing measured noise levels along the project corridor, providing the new total noise with the project. For example, if the proposed project would generate noise was 4 dB to 9 dB below the existing noise levels, the project-related increase would be approximately 1 dB or less, an increase which is not perceptible to an average person.

3.4 Introduction to vibration

Ground-borne vibration consists of oscillatory waves that propagate from the source through the ground to adjacent buildings. Although the vibration is sometimes noticeable outdoors, it is almost exclusively an indoor problem. The primary concern is that the vibration and radiated noise can be intrusive and annoying to building occupants.

Factors that influence the amplitude of ground-borne vibration from vehicles include vehicle suspension parameters, condition of the wheels, type of building foundation, the properties of the soil and rock layers through which the vibration propagates, and the condition of the roadway.

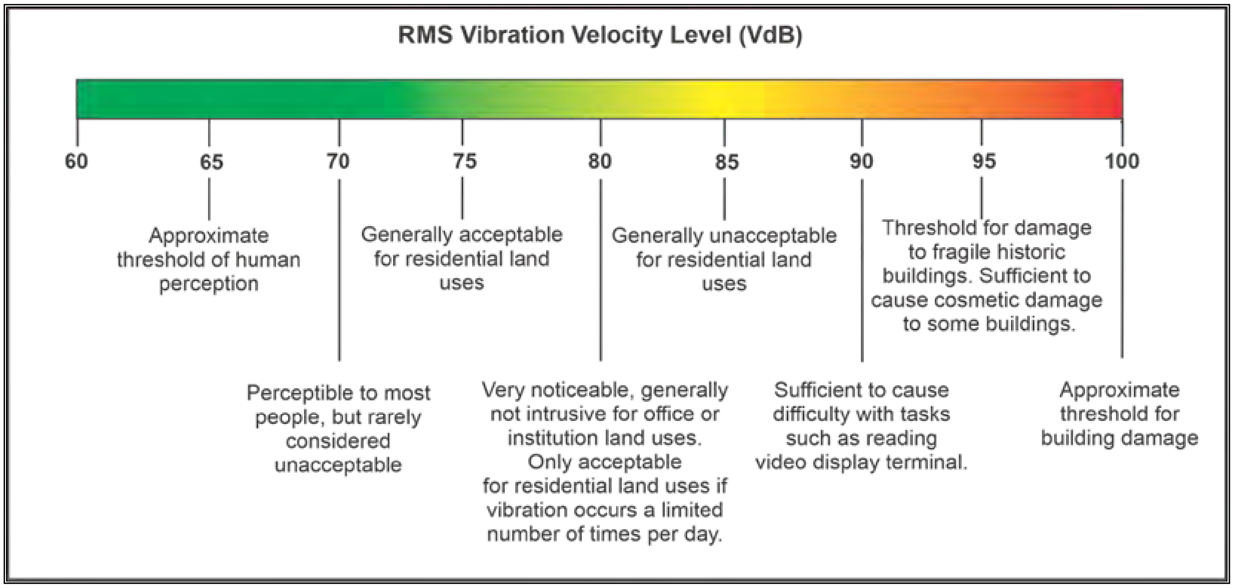
Although all vehicular traffic causes some level of ground-borne vibration, the vibration is not usually perceptible because of the vibration isolation characteristics of the pneumatic tires and suspension systems. For vehicles with rubber tires, most of the vibration produced is absorbed by the tires and the suspension system, and vibration is usually only a problem if the roadway surface is very rough or has potholes and other abnormalities.

Vibration velocity is usually given in terms of either inches per second or decibels. The following equation defines the relationship between vibration velocity in inches per second and decibels:

$L_v = 20 \times \log (V/V_{ref})$:

where V is the velocity amplitude in inches/second; Vref is 10^{-6} *inches/second; and Lv is the velocity level in decibels.*

The abbreviation VdB is used for vibration decibels in this report, to minimize confusion with sound decibels. Figure 3-3 provides a general idea of human and building response to different levels of vibration. Existing background building vibration is usually in the range of 40 VdB to 50 VdB, which is well below the range of human perception. Although the perceptibility threshold is about 65 VdB, human response to vibration is usually not bothersome unless the Root Mean Square (RMS) vibration velocity level exceeds 70 VdB. Buses and trucks rarely create vibration that exceeds 70 VdB unless there are large bumps or potholes in the road and the travel lanes are close to the structure.



Source: FTA 2018.

Figure 3-3 Typical RMS vibration levels

4 METHODS

This section provides an overview of the methods used to predict noise and vibration levels related to the project, as well as criteria used to determine project related impacts. The ambient noise measurement methods used complied with the FTA noise assessment guidance. The methodology addresses both the long-term operational impacts and the short-term construction impacts related to the project. Long-term operational impacts are related to system operation after construction. Short-term construction impacts are related only to noise and vibration generated during project construction.

The assessment of potential noise and vibration impacts from the project was based on the current FTA Manual (2018). Other regulatory information and ordinances reviewed and applicable to the project include the WAC and the noise control ordinance from the City of Tacoma.

In addition to analyzing noise and vibration from operation of the project, this report discusses noise and vibration from construction of the project. The methods for analyzing construction noise and vibration follow the methods given in the FTA Manual (2018) and the Federal Highway Administration (FHWA) Roadway Construction Noise Model (FHWA 2006) was used to provide an estimate of the project construction noise levels. Local noise control regulations and ordinances for construction noise were reviewed and summarized in the following sections.

4.1 FTA transit operational noise criteria

Transit operational noise impacts of the project were determined based on the criteria defined in the FTA Manual (2018). The FTA noise impact criteria are based on documented research on community reaction to noise and on change in noise exposure rated using a sliding scale.

Although more transit noise is allowed in neighborhoods with high levels of existing noise, as existing noise levels increase, smaller increases in total noise exposure are allowed than in areas with lower existing noise levels. The FTA noise impact criteria group noise-sensitive land uses into the following three categories:

Category 1: Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and land uses that rely upon a quiet background, such as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included in this category are recording studios and concert halls.

Category 2: Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.

Category 3: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study, cemeteries, monuments, museums, campgrounds, and recreational facilities are also considered to be in this category. Certain historical sites and parks are also included, but their sensitivity to noise must be related to their defining characteristics, and generally parks with active recreational facilities are not considered noise sensitive.

It is important to note that no criteria exist for noise impacts to commercial or industrial uses, including most office buildings, restaurants, or other commercial uses, because activities within these buildings are compatible with higher noise levels; unless sensitivity to noise is assumed to be of utmost importance for operations of that facility, for example, an audiology laboratory.

The Ldn is used to characterize noise exposure for residential areas (Category 2). For other noise-sensitive land uses, such as outdoor amphitheaters and school buildings (Categories 1 and 3), the maximum 1-hour Leq during the facility's operating period is used. There are no noise impact criteria for most commercial and industrial land use.

There are two levels of impact included in the FTA criteria—severe and moderate—interpreted as follows:

Severe Impact: Project-generated noise in the severe impact range can be expected to cause a large percentage of people to be highly annoyed by the new noise and represents the most compelling need for mitigation. Noise mitigation will normally be specified for severe impact areas unless there are truly extenuating circumstances that prevent mitigation.

Moderate Impact: In this range of noise impact, the change in the cumulative noise level is noticeable to most people but may not be sufficient to cause strong, adverse reactions from the community. In this transitional area, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation. These factors include the existing noise level, the projected level of increase over existing noise levels, the types and numbers of noise-sensitive land uses affected, the noise sensitivity of the properties, the effectiveness of the mitigation measures, community views and the cost of mitigating noise to more acceptable levels.

Figure 4-1 presents the FTA noise impact criteria. As shown in the figure, the impact level is based on the existing noise environment. As the existing noise levels increase, the allowable noise from transit operations decreases. The following two examples help provide an understanding of the FTA criteria and determination of noise impacts:

> A residence with an existing noise level of 64 dBA Ldn and a predicted project noise level of 63 dBA Ldn: For a residential land use (FTA Category 2) with an existing Ldn of 64 dBA, a moderate impact occurs if the project noise exceeds 61 dBA Ldn, or a severe impact occurs if the project noise exceeds 65 dBA Ldn. Because the project is predicted to produce 63 dBA Ldn, this would be a moderate noise impact.

> A residence with an existing noise level of 72 dBA Ldn and a predicted project noise level of 63 dBA Ldn: For a residential land use (FTA Category 2) with a 72 dBA Ldn the moderate criteria is 66 dBA, and the severe criteria is 71 dBA. Because the project is predicted to produce 63 dBA Ldn, no noise impact is predicted.

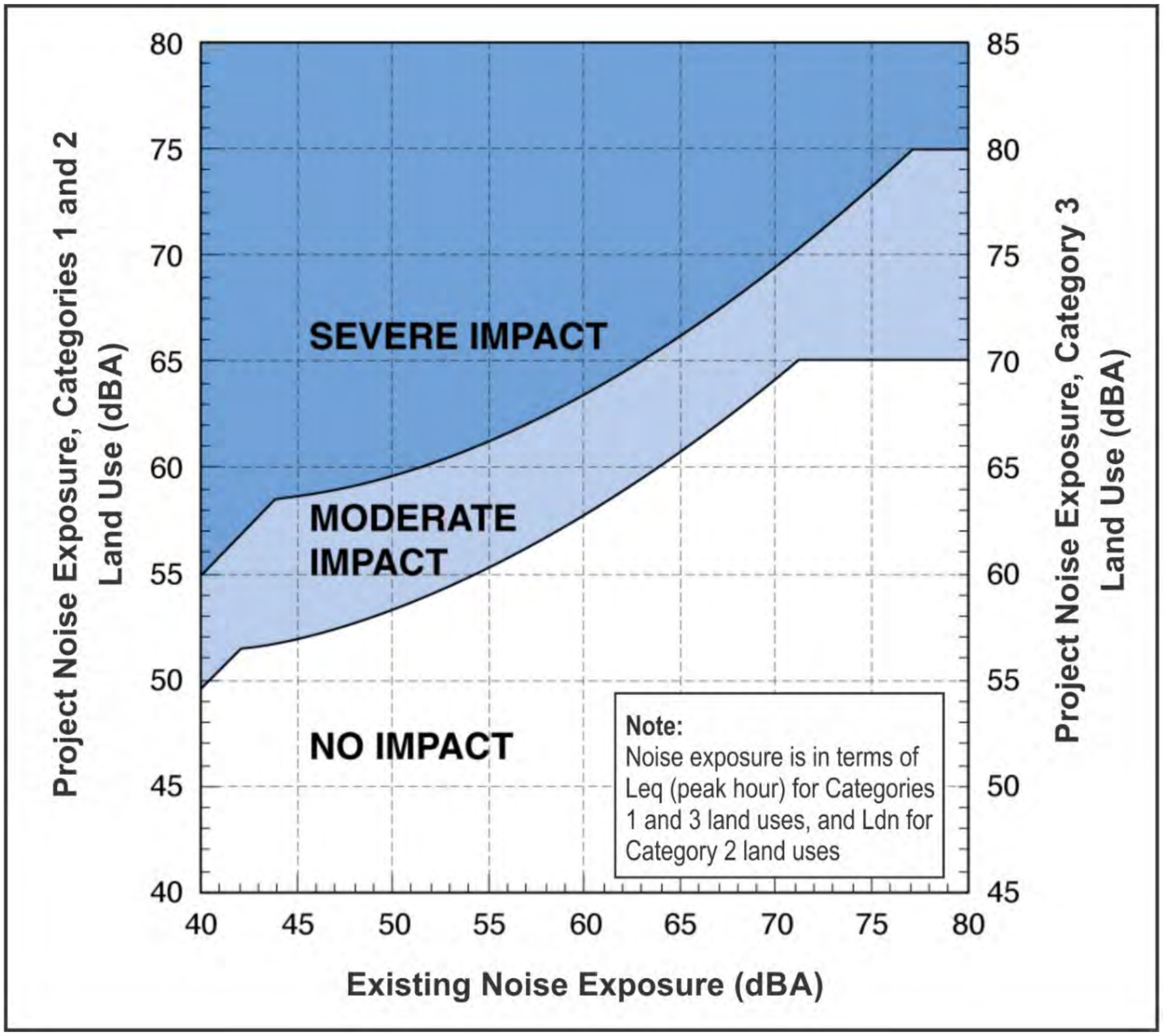


Figure 4-1 FTA noise impact criteria

4.2 Local noise control ordinance

Sound Transit also follows the local noise control ordinances for some project related noise sources. Construction noise and noise from ancillary facilities, such as maintenance facilities, are governed by applicable state laws and regulations and local ordinances. In the case of the

Sounder stations, the City of Tacoma Municipal Code Chapter 8.122, Noise Ordinance, would be applicable to the Sounder improvements, as well as to construction of the project. However, because the City of Tacoma noise control ordinance is a public disturbance code and has no measurable limits, the WAC was considered for analysis of operational noise. Noise from construction also used the WAC; however, construction noise is exempt between the hours of 7 a.m. to 9 p.m., Monday through Saturday, per City of Tacoma Municipal Code Chapter 8.122.

4.2.1 WAC noise control ordinance

Because the Tacoma code does not have any quantitative criteria for impact analysis, the WAC was also considered for noise from ancillary facilities. The WAC Chapter 173-60 (Maximum Environmental Noise Levels) defines three classes of property use, called Environmental Designation for Noise Abatement (EDNA), and states maximum allowable noise levels for each, as shown in Table 4-1 (Washington state noise control regulations). For example, the noise caused by a commercial property must be less than 57 dBA at the closest residential property line. From 10 p.m. to 7 a.m., the allowable maximum sound levels shown in Table 4-1 are reduced by 10 dBA in Class A EDNAs (residential zones). Although not specified in these regulations, the noise analysis assumes the hourly Leq for comparison with the noise levels in Table 4-1. The WAC contains short-term exemptions to the property line noise standards shown in Table 4-1 based on the minutes per hour that the noise limit is exceeded. These exceedances are outlined in Table 4-2.

Table 4-1 Maximum allowable noise levels by land use type

EDNA Source of Noise	EDNA Receiver of Noise (Maximum Allowable Sound Level in dBA1)		
	Residential	Commercial	Industrial
Class A Residential	55	57	60
Class B Commercial	57	60	65
Class C Industrial	60	65	70

Note(s): 1 Between 10 p.m. and 7 a.m., the levels given above are reduced by 10 dBA in Class A EDNAs.

The WAC contains short-term exemptions to the property line noise standards shown in Table 4-1 based on the minutes per hour that the noise limit is exceeded. These exceedances are outlined in Table 4-2 (Washington state exemptions for short-term noise exceedances).

Table 4-2 WAC exemptions for short-term noise exceedances

Minutes per Hour	Adjustment to Maximum Sound Level
15	+5 dBA
5	+10 dBA
1.5	+15 dBA

4.2.2 WAC construction noise criteria

Sounds received in Class A EDNAs that originate from construction sites are exempt from the limits of the WAC regulations during normal daytime hours (7 a.m. to 10 p.m.); however, under the Tacoma Noise Ordinance, construction noise is exempt only between the hours of 7 a.m. and 9 p.m., Monday through Saturday (more stringent criteria). Therefore, using the most stringent allowable hours for construction, if construction is performed between the hours of 9 p.m. and 7 a.m. the following day, the contractor must obtain a noise variance from the City of Tacoma.

The WAC also contains a set of construction-specific allowable noise-level limits. These construction noise regulations are organized by type of noise and, among other things, include criteria for haul trucks and backup safety alarms.

4.2.3 Construction 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 feet (Chapter 173-62, WAC). For trucks operating within staging areas, the general construction equipment noise criteria would be used to determine compliance during nighttime hours in Class A EDNAs.

4.2.4 Construction noise related to backup alarms

Sounds created by backup alarms are essentially prohibited by the WAC during nighttime hours (between 10 p.m. and 7 a.m.) in Class A EDNAs, and during these hours, other forms of backup safety measures would need to be used. These measures could include using smart backup alarms, which automatically adjust the alarm level based on the background level or switching off backup alarms and replacing them with spotters. No other city or county noise regulations are applicable to construction of the project.

4.3 Vibration impact criteria

Because the proposed project will not change the Sounder operations, and there are no track modifications included as part of this project, there is no predicted change in the vibration levels in the project area. However, there may be some construction related vibration and this section briefly defines criteria for vibration that might be produced by construction.

4.3.1 Construction vibration

There are no formal vibration criteria from the FTA or any state or local agencies. The primary concern regarding construction vibration relates to risk of damage. Vibration is generally assessed in terms of peak particle velocity (PPV) for risk of building damage. PPV is the appropriate metric for evaluating the potential for building damage and is often used when monitoring blasting and construction vibration because it relates to the stresses that are experienced by the buildings. Vibration damage risk thresholds to assess potential for damage from construction are taken from the FTA Manual (2018). Table 4-3 presents the vibration damage risk thresholds for different building categories.

Table 4-3 Cosmetic structural damage criteria

Building Category	PPV (in./sec)	Approximate Lv [a]
I. Reinforced concrete, steel, or timber (no plaster)	0.50	102
II. Engineered concrete and masonry (no plaster)	0.30	98
III. Non-engineered timber and masonry buildings	0.20	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Notes:
Source: FTA 2018.
[a] Root mean square velocity level in decibels re 1 micro-in./sec.
in./sec. = inch per second
Lv = vibration velocity level
PPV = peak particle velocity

The damage risk criterion of 0.5-inch per second (in./sec.) PPV is appropriate for single- and multi-family residences along the alignment and the criterion of 0.12 in./sec. PPV is appropriate for extremely fragile buildings.

Construction vibration, unlike vibration from operations, has the potential to cause damage to structures at very close distances, from activities such as impact hammering and soil compacting. Generally, because of the short duration of construction vibration activities, annoyance is usually not an issue. The thresholds for damage for even the most sensitive buildings are one to two orders of magnitude higher than the criteria for annoyance from vibration.

5 AFFECTED ENVIRONMENT

Sound Transit examined the project corridor to identify noise- and vibration-sensitive locations and select locations where noise monitoring would be performed. The potential area of affect for the noise study was determined by modeling the worst-case operational noise levels and including all noise-sensitive properties within that area that have a potential for experiencing a noise impact. For noise, this was only applicable to new project components that have the potential to produce noise. Because most improvements are for non-motorized transportation, most of the project components would not change the noise environment by a measurable amount. In addition, any new hard surfaces installed as part of the project, including new pavement for bike lanes and sidewalks, would not be predicted to cause a measurable increase in noise levels at any noise sensitive properties. The only potential exception is the expanded SERA Campus parking area south of the station, where the traffic could affect the noise environment.

The Sounder operations are not changing with these improvements, and therefore no change in Sounder vibration levels is predicted.

The following sections describe the land use along the project corridor, the existing noise-level measurements, and the current noise sources in the project corridor.

5.1 Existing land uses

Land use in the project area is a mix of residential housing, healthcare, churches, childcare facilities, commercial and industrial uses and undeveloped lands. The overall area of potential improvements covers over 16,000 feet north and south and 9,500 feet east to west, making the analysis area very large. Due to the majority of the improvements being related to non-motorized transportation that would not likely affect the overall noise levels by a measurable amount, the analysis focused on noise sensitive properties where changes in noise levels could occur.

Figure 5-1 is an index figure showing the outline of the eight figures used to identify land use and the noise monitoring location (see Figure 5-6) in the project area. The overall project area land uses are shown in Figure 5-2 through Figure 5-9. Due to the large area of potential improvements, there are areas shown that are well outside the typical noise study area of 300 to 500 feet; however, to make sure all sensitive land uses are identified, the full set of figures was needed.

In the northeast part of the study area (see Figure 5-2), land use is mainly commercial and industrial. There is a group of single-family residences located along S Steele Street, Montana Avenue, and Nevada Avenue just south of S 35th Street. These homes are near the proposed bicycle lanes on S Pine Street, from S Center Street to S 47th Street. Lincoln Heights Park is also located near the residences, off S Steele Street.

In the northwest part of the study area (see Figure 5-3), land use is primarily single-family and multi-family residential along both sides of S Tyler Street, from S Wright Avenue to S 41st Street, where the land uses changes to undeveloped and industrial. Two daycares were also identified near S Tyler Street (My Little Kingdom and Alice's Precious Jewels Child Care & Preschool) and a church on S 34th Street.

In the north central part of the study area (see Figure 5-4) land use north of S 40th Street is entirely commercial and industrial. South of S 40th Street, land use includes single and multi-family residences between S Union and S Pine Street, however, along S Tacoma Way, where bile lane improvements are planned, land use is mainly commercial and light industrial. Along S Pine Street land use included mainly residential on the westside of Pine Street, and commercial on the eastside of Pine Street, including the Tacoma Mall and the Pacifica Apartments, located at Pine Stret and Tacoma Mall Road. The northern part of South Park and the Tacoma Cemetery is also located in this area; however, there are no improvements that would have any notable affect to noise at the park or cemetery.

In the central east area (see Figure 5-5), south of S 47th Streets, land use includes several multi-family buildings in the north segment, followed by the Tacoma Cemetery, with single family residences occupying most of the remaining area. Other sensitive uses include South Park, Oak Wood Cemetery, the Water Flume Line Trail, Edison Elementary School, Visitation Catholic Church, Pope St. John XXIII STEM Academy, and Wapato Hills Park. Non-motorized improvements are proposed near the Gray Middle School and Edison Elementary School on S 58th Street and S 60th Street and in the northern part, along S 47th Street and S Fife Street.

The central west part of the study area (see Figure 5-6) the only improvement is along S Tyler Street, with industrial land use on the eastside of the street and residential land use on the westside of the street. In addition, this area also has some undeveloped lands and the Zion's River Church.

The central area, which includes the South Tacoma Sounder Station (see Figure 5-7) is mainly commercial and industrial in the north end with the exception of some residences north of S 56th Street east of S Puget Sound Avenue. South of S 56th Street to S 66th Street, land use east of S Puget Sound Avenue is mainly residential and also includes the house of Prayer Church, Bridge Methodist church, New Salem Church, Slavic Church of One God, the Vietnamese Baptist Church, the LCC Church, and the Galilee Missionary Baptist. Other sensitive uses include the Tacoma Public Library, the SERA Campus, Gray Middle School, Boys & Girls Club Schatz Branch, Metro Parks STAR Center, and associated playfields. The southwest part of this area also includes Tahoma House social services organization and Precious Times Preschool.

Potential improvements include non-motorized improvements on S Tyler Street, S Adams Street, S Tacoma Way, S Washington Street, S Puget Sound Avenue, S 66th Street, S 60th Street, S 58th Street, and S 56th Street. There is also the potential for an expanded parking on the SERA property. The one noise monitoring site was also in this segment, near the multi-use area at SERA.

In the southeast section (see Figure 5-8), land use is mainly single-family and multi-family residential. Other sensitive uses include the Wapato Hills Park, Sound Christian Academy, Trafton Open Space Park, Academy of Busy Bees Daycare (residence), Green Pastures Church, AHHC adult family home (residence), Arlington Elementary School, and Oak Tree Park. The non-motorized improvements would occur along S Fife Street and S 66th Street.

The southwest section (see Figure 5-9) is also primarily residential and includes the Manitou Park Elementary School and Manitou Park. Other sensitive uses, such as the Calvary Cemetery, are too far from the Sounder rail corridor or proposed improvements to be affected by noise from this project. The only improvements in this area are along S 66th Street and S Tyler Street.

The remaining land uses in the area are commercial, industrial, and undeveloped.

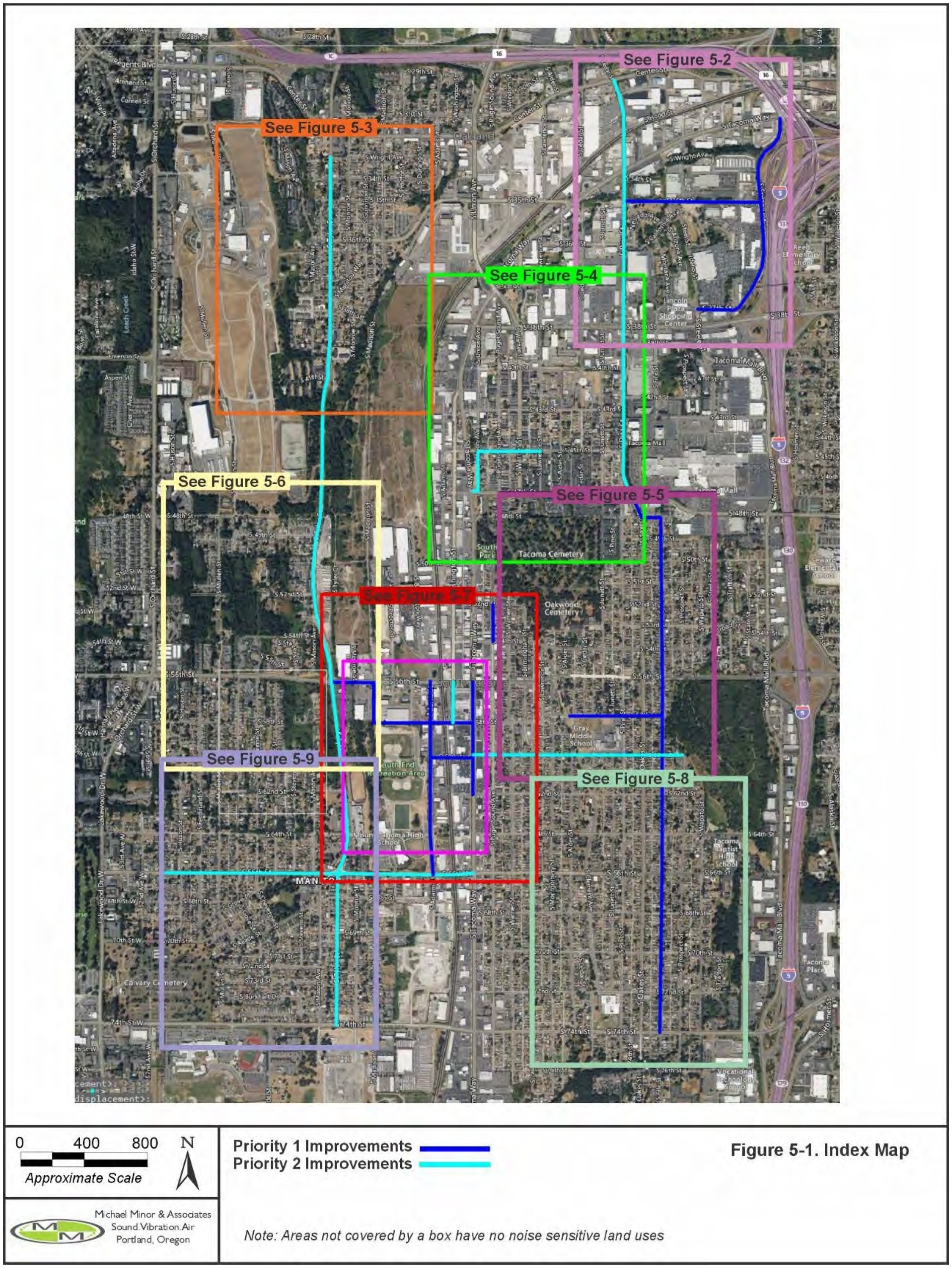


Figure 5-1 Index map

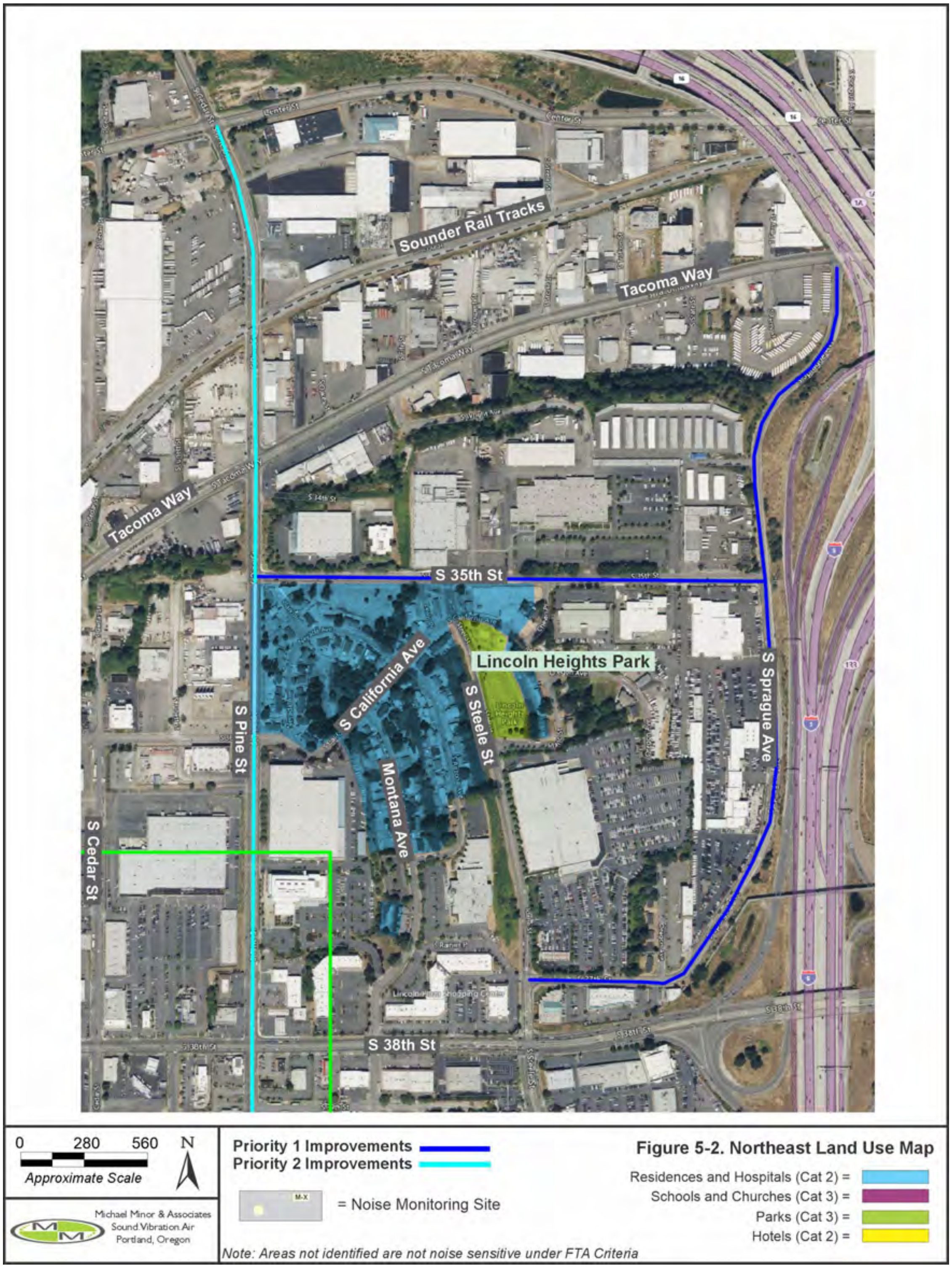


Figure 5-2 Northeast land use map

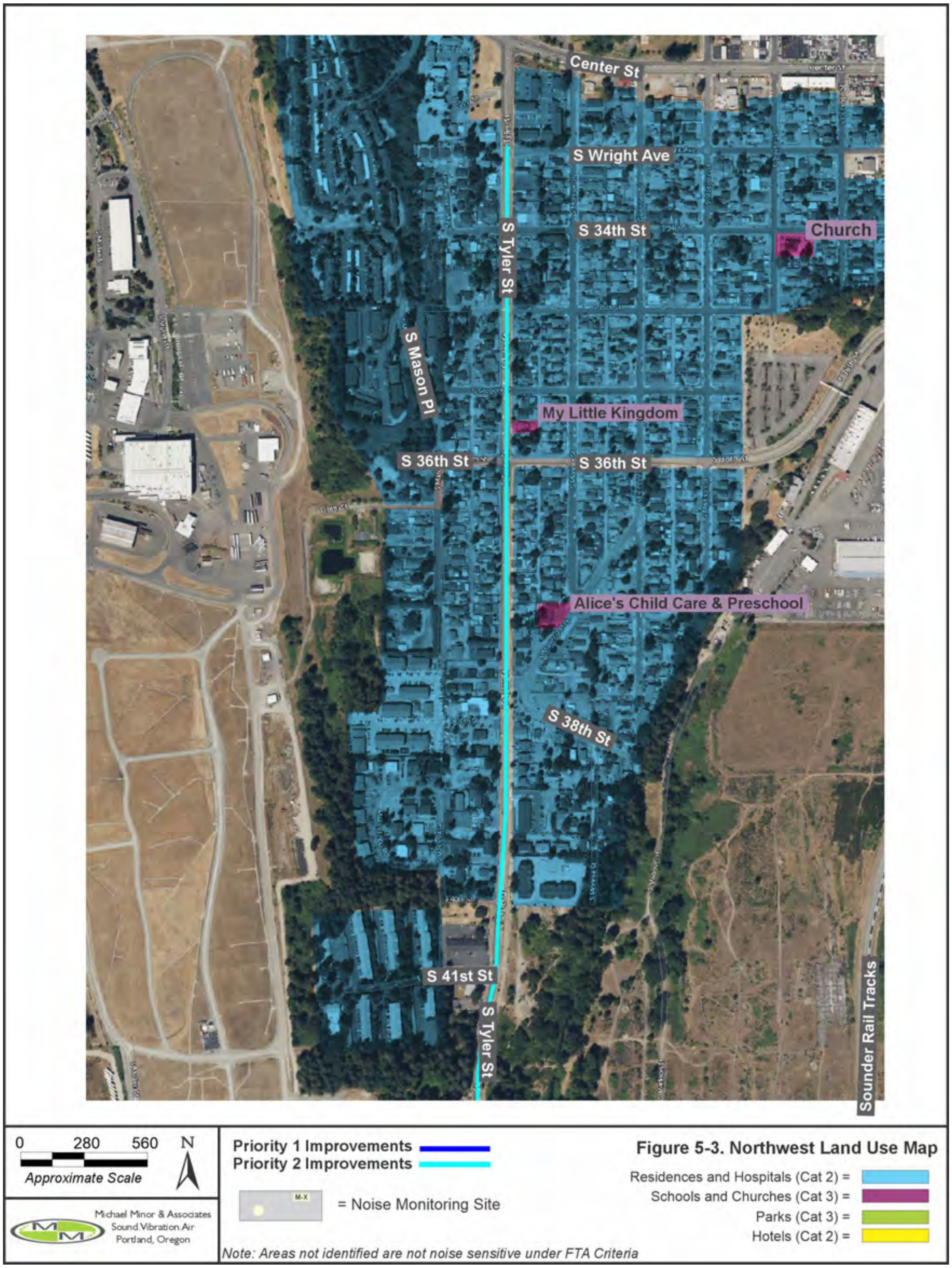


Figure 5-3 Northwest land use map

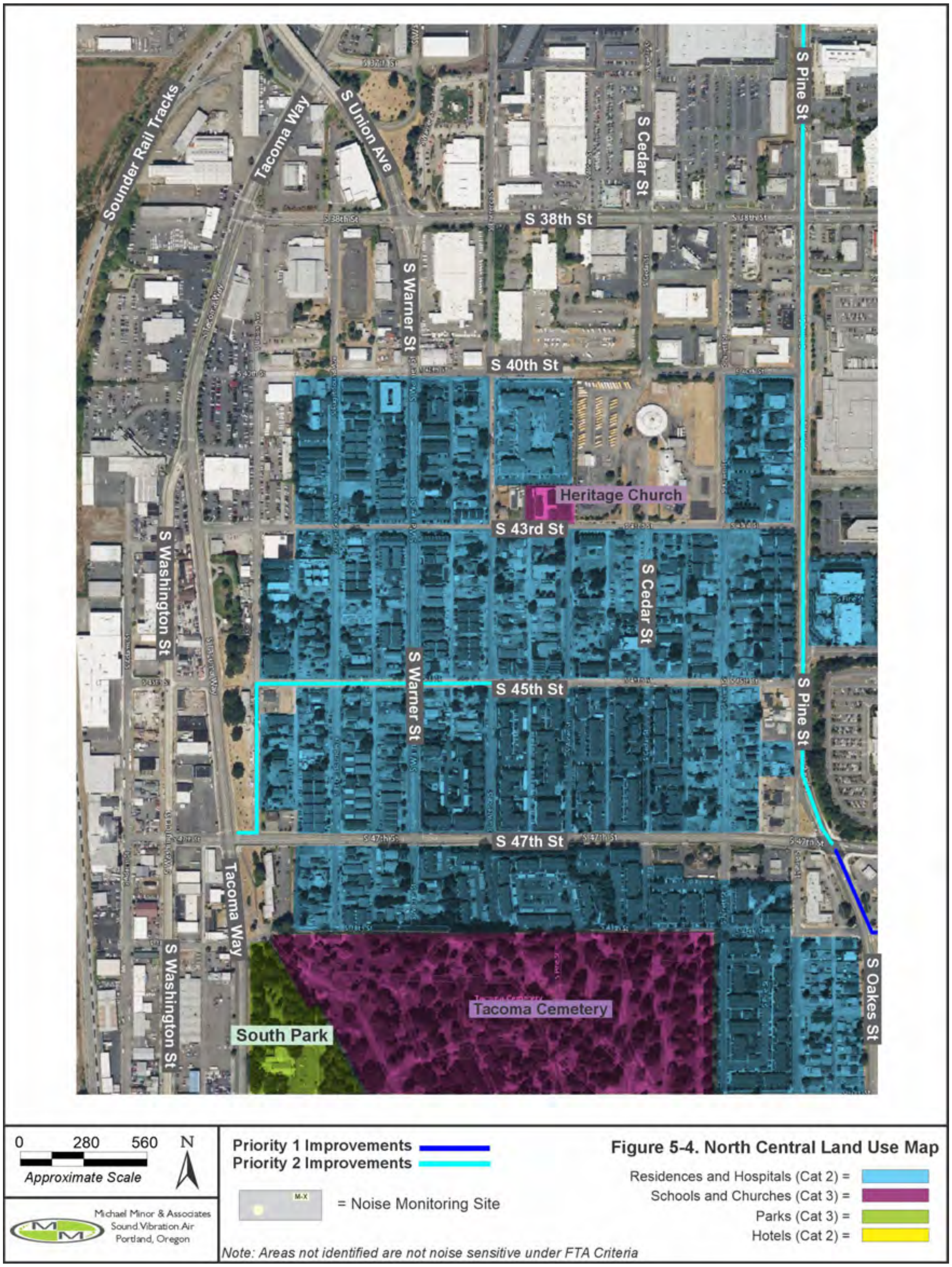


Figure 5-4 North Central land use map

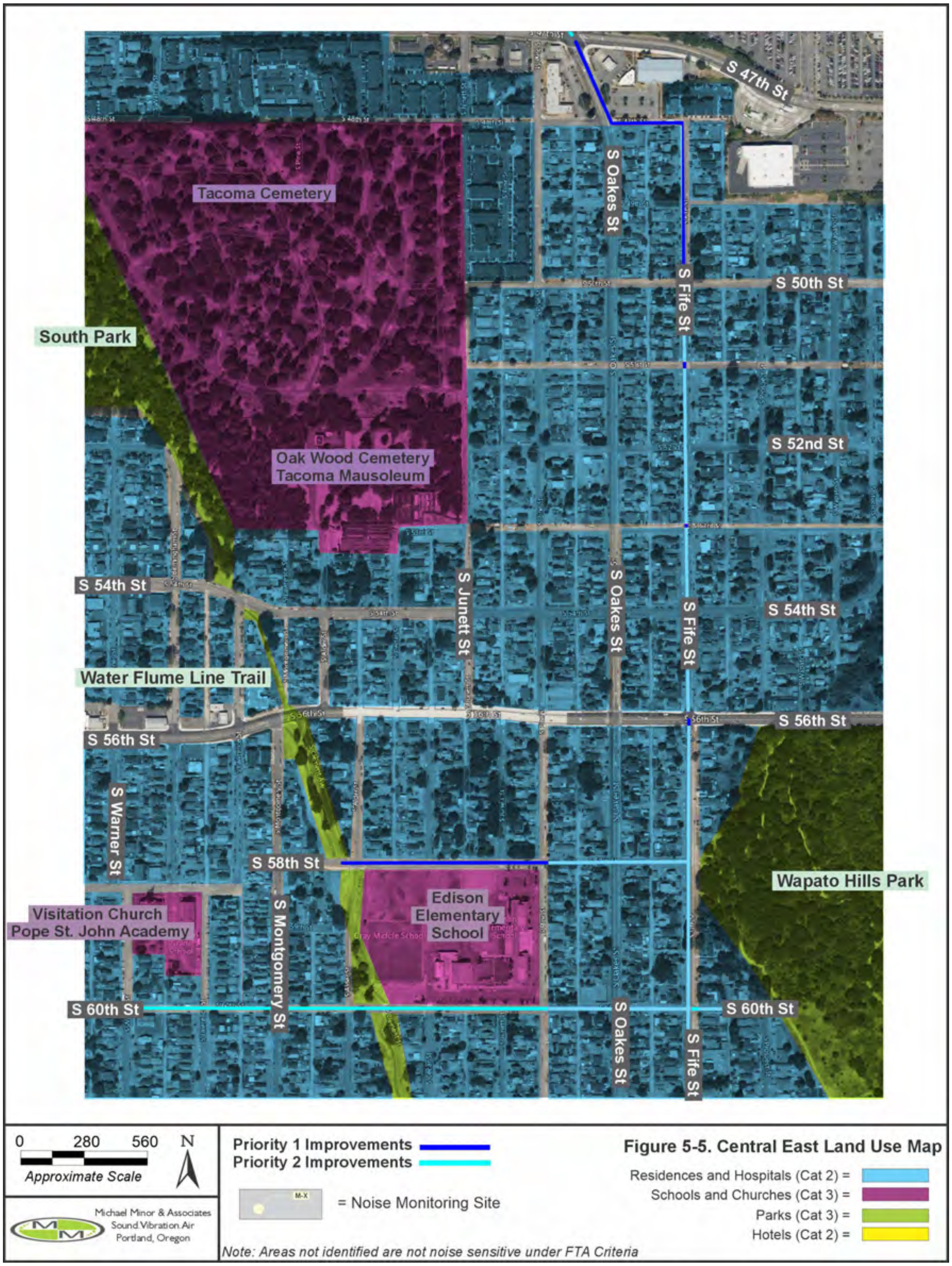


Figure 5-5 Central East land use map

Figure 5-6 Central West land use map

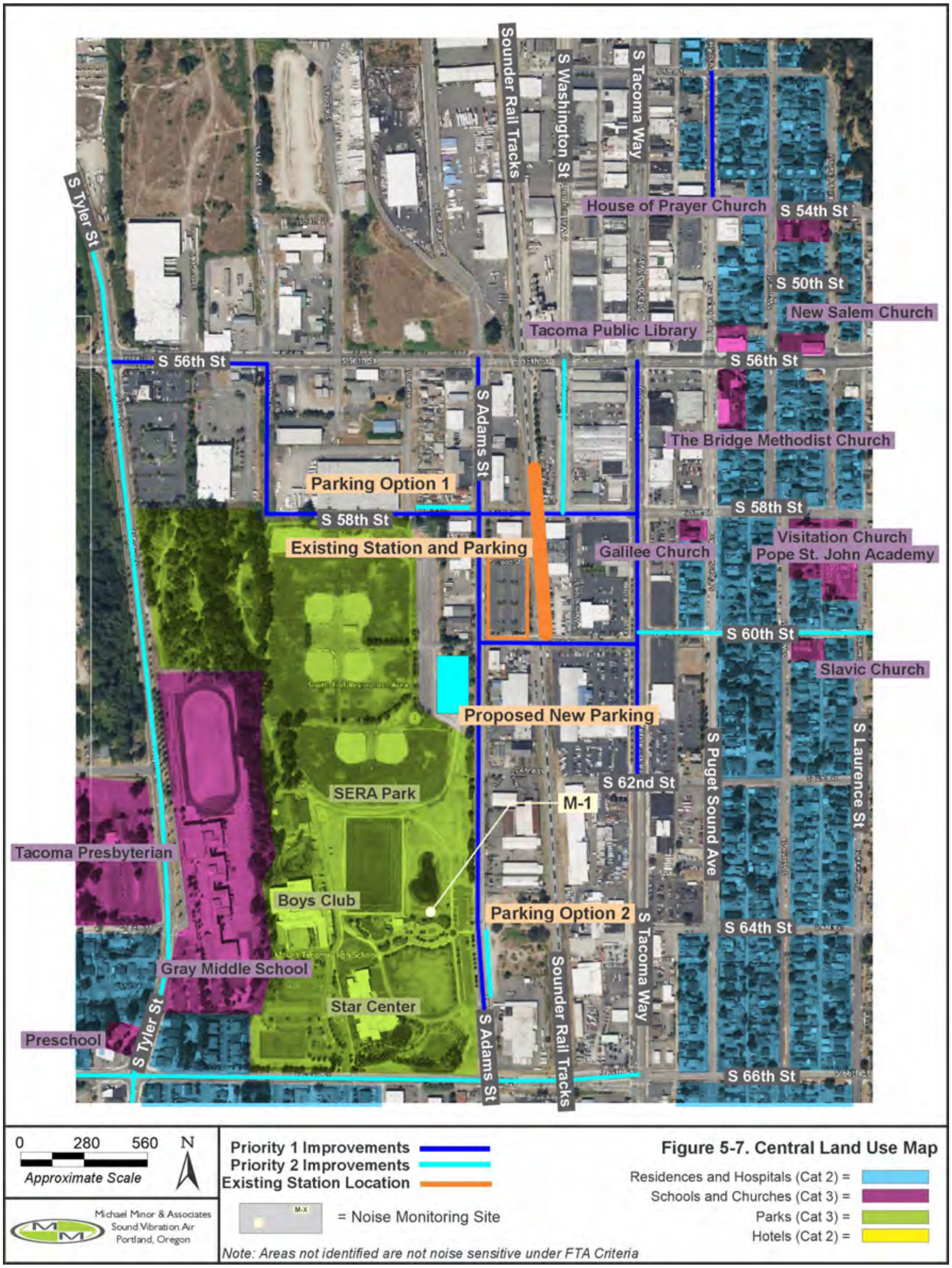


Figure 5-7 Central land use map

Figure 5-8 Southeast land use map

Figure 5-9 Southwest land use map

5.2 Zoning and comprehensive land use plan design

A study of the project area indicated that the area is a mix of high-density to medium-density residential, schools, healthcare, churches, and commercial and federal lands. There are currently no planned or approved land use changes that would affect this noise study.

5.3 Planned and permitted projects

At the time of this analysis, no planned and permitted developments were identified that are sensitive to noise and/or vibration that would affect the results of this noise and vibration analysis.

5.4 Structure removal due to project construction

There are no displacements and associated building demolition planned that would affect the transmission of noise, noise impacts, or noise abatement measures.

5.5 Measured noise levels and sources

The only motorized improvement planned as part of the South Tacoma Station area improvements is to add up to 50 new shared parking spots near the existing parking lot on SERA property. The current lot has approximately 90 spots located south of the station and west of S Adams Street. Noise monitoring was performed near the existing sensitive use area at SERA to establish the existing background noise levels in this area. Measurements were taken during morning hours and again during the midafternoon hours. Early morning hours are applicable because some facilities at SERA open at 6 a.m. Land use at SERA includes parks and schools (FTA Category 3) but no residential uses. Hourly noise levels ranged from 58 to 61 dBA Leq with an Ldn of 60 dBA. The measurement results are provided in Table 5-1.

Table 5-1 Noise measurement results

Site[a]	Period[b]	Time of Day	Leq[c]	Ldn[d]	Notes[e]
M-1	Morning	6:30 a.m.	58	60	No trains, normal traffic
M-1	Daytime	8:30 a.m.	59	60	No trains, normal traffic
M-1	Daytime	2:50 p.m.	61	60	No trains, normal traffic

Notes

a. See Figure 5-7 for noise monitoring sites.
b. Morning = 5 a.m. to 7 a.m., daytime = 7 a.m. to 7 p.m., evening = after 7 p.m.
c. Leq over the measurement period, 30 minutes.
d. Calculated existing 24-hour Ldn using the methods provided by the FTA.
e. Notes are on train operations and traffic.

6 NOISE AND VIBRATION EVALUATION AFFECTED ENVIRONMENT

Sound Transit performed a noise impact assessment for construction and operations based on the criteria and methods described in Section 4.0 of this report.

Project construction was evaluated and compared to the local regulations related to construction noise from the City of Tacoma. If impacts are identified, construction noise mitigation measures may be required. If some work may occur at nighttime to prevent service disruptions, consideration of a noise variance from the City of Tacoma will be required.

Using the measured background noise levels to establish the FTA criteria and using the new future project-related operational noise levels, the future total noise can be predicted and compared to the appropriate criteria. The change in noise levels near the station would be related to the projected operational noise, which would include any new noise-producing activities related to the improvements.

Project noise impacts, if any exist, would be determined using the methods in the FTA Manual (see Figure 4-1) and the WAC (see Table 4-1). If noise impacts are identified, noise mitigation will be considered and, if reasonable and feasible forms of mitigation are available, they may be included with the project.

Vibration analysis uses the maximum pass-by level; therefore, because there will be no changes in Sounder operations with the project, the project-related vibration is not predicted to change from the existing conditions.

6.1 Construction noise analysis

Several construction phases would be required to complete the proposed upgrades. The FHWA Roadway Construction Noise Model (FHWA 2006) was used to provide an estimate of the project construction noise levels, as well as to predict the maximum noise levels for several different construction phases. The analysis assumes the worst-case average and maximum noise levels based on the three major types of construction described below and shown in Table 6-1. The actual noise levels experienced during construction would generally be lower than those described in Table 6-1 because these are the maximum noise levels for each activity. The noise levels presented here are for short periods of maximum construction activity and would occur for a limited period of time.

Table 6-1 Noise levels for typical construction phases

Combined worst-case noise levels for all equipment at a distance of 50 feet from work site			
Scenario [a]	**Equipment [b]**	**Lmax [c]**	**Leq [d]**
Demolition, site preparation, and utilities relocation	Air compressors, backhoes, concrete pumps, cranes, excavators, forklifts, haul trucks, loaders, pumps, power plants, service trucks, tractor trailers, utility trucks, and vibratory equipment	88	87
Roadway improvement construction and paving activities	Air compressors, backhoes, cement mixers, concrete pumps, cranes, forklifts, haul trucks, loaders, pavers, pumps, power plants, service trucks, tractor trailers, utility trucks, vibratory equipment, and welders	88	88
Miscellaneous activities	Air compressors, backhoes, cranes, forklifts, haul trucks, loaders, pumps, service trucks, tractor trailers, utility trucks, and welders	86	83

Note(s):
[a] Operational conditions under which the noise levels are projected.
[b] Normal equipment in operation under the given scenario.
[c] Lmax (dBA) is the highest maximum noise level for the construction equipment listed under the given scenario.
[d] Leq (dBA) is a 1-hour energy average noise emission for construction equipment operating under the given scenario.

6.1.1 Demolition, site preparation, and utilities relocation construction noise

This is the initial phase of construction and would occur throughout the areas with proposed improvements where necessary, including demolishing curbs to install ADA ramps, saw cutting pavement for installation and relocation of any utilities, preparing for installation of sidewalks, curbs, gutters, and bike lanes. Major noise-producing equipment in use during this stage of construction could include saw cutters, jackhammers, backhoe, haul trucks, loaders, tractor-trailers, and vibratory equipment. Maximum noise levels could reach 83 dBA to 88 dBA at the nearest residences (i.e., within 50 to 100 feet) for normal construction activities during this phase. Other less-notable noise-producing equipment expected during this phase would include air compressors, forklifts, pumps, power plants, service trucks, and utility trucks.

6.1.2 Roadway improvement construction and paving activities

Repaving roadways, paving the new parking lot, adding bike lanes and sidewalks, and ADA access construction would occur during this phase of construction. The loudest noise sources in use during this phase of construction would include cement mixers, concrete pumps, pavers, haul trucks, and tractor-trailers. Cement mixers, concrete pumps, and pavers would be required for construction of the new sidewalks, streetside parking areas, curbs, gutters, and roadway improvements in addition to any improvements at the station and the new SERA parking lot. The pavers and haul trucks would be used to provide the final surface on the roadways modified during other phases of construction. Maximum noise levels are predicted to reach 86 dBA to 88 dBA at the closest receiver locations.

6.1.3 Miscellaneous activities

Following heavy construction, general construction would still be required, such as installation of signage and roadway striping. These less-intensive activities are not expected to produce noise levels above 80 dBA at 50 feet except during rare occasions, such as when construction is in close proximity to a structure, and even then, the elevated noise levels would only occur for short periods of time.

6.1.4 Construction noise summary

Using the information in Table 6-1, typical construction noise levels were projected for several distances from the project work area. Figure 6-1 is a graph of general construction noise level versus distance for typical phases of construction. Note that the noise levels presented do not include any noise reduction from structures or topographical conditions between the construction activity and the receiving property.

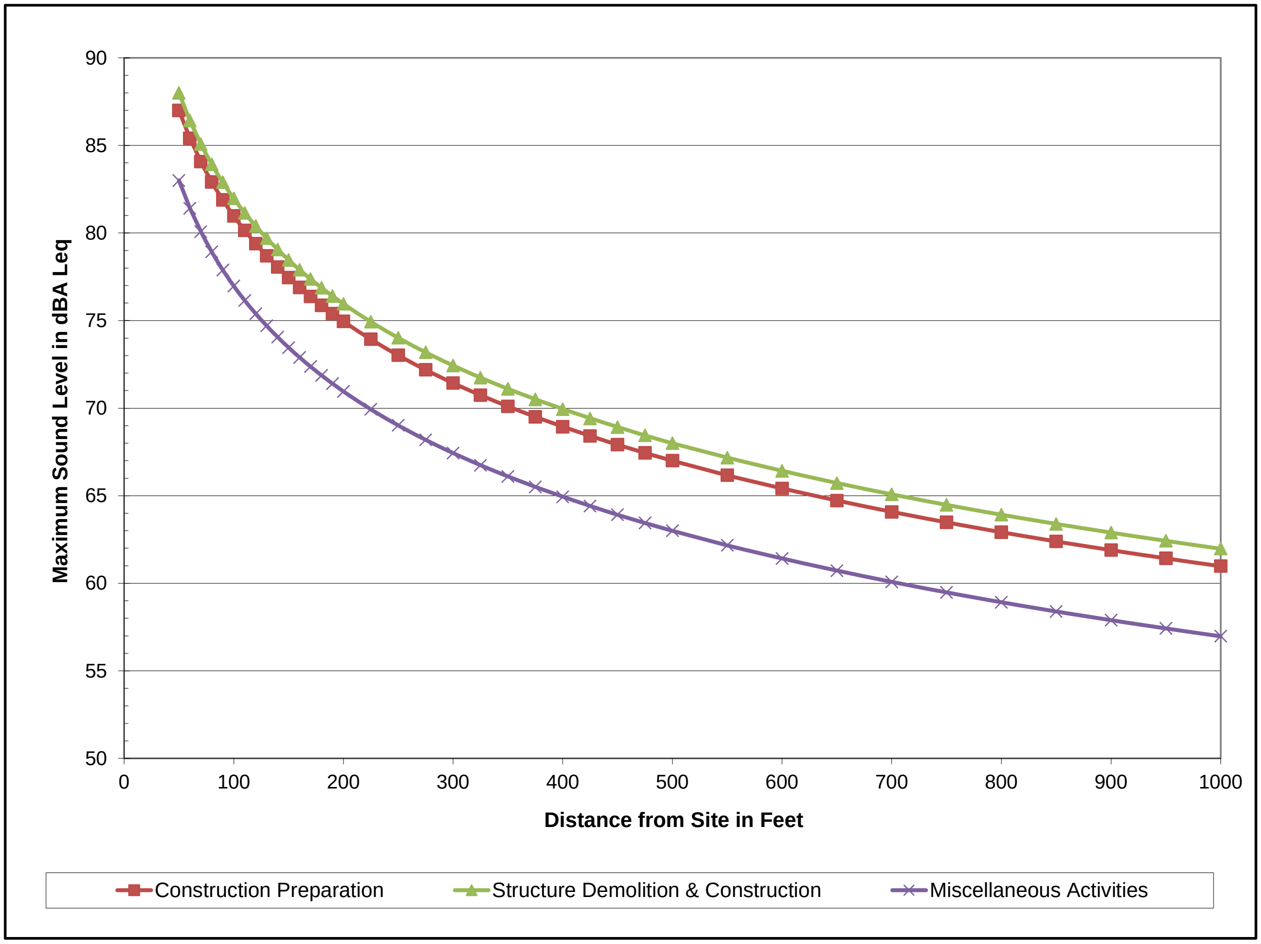


Figure 6-1 Maximum noise level versus distance for typical construction phases

6.2 Construction vibration analysis

Vibration associated with general construction activities can result in increased vibration levels. Project-related vibration sources include soil compactors, excavators, haul trucks, flat-bed tractor-trailers, backhoes, cranes, and jackhammers.

The vibration sources associated with the project, even though they may be noticeable to residents when construction is nearby, are not expected to cause any structural damage.

Vibration levels for construction activities are projected to be the highest during demolition activities and soil compacting. Demolition activities would include removing existing curbs for installation of new ADA compliant ramps and removing existing concrete during utility installation and relocation. Major construction equipment that would be used during demolition includes excavators, haul trucks, backhoes, jackhammers, and saw cutters. Based on information from the U.S. Bureau of Mines, it typically takes vibration levels in excess of 0.5 inch per second (in./sec.) to cause cosmetic damage to plaster walls, and 0.75 in./sec. for cosmetic damage to drywall.

Vibration levels from project construction, including roadway and bike lane paving, are also projected to remain below 0.5 in./sec. at residences along the project corridor because of the distance between the work zones and structures. The main vibration producing equipment in this phase are soil compactors and vibratory rollers. Because of the type of construction, which is the same as typical roadway construction frequently performed by all municipalities, there is only a virtually no potential for any structural damage during construction, and even then, only for structures located within 25 of heavy construction activities, like soil compacting or jackhammering. Table 6-2 provides typical vibration levels for several common types of construction equipment.

Table 6-2 Construction vibration impact levels at 25 feet

Equipment	Conditions	Peak Particle Velocity at 25 feet (in./sec.)	Vibration Level in VdB at 25 feet (re: 1 micro-in./sec.)
Large bulldozer	Normal operations	0.089	87
Loaded haul trucks	Normal operations	0.076	86
Jackhammer	Normal operations	0.035	79
Small bulldozer	Normal operations	0.003	58
Vibratory roller	Normal operations	0.210	94

Notes:
Source: FTA 2018.
in./sec. = inch(es) per second.
VdB = vibration decibels.

6.3 Operational noise analysis

The majority of the proposed improvements for the South Tacoma Station are related to non-motorized transportation. Improvements, including new sidewalks, curbs, gutters, bike lanes, and other safety improvements, are not predicted to result in any long-term changes in the overall area noise levels. All vehicle travel lanes along roadways that are associated with the project will remain in the same general location as they currently are, and no increase in motorized traffic capacity (e.g., new through lanes) are planned with the project.

The S Adams Street non-motorized improvements would reduce some parking spots. To replace the lost parking, two new parking areas are proposed, Parking Option 1 is located on the north side of S 58th Street between S Durango Street and S Adams Street. Parking Option 2 is along the east side of S Adams Street, starting at S 64th Street and continuing for approximately 300 feet to the south. Parking Option 1 would have seven regular angled parking spots and one ADA parking spot. Parking Option 2, also with angled parking, would include approximately 21 regular spots and one ADA spot. The parking areas would be within City of Tacoma ROW but outside the existing streetscape and pavement.

Finally, there is also a Priority 2 addition of 50 new parking spaces on SERA property near the existing SERA Campus parking area. The SERA Campus parking spots are near an outdoor use area at SERA, the Star Center, Boys Club, and Gray Middle School. The SERA Campus

Shared Parking Lot will include lighting, ADA improvements, curbs, gutter, sidewalks, and lighting. All three parking areas are shown in Figure 6-2.

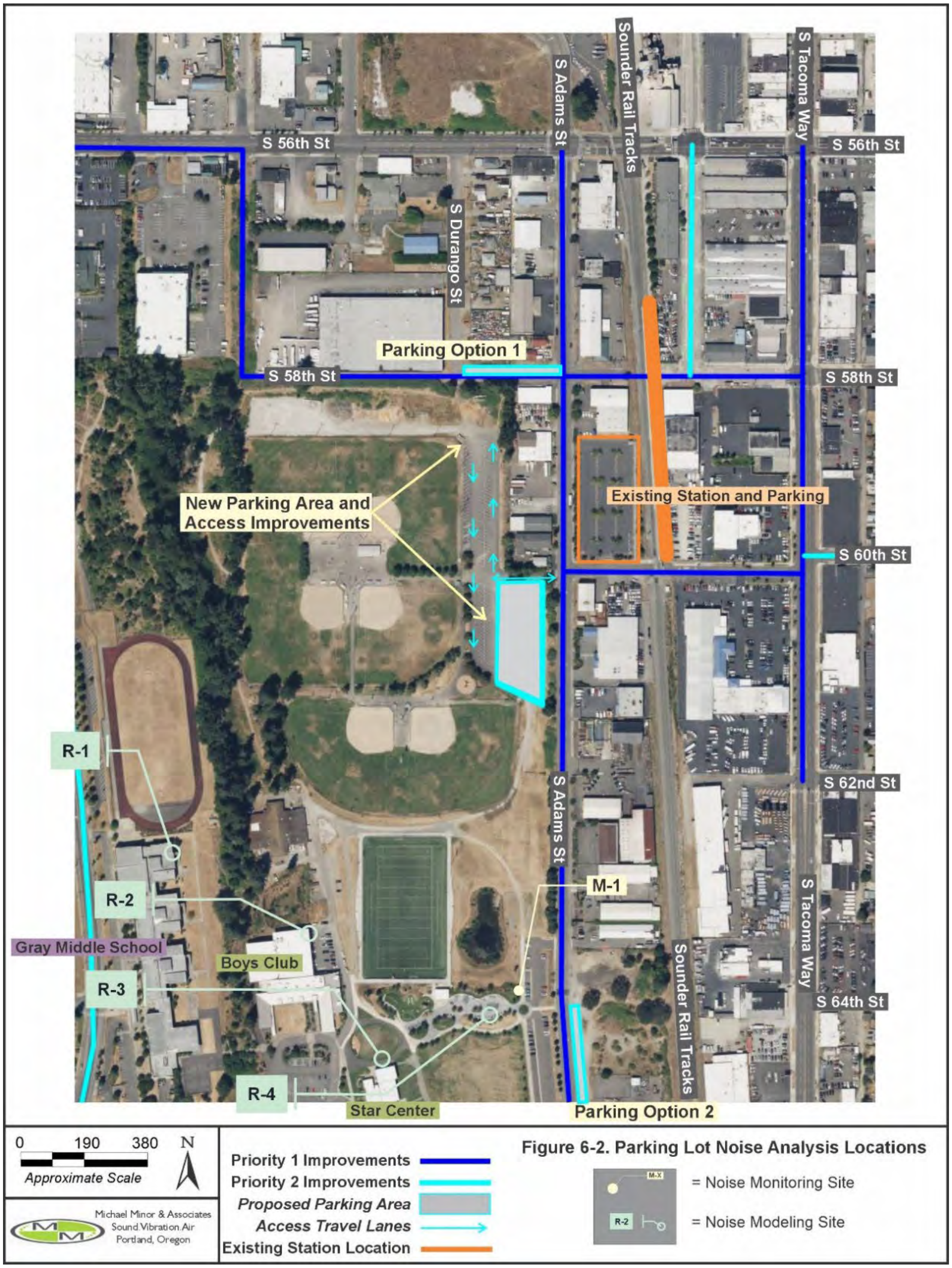


Figure 6-2 Parking lot noise analysis locations

Noise levels from the operation of the SERA Campus Shared Parking Lot and Parking Option 2 were calculated using the methods for a parking lot as provided in the FTA Manual. Parking Option 1 was not considered because Parking Option 1 only has eight parking spots and is more than1,000 feet and/or well shielded from any noise-sensitive property. Therefore, any added noise from vehicles parking under Option 1 would not affect the overall noise levels at any nearby sensitive property.

To verify compliance with the FTA criteria and WAC noise control ordinance, noise levels from operation of the new SERA Campus Shared Parking Lot and Parking Option 2 were predicted assuming all parking spaces would be accessed during a single hour, providing the worst-case hourly Leq (see Table 6-3). A more typical scenario would be cars arriving throughout the morning hours and departing in the afternoon hours. By assuming all spots would be accessed in a single hour, the analysis produces a worst-case volume of traffic and therefore the worst case hourly Leq. For the WAC analysis, the predicted noise level at each receiver is compared to the nighttime criteria, which have maximum allowable noise levels that are 10 dB lower than the daytime criteria. The nighttime hour criteria were used because the Star Center opens at 6 a.m.

The following receiver locations, shown in Figure 6-2, were selected:

- R-1. Gray Middle School (north end of school building).
- R-2. Boys and Girls Club Classroom Area (north end of building).
- R-3. STAR Center (north end of STAR Center building).
- R-4. Outdoor shared area near playground, also used for farmers markets and other outdoor activities.

No predictions were performed for the active playing fields, as active sports fields are not considered noise sensitive under FTA criteria. Because the analysis assumes all spots used in a single hour twice per day, once before 7 a.m. (nighttime hours) and once during daytime hours, the Leq noise levels provided are worst-case noise levels and are likely slightly higher than what would actually occur. Finally, because there are no FTA Category 2 land uses (residential), the Ldn for parking operations was not calculated.

Table 6-3 Parking lot noise analysis

Rec.[a]	Rec. Type[b]	Dist. (feet)[c]	Background Noise, Leq dBA[d]	New Parking Noise, Leq dBA[e]	Future Noise Levels, Leq dBA[f]	Change in Total Noise, dB[g]
R-1	School	1,060	58	24	58	0
R-2	School	920	58	26	58	0
R-3	School	1,160	58	24	58	0
R-4	Park	935	58	25	58	0

Note(s):

a. Receivers are shown in Figure 6-2.
b. Receiver types: schools and parks (FTA Category 3 land use).
c. Distance from the parking area to the receiver.
d. Background noise levels from Table 5-1.
e. Calculated noise levels from worst-case operation of the parking lot.
f. Total noise levels (background plus parking lot operations).
g. Change in total noise, or the future noise minus background noise.

As is shown in Table 6-3, noise levels from the proposed two parking areas (SERA Campus Shared Parking Lot and Parking Option 2) at the four nearby receivers range from 24 to 26 dBA Leq during peak hour operations. The existing noise levels, based on measurements at M-1, show that the existing noise levels are far more than 10 dB higher than the noise from the parking lot operations. As described in Section 3.1.2, Decibel mathematics, if the existing noise levels are 10 dB higher than the new noise source, the new source will not contribute a measurable change in the overall noise levels.

Noise levels from the parking lot were analyzed for impacts using the FTA and WAC criteria. The analysis results, shown in Table 6-3, show that adding the parking lot and street side parking on S Adams Street would not change the noise levels at any of the nearby receiver locations due to the large distance from the SERA parking lot and Parking Option 2 to the noise-sensitive uses. Therefore, no FTA or WAC noise impacts were identified.

There are no other project-related noise impacts predicted under the proposed South Tacoma Station improvement project package.

6.4 Operational vibration analysis

Major vibration-related sources include the existing Sounder and Amtrak trains, trains related to the Tacoma Rail service, and rail service to and from Joint Base Lewis-McChord. Other vibration sources include heavy trucks and industrial activities. Because the project would make no track modifications or changes in Sounder or Amtrak headways, there is no change predicted in the overall vibration levels in the area. Therefore, no vibration impacts are predicted.

7 PROJECT MITIGATION

7.1 Construction noise mitigation

Potential construction noise impacts can be reduced with operational methods and scheduling, equipment choice, and acoustical treatments. If required for construction outside the allowable hours (see Section 4.2), Sound Transit or its contractor would seek the appropriate noise variance from the City of Tacoma and require the appropriate noise control measures. Noise control mitigation to meet local regulatory requirements, noise ordinances, and permit or variance conditions would be required. These measures could include:

- Use smart back-up alarms during nighttime.
- Use low-noise emission equipment.
- Implement noise-deadening measures for truck loading and operations.
- Monitor and maintain equipment to meet noise limits.
- Use lined or covered storage bins, conveyors, and chutes with sound-deadening material.
- Use acoustic enclosures, shields, or shrouds for equipment and facilities.
- Install high-grade engine exhaust silencers and engine-casing sound insulation.
- Prohibit jack hammering and impact pile driving during nighttime hours.
- Minimize the use of generators or use whisper-quiet generators to power equipment.
- Use movable noise barriers at the source of the construction activity.
- Limit or avoid certain noisy activities during nighttime hours near residential areas.

7.2 Construction vibration mitigation

The primary concern from construction vibration in the project corridor is annoyance inside sensitive spaces. No construction vibration impacts are predicted. However, the following precautionary vibration mitigation strategies could be implemented if construction occurs within 25 feet of a sensitive or historic structure:

- Pre-construction verification: Given the types of construction activities required for completion of the project, as previously stated, no vibration impacts are projected and no pre-construction survey or verification should be required. If, however, during construction, highly sensitive or historic buildings are identified within 25 feet of a site with heavy construction activities, an inspection of those buildings may be warranted.
- Vibration limits: The construction contract specifications should limit construction vibration to a maximum of 0.5 in./sec. for all buildings within 25-feet of construction activities.
- Vibration monitoring: Given the types of construction activities required for completion of the project, vibration monitoring should not be necessary. If heavy construction would occur closer than 25 feet to sensitive structures or historic buildings, limited vibration monitoring maybe warranted.

7.3 Operational noise mitigation

No operational noise impacts are predicted, and no vibration mitigation is recommended.

7.4 Operational vibration mitigation

No operational vibration impacts are predicted, and no vibration mitigation is recommended.

8 REFERENCES

City of Tacoma Municipal Code, Chapter 8.122.

Federal Highway Administration (FHWA). 2006. U.S. Department of Transportation. Roadway Construction Noise Model, August 2006.

Federal Transit Administration (FTA). 2018. U.S. Department of Transportation. Transit Noise and Vibration Impact Assessment. September 2018.

Sound Transit. 2021. *Phase 1 South Tacoma Station Access Improvements Report*.

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