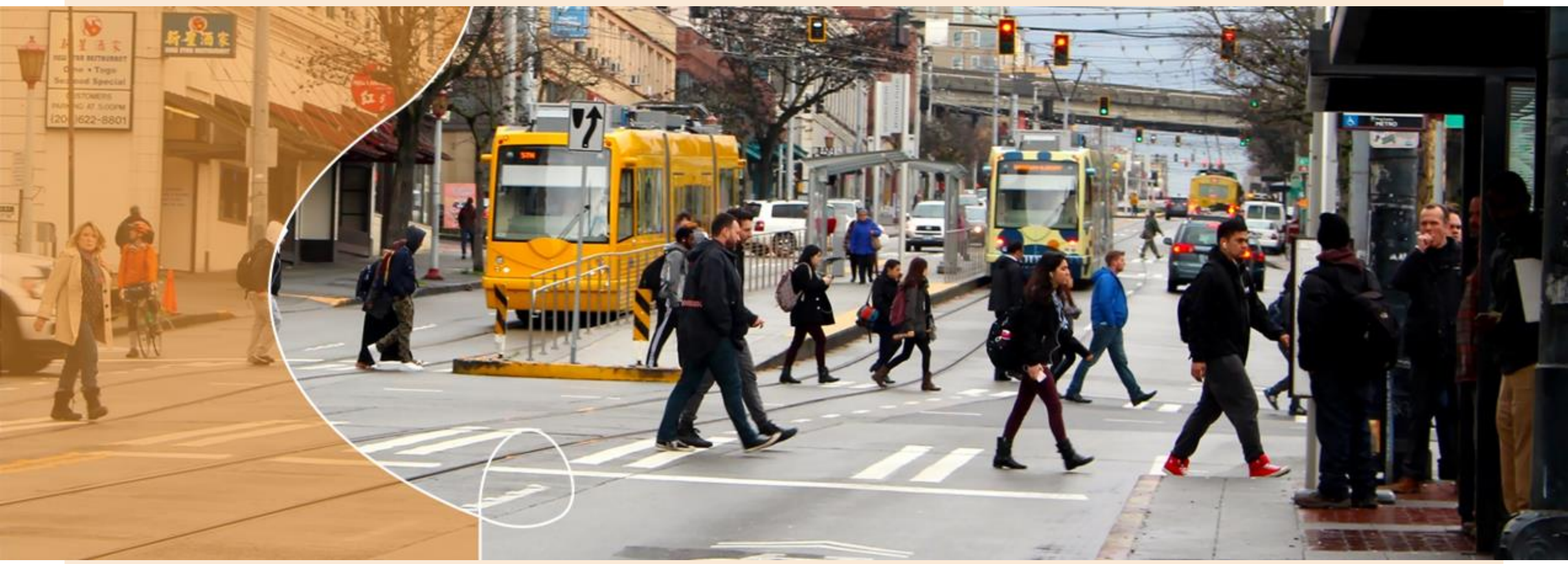
3.5 Noise



Source: City of Seattle, 2023.

This section assesses the potential noise/vibration impacts associated with implementing the alternatives considered in this EIS. The following includes acoustical terminology and background information, a presentation of applicable regulatory standards, assessment of acoustical impacts related to implementing the alternatives, and identification of potentially feasible noise mitigation measures where appropriate.

Thresholds of significance utilized in this impact analysis include:

- The alternative would cause future traffic noise levels of 10 dBA or more above existing noise levels.
- Noise-sensitive receivers are concentrated near noise-generating (non-residential) activities or major roadways.

Data & Methods

The project team used a range of data sources for this assessment of ambient, construction, and traffic noise listed below.

- Highway Construction Noise Handbook (FHWA 2006)
- Highway Traffic Noise: Analysis and Abatement Guidance (FHWA 2011)
- City of Seattle Municipal Code (SMC Chapter 25)
- State of Washington Administrative Code (Chapter 173-60 WAC)
- Port of Seattle Aircraft Noise Monitoring System (2022)

3.5.1 Affected Environment

Environmental Noise & Vibration Fundamentals

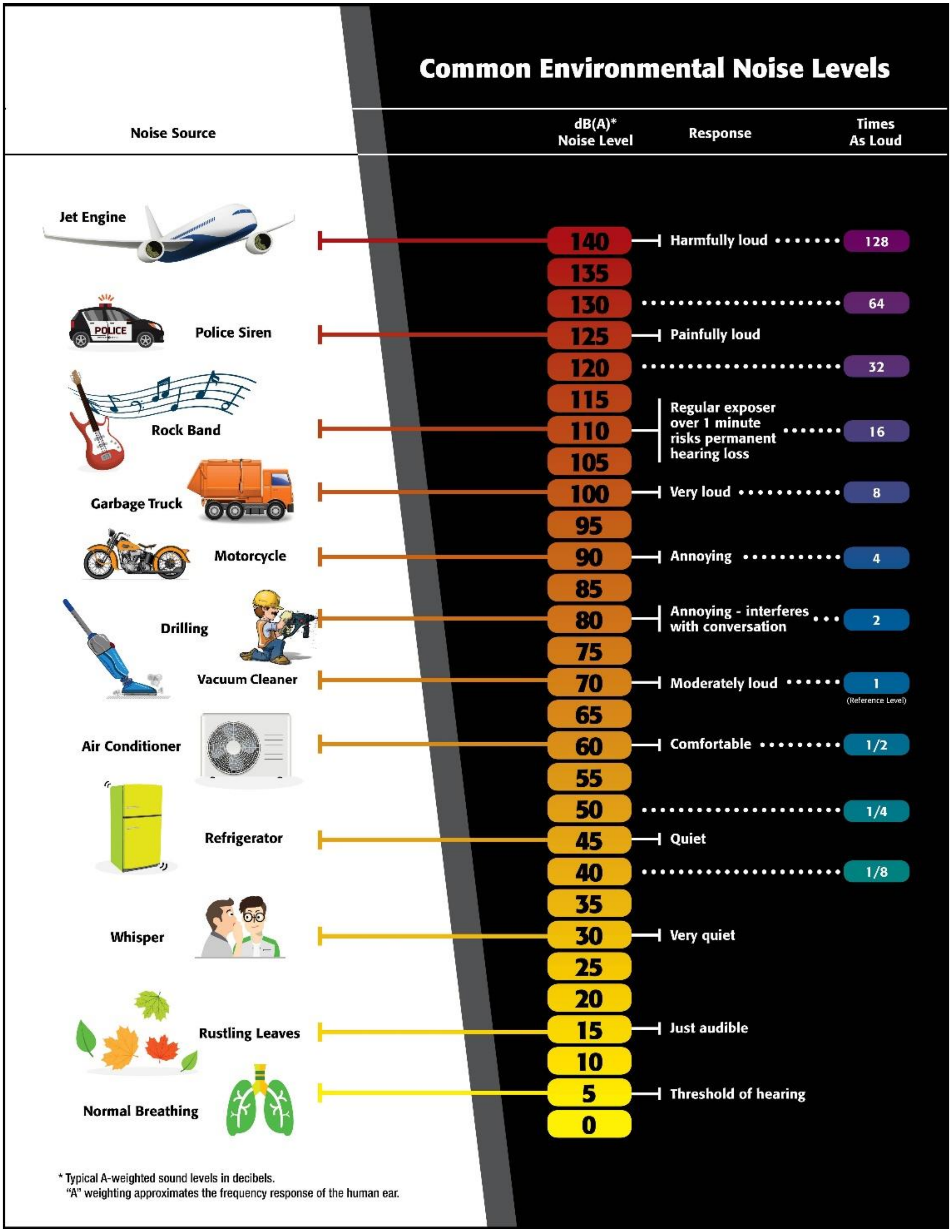
Sound & Fundamental Noise

Acoustics is the science of sound. Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a medium (e.g., air) to a human (or animal) ear. If the pressure variations occur frequently enough (at least 20 times per second), they can be heard and are called sound. The number of pressure variations per second is called the frequency of sound and is expressed as cycles per second, or hertz (Hz).

Noise is defined as loud, unexpected, or unwanted sound. The fundamental acoustics model consists of a noise source, a receptor (or "receiver"), and the propagation path between the two. The loudness of the noise source, obstructions, or atmospheric factors affecting the propagation path determine the perceived sound level and noise characteristics at the receptor. Acoustics deal primarily with the propagation and control of sound. A typical noise environment consists of a base of steady background noise that is the sum of many distant and indistinguishable noise sources. The sound from individual local sources is superimposed on this background noise. These sources can vary from an occasional aircraft or train passing by to continuous noise from traffic on a major highway. Perceptions of sound and noise are highly subjective from person to person. **Exhibit 3.5-1** depicts typical noise levels.

Measuring sound directly in terms of pressure would require a large range of numbers. To avoid this, the decibel (dB) scale was devised. The dB scale uses the hearing threshold of 20 micropascals (μPa) as a point of reference, defined as 0 dB. Other sound pressures are then compared to this reference pressure, and the logarithm is taken to keep the numbers in a practical range. The dB scale allows a million-fold increase in pressure to be expressed as 120 dB, and changes in levels correspond closely to human perception of relative loudness.

Exhibit 3.5-1. Typical Noise Levels



Source: Kimley-Horn and Associates, Inc., 2020.

Noise Descriptors

The dB scale alone does not adequately characterize how humans perceive noise. The dominant frequencies of a sound have a substantial effect on the human response to that sound. Several rating scales have been developed to analyze the adverse effect of community noise on people. Because environmental noise fluctuates over time, these scales consider that the effect of noise on people is largely dependent on the total acoustical energy content of the noise, as well as the time of day when the noise occurs. Most commonly, environmental sounds are described in terms of the equivalent noise level (L_{eq}) that has the same acoustical energy as the summation of all the time-varying events. While L_{eq} represents the continuous sound pressure level over a given period, the day-night noise level (L_{dn}) and Community Equivalent Noise Level (CNEL) are measures of energy average during a 24-hour period, with dB weighted sound levels from 7:00 PM to 7:00 AM. Each is applicable to this analysis and defined in **Exhibit 3.5-2**.

Exhibit 3.5-2. Definitions of Acoustical Terms

Term	Definitions
Decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in μPa (or 20 micronewtons per square meter), where 1 pascal is the pressure resulting from a force of 1 newton exerted over an area of 1 square meter. The sound pressure level is expressed in dB as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e.g., 20 μPa). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency (Hz)	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level (dBA)	The sound pressure level in dB as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level (L_{eq})	The average acoustic energy content of noise for a stated period of time. Thus, the L_{eq} of a time-varying noise and that of a steady noise are the same if they deliver the same acoustic energy to the ear during exposure. For evaluating community impacts, this rating scale does not vary, regardless of whether the noise occurs during the day or the night.
Maximum Noise Level (L_{max}) Minimum Noise Level (L_{min})	The maximum and minimum dBA during the measurement period.
Exceeded Noise Levels (L_{01}, L_{10}, L_{50}, L_{90})	The dBA values that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day-Night Noise Level (L_{dn})	A 24-hour average L_{eq} with a 10 dBA weighting added to noise during the hours of 10:00 PM to 7:00 AM to account for noise sensitivity at nighttime. The

Term	Definitions
	logarithmic effect of these additions is that a 60 dBA 24-hour L_{eq} would result in a measurement of 66.4 dBA L_{dn}.
Community Noise Equivalent Level (CNEL)	A 24-hour average L_{eq} with a 5 dBA weighting during the hours of 7:00 AM to 10:00 AM and a 10 dBA weighting added to noise during the hours of 10:00 PM to 7:00 AM to account for noise sensitivity in the evening and nighttime, respectively. The logarithmic effect of these additions is that a 60 dBA 24-hour L_{eq} would result in a measurement of 66.7 dBA CNEL.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends on its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual, September 2018.

Because sound levels can vary markedly over a short period of time, a method for describing either the sound's average character (L_{eq}) or the variations' statistical behavior (L_{XX}) must be utilized. The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The predicted models' accuracy depends on various factors, such as the distance between the noise receptor and the noise source, the character of the ground surface (e.g., hard or soft), and the presence or absence of structures (e.g., walls or buildings) or topography, and how well model inputs reflect these conditions.

A-Weighted Decibels

The perceived loudness of sounds is dependent on many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable and can be approximated by dBA values. There is a strong correlation between dBA and the way the human ear perceives sound. For this reason, the dBA has become the standard tool of environmental noise assessment. All noise levels reported in this document are in terms of dBA, but are expressed as dB, unless otherwise noted.

Addition of Decibels

The dB scale is logarithmic, not linear, and therefore sound levels cannot be added or subtracted through ordinary arithmetic. Two sound levels 10 dB apart differ in acoustic energy by a factor of 10 (Caltrans, 2013). When the standard logarithmic dB is A-weighted, an increase of 10 dBA is generally perceived as a doubling in loudness. For example, a 70-dBA sound is half as loud as an 80-dBA sound and twice as loud as a 60-dBA sound. When two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dBA higher than one source under the same conditions. Under the dB scale, three sources of equal loudness together would produce an increase of 5 dBA.

Sound Propagation & Attenuation

Sound spreads (propagates) uniformly outward in a spherical pattern, and the sound level decreases (attenuates) at a rate of approximately 6 dB for each doubling of distance from a stationary or point source. Sound from a line source, such as a highway, propagates outward in a cylindrical pattern. Sound levels attenuate at a rate of approximately 3 dB for each doubling of distance from a line source, such as a roadway, depending on ground surface characteristics. No excess attenuation is assumed for hard surfaces like a parking lot or a body of water. Soft surfaces, such as soft dirt or grass, can absorb sound, so an excess ground-attenuation value of 1.5 dB per doubling of distance is normally assumed. For line sources, an overall attenuation rate of 3 dB per doubling of distance is assumed in this report.

Noise levels may also be reduced by intervening structures; generally, a single row of buildings between the noise receptor and the noise source reduces the noise level by about 5 dBA, while a solid wall or berm can reduce noise levels by 5 to 15 dBA (FHWA, 2006). The way older homes were constructed generally provides a reduction of exterior-to-interior noise levels of about 20 to 25 dBA with closed windows. The exterior-to-interior reduction of newer residential units is generally 30 dBA or more.

Human Response to Noise

The human response to environmental noise is subjective and varies considerably from individual to individual. Noise in the community has often been cited as a health problem, not in terms of actual physiological damage, such as hearing impairment, but in terms of inhibiting general well-being and contributing to undue stress and annoyance. The health effects of noise in the community arise from interference with human activities, including sleep, speech, recreation, and tasks that demand concentration or coordination. Hearing loss can occur at the highest noise intensity levels.

Noise environments and consequences of human activities are usually well represented by median noise levels during the day or night or over a 24-hour period. Environmental noise levels are generally considered low when the CNEL is below 60 dBA, moderate in the 60 to 70 dBA range, and high above 70 dBA (Cowan, 1994, and Harris, 1979). Examples of low daytime levels are isolated, natural settings with noise levels as low as 20 dBA and quiet, suburban, residential streets with noise levels around 40 dBA. Noise levels above 45 dBA at night can disrupt sleep. Examples of moderate-level noise environments are urban residential or semi-commercial areas (typically 55 to 60 dBA) and commercial locations (typically 60 dBA). People may consider louder environments adverse, but most will accept the higher levels associated with noisier urban residential or residential-commercial areas (60 to 75 dBA) or dense urban or industrial areas (65 to 80 dBA). Regarding increases in dBA, the following relationships should be noted (Caltrans, 2013 and 2017):

- Except in carefully controlled laboratory experiments, a 1-dBA change cannot be perceived by humans.
- Outside of the laboratory, a 3-dBA change is considered a just-perceivable difference.
- A minimum 5-dBA change is required before any noticeable change in community response would be expected. A 5-dBA increase is typically considered substantial.
- A 10-dBA change is subjectively heard as an approximate doubling in loudness and would almost certainly cause an adverse change in community response.

Effects of Noise on People

Hearing Loss

While physical damage to the ear from an intense noise impulse is rare, a degradation of auditory acuity can occur even within a community noise environment. Hearing loss occurs mainly due to chronic exposure to excessive noise but may be due to a single event such as an explosion. Natural hearing loss associated with aging may also be accelerated from chronic exposure to loud noise. The Occupational Safety and Health Administration has a noise exposure standard that is set at the noise threshold where hearing loss may occur from long-term exposures. The maximum allowable level is 90 dBA averaged over 8 hours. If the noise is above 90 dBA, the allowable exposure time is correspondingly shorter (U.S. Department of Labor, 1974).

Annoyance

Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The L_{dn} as a measure of noise has been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. A noise level of about 55 dBA L_{dn} is the threshold at which a substantial percentage of people begin to report annoyance (FICON, 1992).

Ground Borne Vibration

Sources of ground borne vibrations include natural phenomena (earthquakes, volcanic eruptions, sea waves, landslides, etc.) or man-made causes (explosions, machinery, traffic, trains, construction equipment, etc.). Vibration sources may be continuous (e.g., factory machinery) or transient (e.g., explosions). Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One is the peak particle velocity (PPV); another is the root mean square (RMS) velocity. The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave and is expressed in terms of inches-per- second (in/sec). The RMS velocity is defined as the average of the squared amplitude of the signal and is expressed in terms of velocity decibels (VdB). The PPV and RMS vibration velocity amplitudes are used to evaluate human response to vibration.

Exhibit 3.5-3 displays the reactions of people and the effects on buildings produced by continuous vibration levels. The annoyance levels shown in the table should be interpreted with care since vibration may be found to be annoying at much lower levels than those listed, depending on the level of activity or the individual's sensitivity. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage. In high noise environments, which are more prevalent where ground borne vibration approaches perceptible levels, this rattling phenomenon may also be produced by loud airborne environmental noise causing induced vibration in exterior doors and windows.

Ground vibration can be a concern in instances where buildings shake, and substantial rumblings occur. However, it is unusual for vibration from typical urban sources such as buses and heavy trucks to be perceptible. Common sources for ground borne vibration are planes, trains, and construction activities such as earthmoving which requires the use of heavy-duty earth moving equipment. For the purposes of this analysis, a PPV descriptor with units of inches per second (in/sec) is used to evaluate construction-generated vibration for building damage and human complaints.

Exhibit 3.5-3. Human Reaction and Damage to Buildings for Continuous or Frequent Intermittent Vibrations

Maximum PPV (in/sec)	Vibration Annoyance Potential Criteria	Vibration Damage Potential Threshold Criteria	FTA Vibration Damage Criteria
0.008	—	Extremely fragile historic buildings, ruins, ancient monuments	—
0.01	Barely Perceptible	—	—
0.04	Distinctly Perceptible	—	—
0.1	Strongly Perceptible	Fragile buildings	—
0.12	—	—	Buildings extremely susceptible to vibration damage
0.2	—	—	Non-engineered timber and masonry buildings
0.25	—	Historic and some old buildings	--

Maximum PPV (in/sec)	Vibration Annoyance Potential Criteria	Vibration Damage Potential Threshold Criteria	FTA Vibration Damage Criteria
0.3	—	Older residential structures	Engineered concrete and masonry (no plaster)
0.4	Severe	—	—
0.5	—	New residential structures, Modern industrial/commercial buildings	Reinforced-concrete, steel or timber (no plaster)

PPV = peak particle velocity; in/sec = inches per second; FTA = Federal Transit Administration
Source: California Department of Transportation, Transportation and Construction Vibration Guidance Manual, 2020 and Federal Transit administration, Transit Noise and Vibration Assessment Manual, 2018.

Current Policy & Regulatory Framework

Federal Guidelines

The U.S. Department of Housing and Urban Development (HUD) has established federal noise abatement and control standards (24 CFR Part 51, Subpart B) for new construction. These standards are widely used to assess the significance of noise impacts in residential communities. According to HUD standards, sites where community noise exposure exceeds a day-night average sound level (L_{dn}) of 65 dB (typically expressed as dBA for averages) are classified as noise-impacted, and interior noise levels within residences—typically 20 dB below exterior levels—should not exceed 45dB. Residential construction in noise-impacted areas require additional noise mitigation features for interior noise levels to meet the 45 dB standard.

In urban areas, noise from vehicles traveling on roads is a major source of noise, and changes in travel patterns and land use have the potential to affect traffic noise. Transportation facilities that receive federal funding (federal-aid projects) are subject to federal noise guidelines from the Federal Highway Administration (FHWA). FHWA also requires state departments of transportation such as the WSDOT to develop noise policies that will apply to projects within that state. WSDOT's 2020 Traffic Noise Policy and Procedures (WSDOT 2020) are consistent with the requirements of FHWA Code Federal Regulations 772 for roadway related traffic noise and are approved by FHWA for federal-aid projects in Washington.

FHWA guidelines require analysis of expected noise impacts and consideration of noise abatement by land use or Activity Category. FHWA applies different noise abatement criteria (NAC) to each Activity Category based on either exterior or interior noise levels. NAC of 67 dBA Activity Category B, which includes single- and multi-family residences, and Activity Category C, which includes places of worship, schools, recreation areas and other similar land uses. **Exhibit 3.5-4** describes WSDOT's NAC by land use category. Activity Category E includes including, hotels, motels, offices, restaurants, bars, or other developed lands with a NAC of 72 dBA. FHWA determines whether a noise impact is expected to occur when predicted future traffic noise levels approach or exceed the established FHWA a particular Activity Category. The WSDOT definition of approach in this instance is within 1 dBA on the FWHA NAC, or 66 dBA for Activity Categories B and C or 71 dBA for Category E.

Exhibit 3.5-4. Noise Abatement Criteria by Land Use Category

Activity Category	$L_{eq(h)}$*dBA	Description
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Residential (single and multi-family units)
C	67 (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 (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	72 (exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F. Includes undeveloped land permitted for these activities.
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

Source: WSDOT, 2020.

State Guidelines

Washington State Noise Control Act of 1974

In 1974, the Washington State legislature authorized the establishment of regulations for the abatement and control of noise pollution considering social and economic impacts (Revised Code of Washington 70A.20). Regulations in Washington Administrative Code (WAC) 173-06-040 established maximum permissible noise levels for specific areas or environments called Environmental Designation for Noise Abatement (EDNA), which vary based on the land use of the noise source and the receiving property. Maximum permissible noise levels are measured in decibels generated by the source or project at the property line of adjacent land uses, rather than the combined project and background noise. Maximum Permissible Environmental Noise Levels apply to a variety of activities and facilities including residences, hospitals, commercial services, storage facilities, warehouses and distribution facilities, and industrial property. However, electrical substations, certain industrial installations, mobile noise sources, vehicles traveling in the public right of way, and warning devices (i.e., bells) are exempt. The state provisions have been adopted by most cities around the state, including the City of Seattle (SMC 25.08).

City Guidelines

Seattle Municipal Code 25.08 Noise Control

Operational Noise Standards

Chapter 25.08 of the Seattle Municipal Code (SMC) establishes exterior sound level limits for specified land use zones or "districts," which vary depending on the district of sound source and the district of the receiving property. The exterior sound limits based on noise source and receiving property in the City of Seattle Noise control ordinance are summarized in **Exhibit 3.5-5**.

Exhibit 3.5-5. Maximum Permissible Noise Level

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

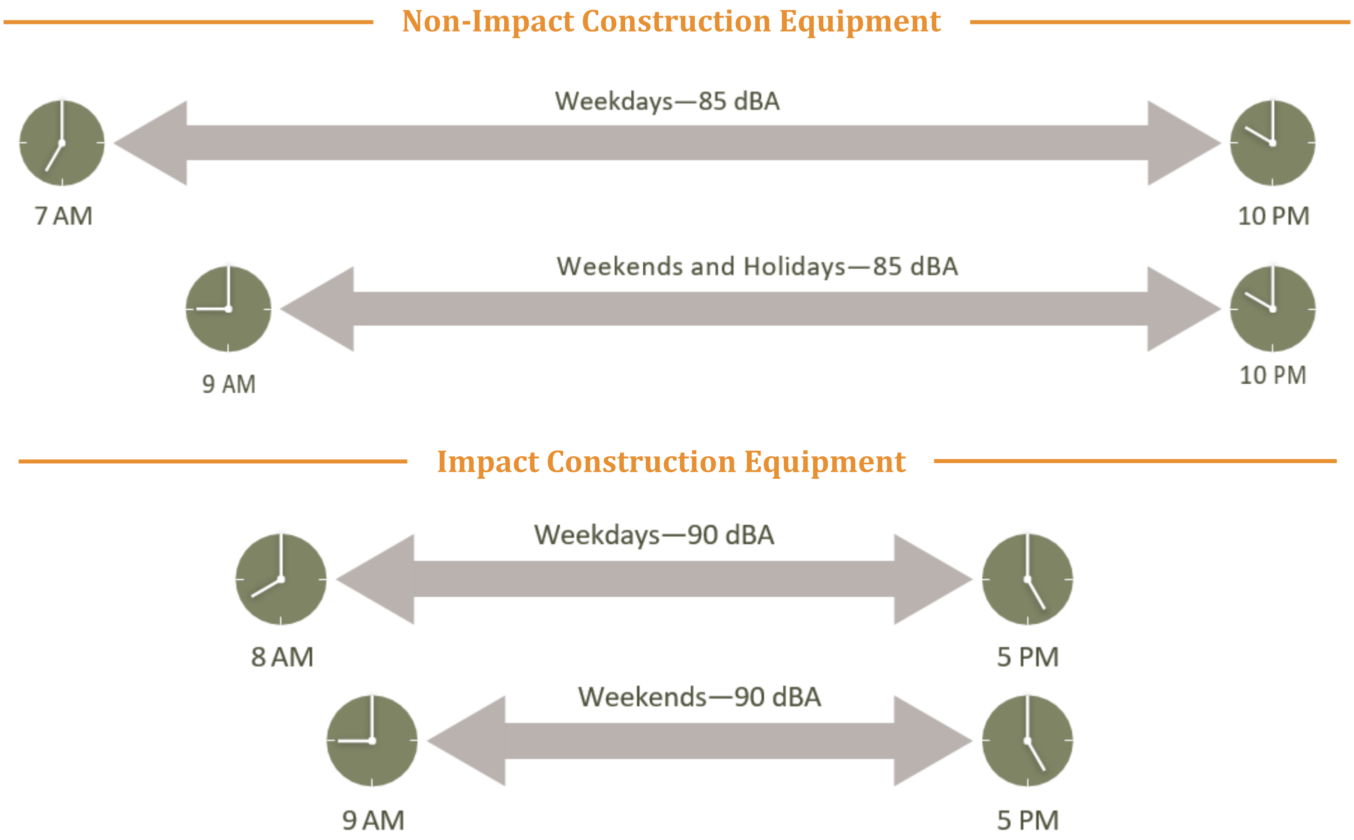
Source: City of Seattle Noise Control Ordinance SMC Chapter 25.08, 2023.

Between the hours of 10 PM and 7 AM on weekdays and 10 PM and 9 AM during weekends, the maximum limits for receivers within residential zones are to be reduced by 10 dBA. For noise of short duration, these limits can be exceeded by a maximum of 5 dBA for 15 minutes/hour, 10 dBA for 5 minutes/hour, or 15 dBA for 1.5 minutes/hour.

Construction Noise Standards

The City's Noise Control code allows the exterior sound level limits to be exceeded by certain types of construction equipment operating in most commercial districts between 7 AM and 10 PM on weekdays and between 9 AM and 10 PM on weekends and legal holidays (SMC 25.08.425; see **Exhibit 3.5-6**). The types of equipment that would usually exceed the exterior sound level limit of 60 dBA are tractors, loaders, excavators, and cranes. This equipment may exceed the applicable standard by up to 25 dBA (an 85 dBA standard) when measured at a reference distance of 50 feet. Use of impact equipment—such as a pile driver—is restricted to between 8 AM and 5 PM on weekdays and between 9 AM and 5 PM on weekends and holidays. It is also limited to a continuous noise level of 90 dBA and a maximum noise level of 99 dBA L_{max} when measured at a reference distance of 50 feet.

Exhibit 3.5-6. Construction Noise Time Limits



Source: City of Seattle Noise Control Ordinance SMC Chapter 25.08, 2023.

Current Conditions

Citywide

Traffic Noise Sources

Traffic noise exposure is comprised of several factors: the volume of vehicles per day, the speed of those vehicles, the number of those vehicles that are medium and heavy trucks, the distribution of those vehicles during daytime and nighttime hours, and the proximity of noise-sensitive receivers to the roadway. Existing traffic noise exposure is expected to be as low as 50 dB L_{dn} in the most isolated areas of the City, while receivers adjacent to interstate highways are likely to experience levels as high as 75 dB L_{dn} (U.S. Department of Transportation 2022). Traffic noise assessment in this analysis is also inclusive of bus transit, as buses are an assumed percentage of overall roadway volumes used in the calculation of roadside noise levels.

Exhibit 3.5-7 presents the distance to various noise contours for representative roadways within each subarea in Seattle. The modeled roadway segments were selected to provide an estimate of traffic noise impacts from implementation of the alternatives and compare to the measured ambient noise levels provided in **Exhibit 3.5-7**. The values in **Exhibit 3.5-7** do not take into consideration the presence of existing sound barriers, topographical conditions or roadway elevation, all of which can vary by location. The 65 L_{dn} contour is important because it represents the exterior noise level which can be reduced to 45 dBA L_{dn} using standard construction techniques. An interior noise level of 45 L_{dn} is the commonly accepted maximum recommended interior noise level for residential uses (EPA, 2016).

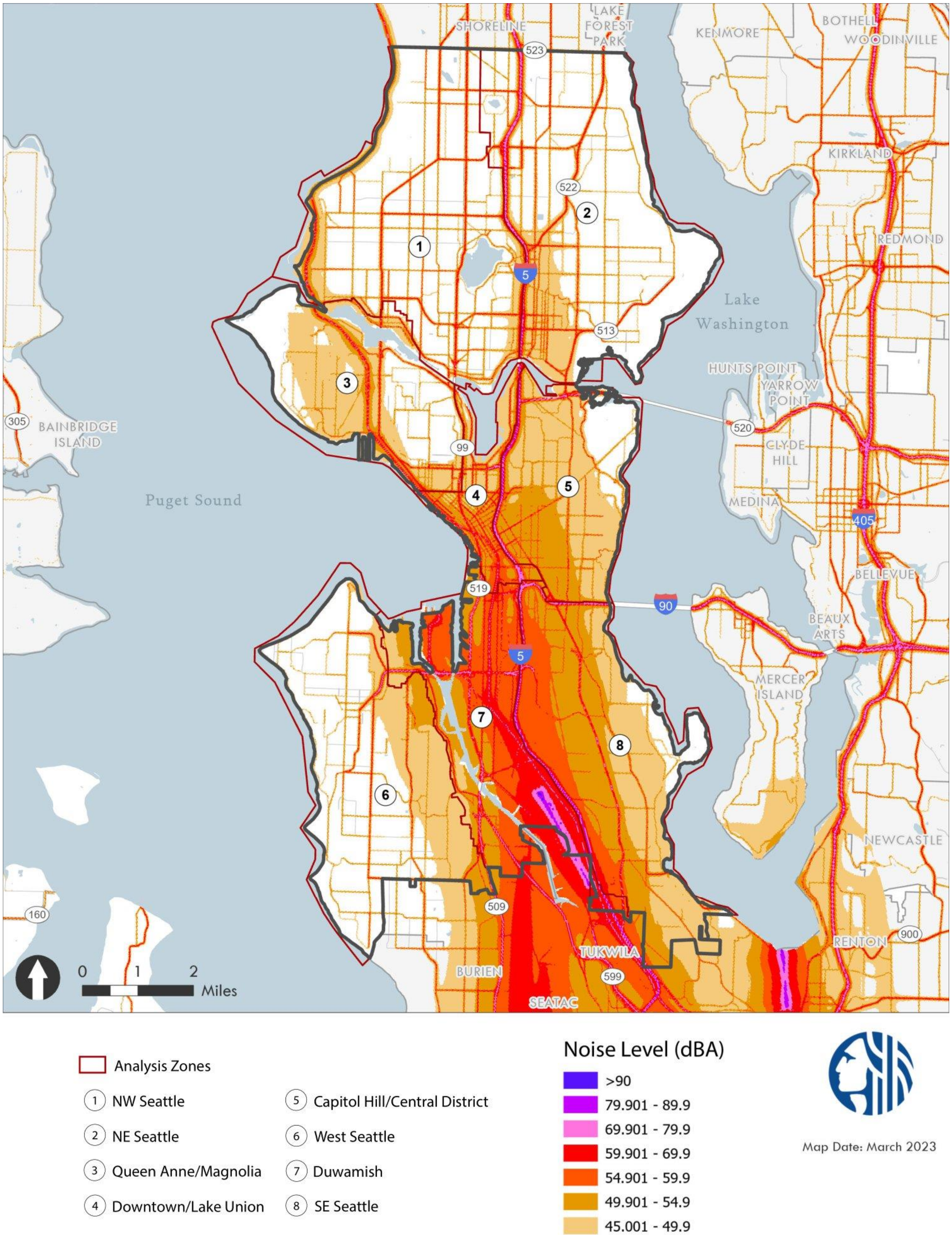
Exhibit 3.5-7. Existing Roadway Noise Levels

Roadway	Roadway Segment	Ldn at 150' from Roadway Center	Distance (feet) from Roadway Center to Noise Contours		
			65 dBA Ldn	60 dBA Ldn	55 dBA Ldn
Martin Luther King Jr Way S	Between S Jackson St and S Massachusetts St	58.4	33	105	332
	Between S Orcas St and S Graham St	59.7	—	139	440
Harbor Ave SW/Alki Ave SW	Between SW Admiral Way and California Way SW	57.5	—	83	264
Beacon Ave S	Between S Spokane St and S Columbian Way	54.8	—	46	144
34th Ave W	Between W Barrett St and W McGraw St	54.3	—	40	127
Roosevelt Way NE	Between NE Northgate Way and 80th St	56.7	—	70	220
Roosevelt Way NE	Between 5th Ave NE and 10th Ave NE	60.9	59	186	588
15th Ave NE	Between NE 135th St and NE 145th St	58.9	—	116	367

Source: Kimley-Horn, 2023.

According to the U.S. Department of Transportation National Transportation Noise Map, traffic noise levels along major highways and freeways in the City (e.g., I-5, I-405, I-90, and Highway 99) range from approximately 50 dBA L_{eq} to 75 dBA L_{eq} (U.S. Department of Transportation 2022). The National Transportation Noise Map is provided in **Exhibit 3.5-8**.

Exhibit 3.5-8. National Transportation Noise Map



Source: U.S. Department of Transportation, 2022.

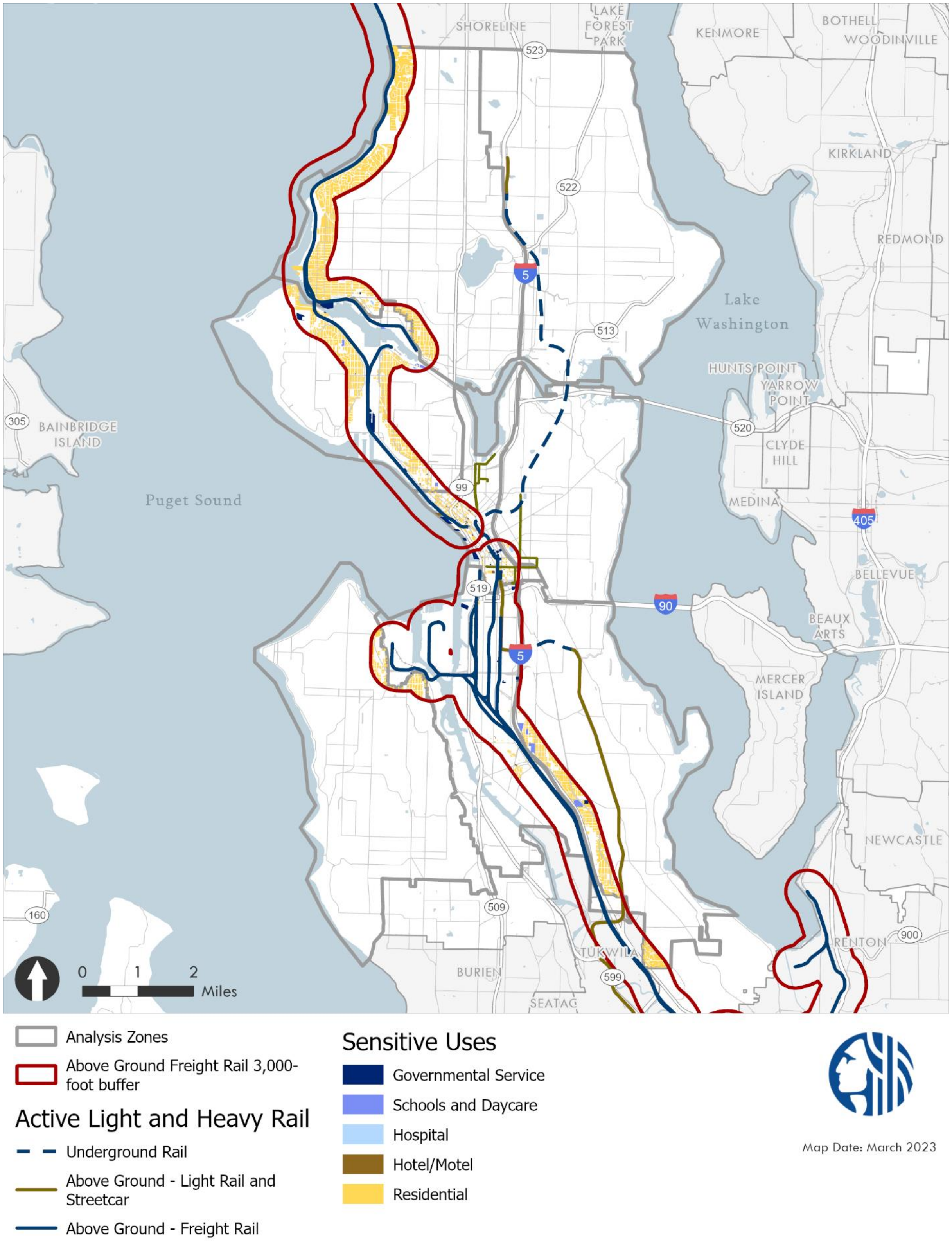
Rail Noise Sources

Seattle is also affected by noise from freight and passenger rail operations. While rail operations generate substantial noise levels in the immediate vicinity of railways, train operations are intermittent and area railways are widely dispersed. Sound Transit's light rail system operates frequently but thanks to electrification, lower speeds, and lighter loads, this results in overall lower noise levels than heavy rail systems. The contribution of rail noise to Seattle's ambient noise environment is relatively minor compared to other sources such as roadway traffic. However, areas near freight rail yards often experience higher noise levels due to the maintenance of rail vehicles, assembly of trains, and idling engines. Train operations can also be a source of significant ground-borne vibration near railroad tracks and yards. Vibration-sensitive receivers located within 100 feet of rail operations may be adversely affected by vibration exposure during train events (FTA, 2018). **Exhibit 3.5-9** shows active rail lines in the City of Seattle.

Aircraft Noise Sources

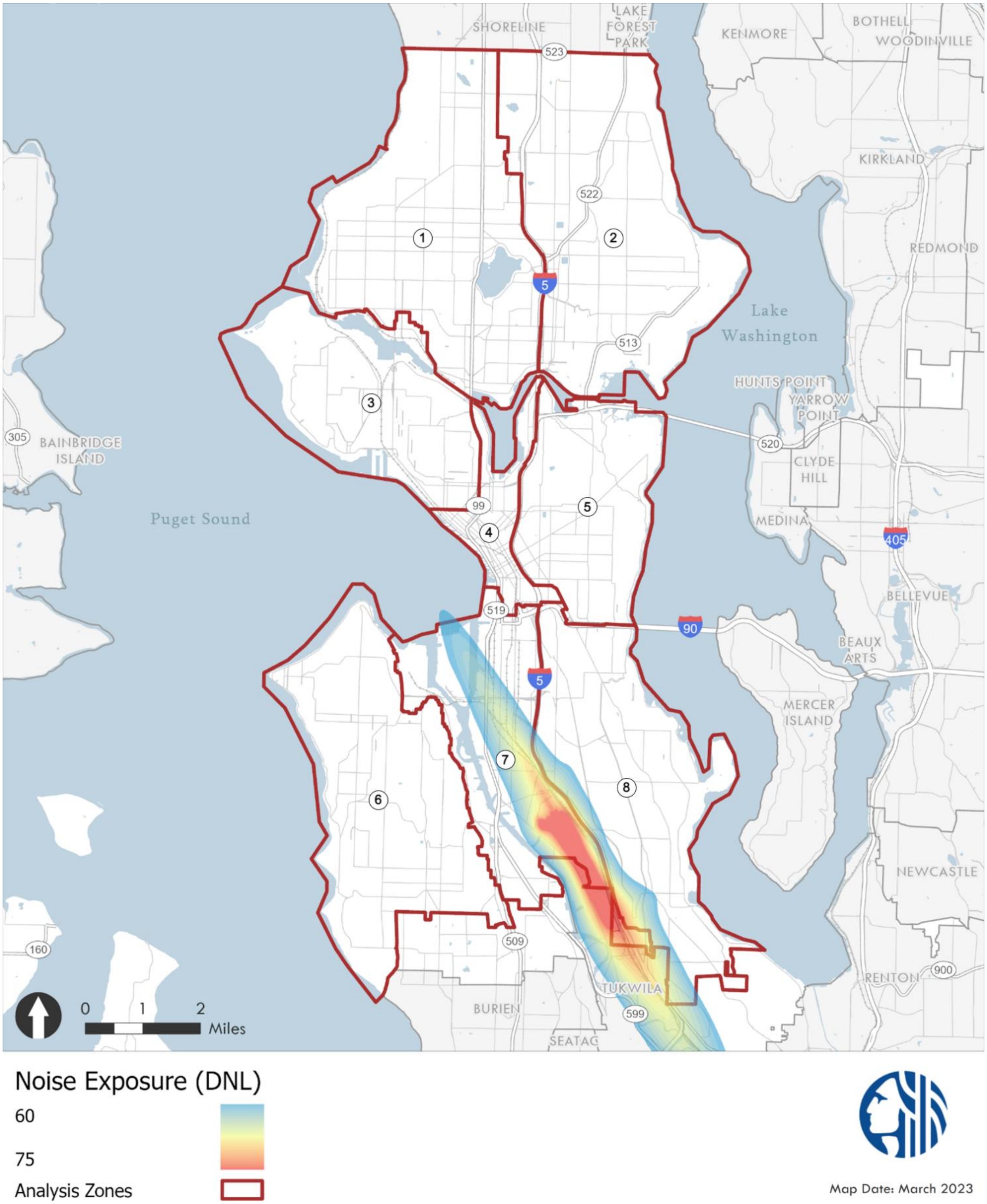
King County International Airport (also known as Boeing Field) is located in the southern portion of the City and generates approximately 500 aircraft operations a day. Aircraft originating from other airports such as Seattle-Tacoma International Airport frequently fly over Seattle. All these operations contribute to the overall ambient noise environment within the City. Similar to rail noise, the proximity of the receiver to the airport and aircraft flight path influences the noise level exposure. Other contributing factors include the type of aircraft operated, altitude of the aircraft, and atmospheric conditions. Atmospheric conditions may contribute to the direction of aircraft operations (flow) and affect aircraft noise propagation. The 60-75 DNL noise contours for Boeing Field are shown in **Exhibit 3.5-10**. As shown in **Exhibit 3.5-10**, the highest noise levels (up to 75 DNL) are concentrated near the central portion of the Boeing Field Airport where the runway is located. Lower noise levels (approximately 60-70 DNL) extend further to the northwest and southeast of the airport and follow the general flight path for airplanes departing/arriving at Boeing Field.

Exhibit 3.5-9. Active Rail Lines in Seattle



Source: Kimley Horn, 2023.

Exhibit 3.5-10. Boeing Field Noise Contours



Source: Kimley Horn, 2023.

Construction Noise Sources

Construction activities related to new development and transportation improvements can create high noise levels of relatively short duration. Noise generated by construction equipment varies greatly depending on factors such as the operation performed, equipment type, model, age, and condition. Noise from heavy equipment diesel engine operations can dominate the noise environment surrounding construction sites. Other stationary equipment sources such as generators, pumps, and compressors can also contribute significantly. Operation of impact equipment such as pile drivers generally produces the highest noise levels and may also produce significant vibration in the vicinity. Maximum noise exposure from typical construction equipment operations is approximately 75–100 dB (L_{max} at 50 feet), the highest noise production from heavy demolition and pile driving operations. Please refer to **Exhibit 3.5-11** for typical construction noise levels.

Exhibit 3.5-11. Typical Noise Levels from Construction/Demolition Equipment

Construction Equipment	Typical Noise Level at 50 ft from Source
Air Compressor	80 dBA
Backhoe	80 dBA
Compactor	82 dBA
Concrete Mixer (Truck)	85 dBA
Concrete Pump (Truck)	82 dBA
Concrete Vibrator	76 dBA
Crane	83 – 88 dBA
Dozer	85 dBA
Generator	82 dBA
Grader	85 dBA
Jack Hammer	88 dBA
Loader	80 dBA
Paver	85 dBA
Pile Driver (Impact)	101 dBA
Pneumatic Tool	85 dBA
Pump	77 dBA
Shovel	82 dBA
Truck	84 dBA

Source: FTA Transit Noise and Vibration Impact Assessment Manual, 2018.

Industry & Other Non-Transportation Noise Sources

A wide variety of industrial and other non-transportation noise sources are located in Seattle. These include manufacturing plants, marine shipping facilities, landfills, treatment plants (e.g., water), food packaging plants and lumber mills, and other general industrial facilities. Noise generated by these sources varies widely and are often intermittent but can exceed 80 dBA close to the source for some activities (City of Seattle, 2022). Noise generated by these sources varies widely, but in many cases may be a significant contributor to a local noise environment.

Noise Levels in Seattle

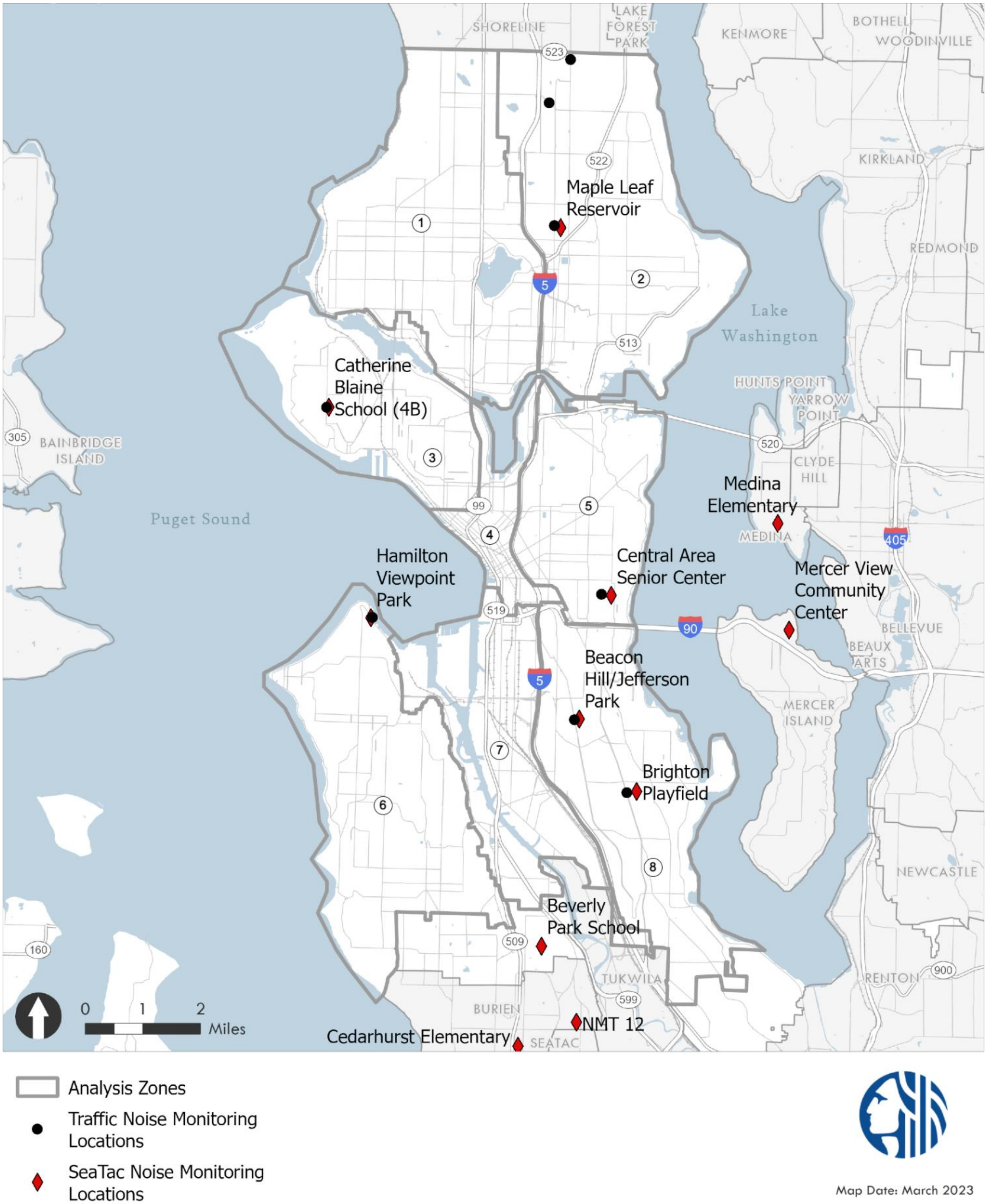
The most recent full year of ambient noise data in Seattle from the Port of Seattle's Aircraft Noise Monitoring System is shown in **Exhibit 3.5-12**. As indicated in **Exhibit 3.5-12**, measured ambient noise levels at various locations throughout the City range from 52.3 dBA L_{eq} to 62.0 dBA L_{eq} and are typical of developed urban areas. In addition, the average annual maximum (or instantaneous) noise levels reach 88.1 dBA but are short in duration and typically only last a few seconds; see **Exhibit 3.5-12**. Maximum noise levels can occur from cars or trucks passing by, train horns, emergency vehicle sirens, and other high-generating noise sources. It is noted there are slightly higher noise levels at the Jefferson Park noise monitoring station, which may reflect an increase of nearly 80,000 take-offs and landings at Seattle-Tacoma International airport between 2020 and 2021, a recovery in air traffic from the COVID-19 pandemic. This noise monitor is directly beneath the flight path for Seattle-Tacoma International Airport, and the Beacon Hill neighborhood of Seattle is more affected my aircraft noise than other areas within Seattle covered by the Port's noise monitoring system; see **Exhibit 3.5-13**.

Exhibit 3.5-12. Average Annual Noise Level (most recent complete year) for Selected Monitoring Locations in Seattle

Measurement Location (Noise Monitoring Location)	Avg Annual L_{eq} dBA	Avg Annual L_{max} dBA
NMT3: Maple Leaf Reservoir (2020)—Area 2: NE Seattle	54.7	83.4
NMT4: Catherine Blain School (2020)—Area 3: Queen Anne/Magnolia	52.3	80.6
NMT6: Hamilton Viewpoint Park (2020)—Area 6: West Seattle	58.1	82.9
NMT7: Central Area Senior Center (2020)—Area 5: Capitol Hill/Central District	54.7	83.4
NMT9: Jefferson Park (2021)—Area 8: SE Seattle	62.0	88.1
NMT10: Brighton Playfield (2020)—Area 8: SE Seattle	54.7	85.7

Source: Port of Seattle, 2022.

Exhibit 3.5-13. Noise Monitoring Locations



Source: Kimley Horn, 2023.

Sensitive Receivers

Noise-sensitive land uses are generally defined as locations where people reside or where the presence of unwanted sound could adversely affect the use of the land. Noise-sensitive land uses typically include residences, hospitals, schools, transient lodging, libraries, and certain types of recreational uses. Noise-sensitive residential receivers are found throughout the study area.

Analysis Areas

Area 1: NW Seattle

The predominant source of noise in the Northwest Seattle subarea is from transportation. The Sound Transit N line runs along the western edge of this area. The line operates locomotives, with anywhere from 2-7 passenger railcars. This railway also services BNSF freight locomotives and Amtrak passenger rail. The U.S. Department of Transportation National Transportation Noise Map (U.S. Department of Transportation, 2018) illustrates that areas near the rail line are typically in the upper 50 dBA LA_{eq} range for 24-hour noise levels. While rail operations generate significant noise levels in the immediate vicinity of the railways, train operations are infrequent and area railways are widely dispersed. In addition, the contribution of rail noise to the overall ambient noise environment in this subarea is relatively minor compared to other sources such as traffic. The most notable traffic noise sources in the Northwest Seattle area are from Highway 99, 15th Ave NW, and Holman Rd NW. The biggest contributor to noise in this area is proximity to I-5, with 24-hour LA_{eq} levels reaching over 70 dBA when in close proximity. For most areas outside major roadways, ambient noise levels are observed to be minimally affected by traffic noise. Industrial Marina areas are also present along the southern limit of the area near Lake Union and contribute to the existing noise environment.

Area 2: NE Seattle

The noise environment in the Northeast Seattle subarea is mainly comprised of roadway traffic and rail transit noise. A portion of the Sound Transit Link 1 Line traverses through the southernmost portion of this subarea in a northwest direction to Northgate, transitioning from a tunnel to an elevated track profile north of N 92nd Street in Maple Leaf. This area also has notable roadway traffic noise, primarily from Highway 522 and 513, and I-5 along the western border of this subarea trending in a north-south direction. The University District and the uses associated with the University of Washington are also a source of noise from road traffic and a concentration of human activity and sporting events. Marina areas are also present along the southern limit of the area near Lake Union and contribute to the existing noise environment.

130th/145th Station Area

The 130th/145th Station Area (Station Area) is located within the Pinehurst and Haller Lake neighborhoods. Most of the Station Area consists of a mix of single- and multi-family residential uses. However, approximately 16% of the area within a half mile of the Station Area is comprised by the Jackson Park Golf Course, and a smaller portion of the Station Area is comprised of commercial and institutional (school) uses. The primary noise source in this area is road noise from I-5 freeway traffic and adjacent Sound Transit railways.

Area 3: Queen Anne/Magnolia

The same rail line that traverses Northwest Seattle (Sound Transit N Line) continues through the Queen Anne/Magnolia subarea, with Sound Transit Sounder Locomotives, Amtrak passenger rail and BNSF freight lines. Furthermore, the Balmer Yard in Interbay is an 80-acre rail yard with 41 parallel tracks. This industrial area that separates Queen Anne and Magnolia extends to the smith cove terminal, where cruise ships often dock. The National Transportation Noise Exposure Map shows that areas near the industrial sector experience noise levels up to 50 dBA for 24-hour LA_{eq} levels. Significant sources of roadway traffic noise include the Magnolia Bridge, 15th Ave W, Elliot Ave W, and Nickerson St.

Area 4: Downtown/Lake Union

The Downtown/Lake Union subarea has the highest concentration of roadway traffic noise of all subareas, which is to be expected with high traffic volumes in densely developed urban areas. Noise travels further and in various directions in this subarea due to the amount of sound reflective hard surfaces such as tall concrete buildings and a majority of concrete groundcover. I-5 is the largest contributor to traffic noise in the Downtown/Lake Union area; however, Alaskan Way, Mercer Street, and Aurora Ave/Highway 99 are also significant road noise sources, reaching into the 60-70 dBA range for 24-hour LA_{eq} levels. The National Transportation Exposure Map (Seto, 2023) shows noise levels within this subarea ranging from 50 dBA LA_{eq} in the central Downtown areas up to approximately 80 dBA LA_{eq} near I-5.

Area 5: Capitol Hill/Central District

I-5, Highway 90, and Highway 520 are the major sources of noise in the Capitol Hill/Central District subarea. 23rd Ave, Boren Ave, Madison St, and ML King Jr Way are also high-traffic roadways that are notable roadway noise sources. The Seattle Streetcar First Hill Line passes through this subarea, running north-south along Broadway. In addition, a portion of the Sound Transit Link 1 Line traverses through the western portion of this subarea in a north-south direction. This area is primarily residential, with very few industrial sources of noise.

Area 6: West Seattle

The significant roadway noise sources in the West Seattle subarea are the West Seattle Bridge, California Ave S, Fauntleroy Way SW, 35th Ave SW, Delridge Way SW, W Marginal Way, and SW Roxbury St. The northern areas of this subarea are located close to Terminal 5 and Harbor Island, both parts of the Port of Seattle. In this industrial area is also Nucro Steel, which along with the port, brings in additional freight train traffic.

Area 7: Duwamish

Boeing Field is located in the southeastern portion of the Duwamish subarea, and therefore this subarea has the highest levels of airplane noise. Areas near the airport experience noise levels in 75-80 dBA range, while the majority of the subarea is located within the 60-70 dBA noise level contour range. This area also contains two large rail yards, the Union Pacific Argo Yard and BNSF Stacy Yard. This area also contains a large portion of the Port of Seattle. These intermodal facilities run year-round every day. This subarea is predominantly comprised of industrial uses, with some residences located in the southern portion adjacent to the Boeing Field Airport and separated by the Duwamish waterway, which is roughly 500 feet in width. This area also includes the Sound Transit's Link OMF Central, which maintains the light rail trains that service Seattle. This area also has significant noise sources from Highway 99 and Highway 509, as well as the I-5 freeway.

Area 8: SE Seattle

The westernmost portion of the Southeast Seattle subarea is located within the 60-65 noise contour for Boeing Field, while the southwestern portion of this subarea is located within the 60-75 noise contour near the I-5 and Highway 90 interchange. The most notable roadway traffic noise sources are S Columbian Way, Martin Luther King Jr Way S and Rainer Ave S, as well as I-5 and I-90. The Sound Transit's Link Light Rail 1 line runs along Martin Luther King Jr Way S. The Beacon Hill Seattle Noise Project (Seto, 2018) collected 24-hour noise measurements during the spring and summer of 2018 and observed areas with high levels. The sites with the highest noise readings were located near the three notable roadways mentioned above (S Columbian Way, Martin Luther King Jr Way S and Rainer Ave S).

3.5.2 Impacts

Impacts Common to All Alternatives

<u>Construction Noise & Vibration Impacts</u>

The proposed alternatives envision future residential and job growth primarily within urban centers and villages, and also focus growth in compact, walkable, mixed-use neighborhoods linked by transit. Resulting construction activities associated with development of new residences, commercial and retail land uses, and mixed-use developments would have the potential to temporarily affect nearby sensitive receivers such as existing residences, schools, and nursing homes.

Temporary construction noise and vibration within the identified growth areas would occur in urban or suburban areas where ambient noise and vibration levels are influenced by roadway traffic and other transportation sources and would therefore be less noticeable to noise-sensitive receivers than if these activities were to occur in undeveloped areas of the City.

Section 25.08.425 of the Seattle Municipal Code establishes construction noise standards that limit construction activities to times when construction noise would have the least effect on adjacent land uses, and restrict the noise generated by various pieces of construction equipment. Development under the alternatives would range from the construction of high-rise residences in urban centers to townhomes and detached homes in corridors and residential neighborhoods. Consequently, depending on the extent of construction activities involved and background ambient noise levels, localized construction-related noise effects could vary widely.

Construction activities with the highest potential for construction-related noise or vibration impacts are those that require pile driving or other similar invasive foundation work. These types of construction activities are generally associated with high-rise development which all alternatives envision to occur within urban centers.

The Seattle noise ordinance restricts the use of impact equipment, such as pile drivers, to 8 AM to 5 PM on weekdays and 9 AM to 5 PM on weekends and holidays and limits their operation to a continuous noise level of 90 dBA and a maximum noise level of 99 dBA L_{max} when measured at a reference distance of 50 feet.

Because development within urban centers may require pile driving adjacent (within 50 feet) to other buildings that could be occupied by residents or other sensitive receptors, construction noise impacts in excess of 90 dBA within these areas are identified as a potential moderate noise impact and mitigation is identified.

The City of Seattle does not enforce quantitative vibration standards. Construction-related vibration impacts from pile driving and other construction equipment are generally assessed in environmental review documents using the methodology of the Federal Transit Administration (FTA) which includes standards for structural damage as well as for human annoyance.

Pile driving can result in peak particle velocities (PPV) of up to 1.5 inches per second (in/ sec) at a distance of 25 feet (FTA 2018), but typically average about 0.644 PPV. The FTA utilizes a threshold of architectural damage for conventional sensitive structures of 0.3 in/sec PPV for new residential structures and modern commercial buildings and 0.2 in/sec PPV for historic and older buildings. Therefore, a potentially significant vibration impact related to structural damage could occur when pile driving is proposed within 50 feet of a historic building. Thus, mitigation is recommended to reduce potential construction vibration impacts related to pile driving.

Vibration levels can also result in interference or annoyance impacts for residences or other land uses where people sleep, such as hotels and hospitals. The FTA methodology for vibration annoyance is dependent on the frequency of the events. When vibration events occur more than 70 times per day, as is typically the case with pile driving, they are considered "frequent events." Frequent events in excess of 72 VdB are considered to result in a significant vibration impact. However, the prohibited construction hours within the City's Ordinance are sufficient to avoid sleep interference impacts during times that most people sleep.

Land Use Compatibility

As discussed above, exterior noise levels in Seattle close to highways, freeways, and high traffic roadways can exceed 65 dBA L_{dn}. The 65 dBA L_{dn} noise level is important because it represents the exterior noise level which can be reduced to 45 dBA L_{dn} using standard construction techniques. An interior noise level of 45 L_{dn} is the commonly accepted maximum interior noise level for residential uses (HUD 2023). Most alternatives seek to locate residential uses near transit or highly traveled roadways to reduce vehicle miles traveled within the city. As indicated in **Exhibit 3.5-8** through **Exhibit 3.5-10** and **Exhibit 3.5-14**, new sensitive receptors (e.g., residential uses) could be located within noise contours up to 65 dBA L_{dn} (or greater) due to proximity to roadway, rail, and airport noise sources. Consequently, if residences or other noise-sensitive land uses are located in close proximity to major roadways or freeways or noise-generating industrial operations, additional insulation, window treatments, or noise abatement features may be warranted to reduce interior noise levels to acceptable levels. On the other hand, if an active industrial development is proposed adjacent to noise-sensitive land uses, noise compatibility problems could also arise. The potential for future or current to experience roadway noise or stationary noise from industrial or other noise-generating developments would be a potential moderate noise impact and mitigation measures could be considered.

As discussed below, traffic noise levels for all alternatives would increase by less than 1.5 dBA along all roadway segments modeled roadways. Outside of the laboratory, a 3-dBA change is considered a just-perceivable difference, and a 5-dBA change is clearly perceptible and is typically considered substantial. Consequently, an increase of less than 1.5 dBA would be considered a minor impact on environmental noise. While the traffic noise impacts would not be discernible from background noise levels, all of the alternatives are anticipated to result in a cumulative noise increase from stationary sources (e.g., mechanical equipment, parking lot noise, conversations, etc.) due to the intensity, scale, and nature of development associated with these alternatives. Noise increases from the alternatives could worsen noise levels in some areas that experience high noise levels under existing conditions that are considered healthy for residential and other sensitive uses. However, noise levels from stationary sources would be required to comply with the exterior sound level limits outlined in the City's Noise Ordinance (SMC Chapter 25.08). Following compliance with the City's Noise Ordinance, stationary noise source impacts from all alternatives would not be significant.

130th/145th Station Areas

Operational noise impacts to sensitive receptors in the Station Area were evaluated in the Sound Transit Lynwood Link Extension Final Environmental Impact Statement (Sound Transit, 2015) (Lynwood Link Extension Final EIS) and SR 522 Bus Rapid Transit (BRT) SEPA Environmental Checklist (SR 522 BRT SEPA Checklist). According to the Lynwood Link Extension Final EIS and SR 522 BRT SEPA Checklist, operational noise levels from BRT buses at the 145th Station, and light rail pass-bys along the Lynwood Link Extension would result in unnoticeable changes in ambient noise at sensitive receptors in the Station Area. In addition, sound walls are proposed to the south of the 130th Street Station along the northbound I-5/Lynwood Link Extension line that would reduce transit and highway traffic noise levels at existing and future residential receptors.

Construction noise impacts were also evaluated in the Lynwood Link Extension Link Final EIS and SR 522 BRT SEPA Checklist. According to the construction noise analyses in these documents, some construction activities may exceed 80 dBA at residences closest to the Station Area construction sites. In addition, some construction activities might be required during nighttime hours because of the nature of the construction, to avoid daytime traffic impacts, or to accommodate adjacent land uses. Nighttime construction would require a noise variance from the City in order to proceed. Construction noise impacts and mitigation measures were identified for sensitive receptors closest to the stations and rail alignment areas in the Lynwood Link Extension Link Final EIS and SR 522 BRT SEPA Checklist. The One Seattle Comprehensive Plan would not result in additional construction noise impacts in the Station Area than those already identified in these environmental documents.

Equity & Climate Vulnerability Considerations

Exposure to Noise Pollution

Future growth and development patterns under Comprehensive Plan growth strategies would affect future residences' (or other "sensitive receptors" or "sensitive receivers) relationships to mobile and stationary noise sources. The degree of potential for adverse impacts on new sensitive receptors would depend on proximity to major sources of noise and the density of future sensitive development.

Portions of Seattle located along major roadways (freeways and the most-traveled highways) are exposed to relatively high noise levels. The U.S. Department of Housing and Urban Development (HUD) utilizes a screening distance of 1,000 feet of highways or major roadways, 3,000 feet for railroads, and 15 miles for FAA-regulated airfields to evaluate transportation noise effects at sensitive receivers. These distances represent the approximate minimum distance at which a "Normally Acceptable" noise level of 65 dBA L_{dn} is achieved in proximity to the aforementioned transportation noise sources (HUD 2023). Because the authority to set noise standards for off-road and other non-highway vehicles lies with the Washington State

Department of Ecology, and for locomotives with the Federal Rail Administration (FRA), the only strategies available to the City for consideration are related to reducing exposure. Measures such as setbacks for residential and other sensitive land uses from major traffic corridors and rail lines are effective. Other methods to protect sensitive land uses from being exposed to substantial transportation noise levels include noise abatement and insulation requirements for new sensitive uses, and site design measures to block or obstruct transportation noise sources from residences.

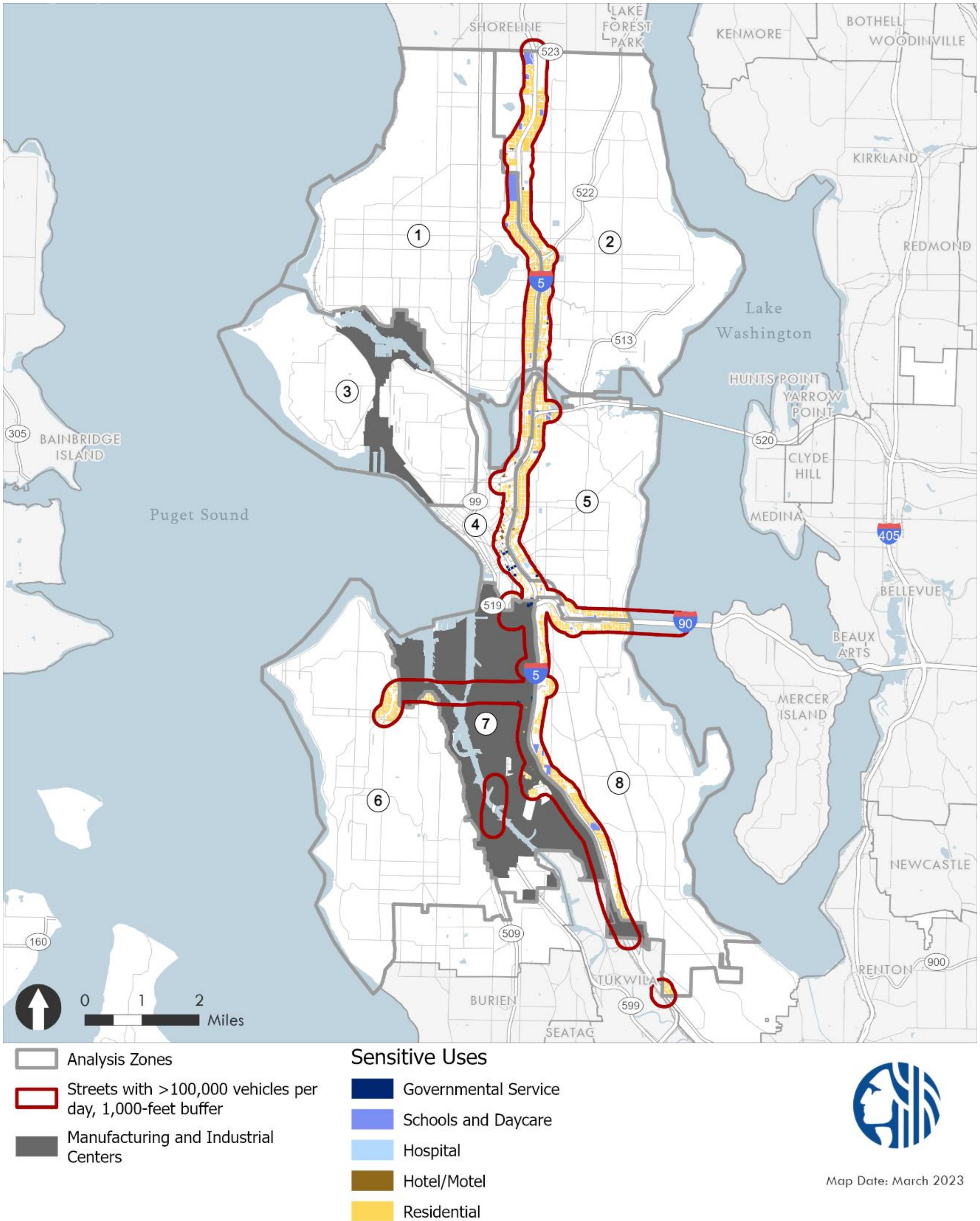
Portions of Seattle are also exposed to elevated stationary noise sources from industrial uses and ports where ships, heavy trucks, and mechanical equipment can result in increased noise levels at sensitive uses. This is considered a moderately adverse noise impact. The City has identified measures to reduce potential noise compatibility conflicts from industrial/maritime centers and noise-sensitive receivers through mitigation measures identified in the Seattle Industrial and Maritime Lands Final EIS (2022). Potential mitigation includes installing noise barriers, siting truck haul routes away from noise sensitive areas, and using green open spaces as noise buffers.

Exhibit 3.5-14 shows a 1,000-feet buffer around roadways and highways with daily trips greater than 100,000 vehicles. This shows that existing uses along Interstate 5 (I-5) north of Interstate 90 (I-90) consist primarily of residential uses, within 1,000 feet of transportation noise sources. **Exhibit 3.5-9** above shows a 3,000-foot buffer around above ground freight railways, which also indicates that residences are the primary noise-sensitive land use near freight railways.

This potential increased exposure to transportation noise is considered a potential moderate adverse impact.

To address the impact, the City could consider risk-reducing mitigation strategies such as setbacks for residential and other sensitive land uses from major traffic corridors, rail lines, port terminals, and similar sources of transportation and stationary noise, and/or to identify measures for sensitive receptors proposed to be in areas near such sources such as upgraded windows treatments, noise barriers, and noise insulation design features.

Exhibit 3.5-14 1,000-Feet Buffer Around Freeways and Roadways with Greater than 100,000 Daily Vehicles



Source: Kimley Horn, 2023.

Impacts of Alternative 1: No Action

Future development under Alternative 1 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.37%, consistent with the transportation analysis. Resultant noise levels are presented in **Exhibit 3.5-15** and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city. As shown in **Exhibit 3.5-15**, Alternative 1 would result in traffic noise increases ranging from 0.1 dBA L_{dn} to 1.0 dBA L_{dn} and would not result in a significant (10 dBA or more) dBA noise increase.

Exhibit 3.5-15. Modeled Noise (L_{dn}) Levels at 150 Feet From the Roadway Center—Alternative 1, No Action (2044)

Roadway	Roadway Segment	Existing	2044 Alt. 1	dBA Difference Over Existing	Significant Increase?
Martin Luther King Jr Way S	Between S Jackson St and S Massachusetts St	58.4	59.4	1.0	No
	Between S Orcas St and S Graham St	59.7	60.6	0.9	No
Harbor Ave SW/Alki Ave	Between SW Admiral Way and California Way SW	57.5	57.9	0.4	No
Beacon Ave S	Between S Spokane St and S Columbian Way	54.8	55.2	0.4	No
34th Ave W	Between W Barrett St and W McGraw St	54.3	54.7	0.4	No
Roosevelt Way NE	Between NE Northgate Way and 80th St	56.7	57.0	0.3	No
Roosevelt Way NE	Between 5th Ave NE and 10th Ave NE	60.9	61.0	0.1	No
15th Ave NE	Between NE 135th St and NE 145th St	58.9	59.8	0.9	No

Notes: Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.
Source: Kimley-Horn, 2023

Equity & Climate Vulnerability Considerations

As shown in **Exhibit 3.2-8** in **Section 3.2 Air Quality & GHG Emissions**, Alternative 1 would locate several urban centers and urban villages within 1,000-feet of roadways with greater than 100,000 daily vehicles. Collectively these urban centers and villages represent 56% of all projected residential growth in the city through 2044. Only a portion of each center or village is within the 1,000-feet buffer, so the potentially affected portion of the new residents would be smaller. Compared to all other alternatives, the number of units within the affected urban centers and villages would be the lowest (same as Alternative 3 and 4).

130th/145th Station Areas

Under Alternative 1, the current Comprehensive Plan and zoning designations would remain. Development around the 130th/145th Station Area would primarily be comprised of three-story single-purpose residential and some 4-8 story multifamily uses. The 130th/145th Station area would experience minimal traffic noise increases and stationary source noise levels (e.g., HVAC systems, parking noise, conversations, and other noise sources typical of urban areas) could increase, although not substantially due to the proximity to I-5, 145th Street, and other traffic noise sources that dominate the existing noise environment.

Impacts of Alternative 2: Focused

Development under Alternative 2 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.43%, consistent with the transportation analysis. Resultant noise levels are presented in **Exhibit 3.5-16** and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city. As shown in **Exhibit 3.5-16**, Alternative 2 would result in traffic noise increases ranging from 0.4 dBA L_{dn} to 1.1 dBA L_{dn} and would not result in a significant (10 dBA or more) dBA noise increase. It should also be noted that the traffic noise levels shown in **Exhibit 3.5-16** would result in a minimal increase when compared to the No Action alternative (Alternative 1).

Exhibit 3.5-16. Modeled Noise (L_{dn}) Levels at 150 Feet From the Roadway Center—Alternative 2 (2044)

Roadway	Roadway Segment	Existing	2044 Alt. 2	dBA Difference Over Existing	Significant Increase?
Martin Luther King Jr Way S	Between S Jackson St and S Massachusetts St	58.4	59.5	1.1	No
	Between S Orcas St and S Graham St	59.7	60.6	0.9	No
Harbor Ave SW/Alki Ave	Between SW Admiral Way and California Way SW	57.5	57.9	0.4	No
Beacon Ave S	Between S Spokane St and S Columbian Way	54.8	55.4	0.6	No
34th Ave W	Between W Barrett St and W McGraw St	54.3	55.1	0.8	No
Roosevelt Way NE	Between NE Northgate Way and 80th St	56.7	57.4	0.7	No
Roosevelt Way NE	Between 5th Ave NE and 10th Ave NE	60.9	61.3	0.4	No
15th Ave NE	Between NE 135th St and NE 145th St	58.9	60.0	1.1	No

Notes: Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.
Source: Kimley-Horn, 2023.

Equity & Climate Vulnerability Considerations

In addition to the regional centers and villages that would be within the 1,000-feet buffer under Alternative 1, Alternative 2 would place additional neighborhood center units within the buffer, as shown in **Exhibit 3.2-10** in **Section 3.2 Air Quality & GHG Emissions**. Included in the additional units is the 130th/145th Station Area. Although a greater number of units would be closer to transportation noise sources and thus at higher risk than under Alternative 1, overall units within these regional centers, urban centers, and neighborhood centers consists of 46% of overall projected growth, which is higher than that of Alternative 1. Only a portion of each center is within the 1,000-feet buffer, so the potentially affected portion of the new residents would be smaller. Alternative 2 would place a greater number of units within the 1,000-foot buffer when compared to Alternative 1, 3, and 4, but fewer units compared to Alternative 5 and the Preferred Alternative.

130th/145th Station Areas

Under Alternative 2, the 130th/145th Station Area would be designated as neighborhood center and would include a mix of low-rise residential, midrise residential, and neighborhood commercial uses. The 130th/145th Station area would experience some traffic noise increases and stationary source noise levels could increase, although not substantially due to the proximity to I-5, 145th Street, and other traffic noise sources that dominate the existing noise environment. It is also noted that Alternative 2 would site residents and commercial/retail uses near transit hubs, which would likely reduce traffic and traffic noise levels associated with increased development in the area.

Impacts of Alternative 3: Broad

Development under Alternative 3 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.41%, consistent with the transportation analysis. Resultant noise levels are presented in **Exhibit 3.5-17** and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city. As shown in **Exhibit 3.5-17**, Alternative 3 would result in traffic noise increases ranging from 0.5 dBA L_{dn} to 1.1 dBA L_{dn} and would not result in a significant (10 dBA or more) dBA noise increase. It should also be noted that the traffic noise levels shown in **Exhibit 3.5-17** would result in a minimal increase when compared to the No Action alternative (Alternative 1).

Exhibit 3.5-17. Modeled Noise (L_{dn}) Levels at 150 Feet From the Roadway Center—Alternative 3 (2044)

Roadway	Roadway Segment	Existing	2044 Alt. 3	dBA Difference Over Existing	Significant Increase?
Martin Luther King Jr Way S	Between S Jackson St and S Massachusetts St	58.4	59.4	1.0	No
	Between S Orcas St and S Graham St	59.7	60.7	1.0	No
Harbor Ave SW/Alki Ave	Between SW Admiral Way and California Way SW	57.5	57.9	0.4	No
Beacon Ave S	Between S Spokane St and S Columbian Way	54.8	55.6	0.8	No
34th Ave W	Between W Barrett St and W McGraw St	54.3	55.0	0.7	No
Roosevelt Way NE	Between NE Northgate Way and 80th St	56.7	57.5	0.8	No
Roosevelt Way NE	Between 5th Ave NE and 10th Ave NE	60.9	61.4	0.5	No
15th Ave NE	Between NE 135th St and NE 145th St	58.9	60.0	1.1	No

Notes: Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.
Source: Kimley-Horn, 2023.

Equity & Climate Vulnerability Considerations

As shown in **Exhibit 3.2-12** in **Section 3.2 Air Quality & GHG Emissions**, the regional centers and villages within the 1,000-feet buffer under Alternative 3 would be the same as Alternative 1, collectively representing 56% of all projected residential growth in the city through 2044. Only a portion of each center or village is within the 1,000-feet buffer, so the potentially affected portion of the new residents would be smaller. A greater proportion of city-wide growth would be located in close proximity to transportation-related noise sources when compared to Alternative 2. Alternative 3 would place the fewest number of units (the same as Alternative 1 and 4) within the 1,000-foot buffer when compared to Alternative 2 and 5 and the Preferred Alternative.

130th/145th Station Areas

The station area plan would not be implemented under Alternative 3; the area would grow based on the applicable citywide place types.

Impacts of Alternative 4: Corridor

The planned housing and job totals are similar in Alternative 4 as for Alternative 3, and traffic associated with Alternative 4 would be similar to (or less than) Alternative 3. For the purposes of this analysis, the traffic noise levels and increases from Alternative 3 also apply to

Alternative 4. Therefore, traffic noise level increases from Alternative 4 would not be significant (10 dBA or more) as discussed above.

Alternative 4 would focus more growth near transit and major highways/roadways than Alternatives 1 through 3. Due to the density of development near major transportation noise sources, the potential for noise compatibility issues from Alternative 4 is profound, and a moderately adverse noise impact would occur. However, implementation of mitigation measures would reduce this noise impact as discussed below.

Equity & Climate Vulnerability Considerations

As shown in **Exhibit 3.2-14** in **Section 3.2 Air Quality & GHG Emissions**, the regional centers and villages within the 1,000-feet buffer under Alternative 4 would be the same as Alternative 1 and Alternative 3, collectively representing 56% of all projected residential growth in the city through 2044. Only a portion of each center or village is within the 1,000-feet buffer, so the potentially affected portion of the new residents would be smaller. A greater proportion of city-wide growth would be located in close proximity to transportation-related noise sources when compared to Alternative 2. Alternative 4 would place the fewest number of units (the same as Alternatives 1 and 3) within the 1,000-foot buffer when compared to Alternative 2 and 5 and the Preferred Alternative.

130th/145th Station Areas

The station area plan would not be implemented under Alternative 4; the area would grow based on the applicable citywide place types.

Impacts of Alternative 5: Combined

Development under Alternative 5 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.51%, consistent with the transportation analysis. Resultant noise levels are presented in **Exhibit 3.5-18** and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city. As shown in **Exhibit 3.5-18**, Alternative ~~3~~5 would result in traffic noise increases ranging from 0.5 dBA L_{dn} to 1.3 dBA L_{dn} and would not result in a significant (10 dBA or more) dBA noise increase. It should also be noted that the traffic noise levels shown in **Exhibit 3.5-18** would result in a minimal increase when compared to the No Action Alternative (Alternative 1).

Exhibit 3.5-18. Modeled Noise (L_{dn}) Levels at 150 Feet From the Roadway Center—Alternative 5 (2044)

Roadway	Roadway Segment	Existing	2044 Alt. 5	dBA Difference Over Existing	Significant Increase?
Martin Luther King Jr Way S	Between S Jackson St and S Massachusetts St	58.4	59.5	1.1	No
	Between S Orcas St and S Graham St	59.7	60.8	1.1	No
Harbor Ave SW/Alki Ave	Between SW Admiral Way and California Way SW	57.5	58.0	0.5	No
Beacon Ave S	Between S Spokane St and S Columbian Way	54.8	55.8	1.0	No
34th Ave W	Between W Barrett St and W McGraw St	54.3	55.0	0.7	No
Roosevelt Way NE	Between NE Northgate Way and 80th St	56.7	57.5	0.8	No
Roosevelt Way NE	Between 5th Ave NE and 10th Ave NE	60.9	61.5	0.6	No
15th Ave NE	Between NE 135th St and NE 145th St	58.9	60.2	1.3	No

Notes: Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.
Source: Kimley-Horn, 2023.

The growth strategy of Alternative 5 would result in a ~~the~~ dens~~est~~er concentration of sensitive uses near major highways/roadways, transit facilities, and industrial/maritime uses compared to Alternatives 1 through 4. Alternative 5 would result in less dense concentration of sensitive uses near major noise sources compared to the Preferred Alternative. ~~As a result, the highest conflict of noise and land use compatibility would occur with implementation of Alternative 5, and a~~ A moderately adverse noise impact would occur. However, implementation of mitigation measures would reduce this noise impact as discussed below.

Equity & Climate Vulnerability Considerations

This alternative would place the emphasis for growth near transit centers, with the 130th Street station designated as an urban center. In addition, additional neighborhood center units would be located in close proximity to transportation-related noise sources as shown in **Exhibit 3.2-16** in **Section 3.2 Air Quality & GHG Emissions**. Consistent across all alternatives, the highest amount of projected growth would be within the Downtown Regional Center and First Hill/Capitol Hill Regional Center. Alternative 5 and the Preferred Alternative have~~s~~ the highest housing studied growth ~~target~~ among the ~~five~~ alternatives. Although Alternative 5 and the Preferred Alternative would have the same housing growth assumption, the allocation of growth differs.

As a result, the proportion of city-wide growth that would be located in close proximity to transportation-related noise sources is the lowest (39%) under this alternative while the total amount of collective growth would be the greatest. Only a portion of each center or village is within the 1,000-feet buffer, so the potentially affected portion of the new residents would be smaller. Alternative 5 would place a greater~~the greatest~~ number of units within the 1,000-foot buffer when compared to Alternatives 1 through 4 and would place fewer units within the 1,000-foot buffer when compared to the Preferred Alternative~~the other alternatives~~.

130th/145th Station Area

Noise impacts at the Station Area would be most substantial under Alternative 5, which includes the strategies for encouraging housing growth in Alternatives 2, 3, and 4 plus some additional changes to existing regional center and urban center boundaries and changes to place type designations. Under this alternative, an urban center would be created on both the west and east sides of I-5 at the Sound Transit light rail station. As a result, the 130th/145th Station Area would experience higher traffic noise and stationary source noise increases than Alternatives 1 through 4 and the Preferred Alternative.

Impacts of Preferred Alternative

Note: The impacts analysis for the Preferred Alternative was added since the Draft EIS.

Development under the Preferred Alternative would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled assuming an annual growth rate of VMT of 0.51%, consistent with the transportation analysis. Resultant noise levels are presented in **Exhibit 3.5-19** and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city. As shown in **Exhibit 3.5-19**, the Preferred Alternative would result in traffic noise increases ranging from 1.0 dBA L_{dn} to 2.4 dBA L_{dn} and would not result in a significant (10 dBA or more) dBA noise increase. Note that traffic noise would be reduced under the Preferred Alternative along 15th Avenue NE between NE 135th Street and NE 145th Street. It should also be noted that the traffic noise levels shown in **Exhibit 3.5-19** would result in a minimal increase when compared to the No Action Alternative (Alternative 1).

Exhibit 3.5-19. Modeled Noise (L_{dn}) Levels at 150 Feet From the Roadway Center—Preferred Alternative (2044)

Roadway	Roadway Segment	Existing	2044 Preferred Alt	dBA Difference Over Existing	Significant Increase?
Martin Luther King Jr Way S	Between S Jackson St and S Massachusetts St	58.4	59.7	1.3	No
	Between S Orcas St and S Graham St	59.7	60.9	1.2	No
Harbor Ave SW/Alki Ave	Between SW Admiral Way and California Way SW	57.5	58.6	1.1	No
Beacon Ave S	Between S Spokane St and S Columbian Way	54.8	57.2	2.4	No
34th Ave W	Between W Barrett St and W McGraw St	54.3	55.8	1.5	No
Roosevelt Way NE	Between NE Northgate Way and 80th St	56.7	58.3	1.6	No
Roosevelt Way NE	Between 5th Ave NE and 10th Ave NE	60.9	61.9	1.0	No
15th Ave NE	Between NE 135th St and NE 145th St	58.9	58.7	-0.2	No

Notes: Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.
Source: Kimley-Horn, 2024.

The growth strategy of Preferred Alternative would result in the densest concentration of sensitive uses near major highways/roadways, transit facilities, and industrial/maritime uses. As a result, the Preferred Alternative has the highest conflict of noise and land use compatibility and would result in a moderately adverse noise impact. However, implementation of mitigation measures would reduce this noise impact as discussed below.

Equity & Climate Vulnerability Considerations

This alternative would place the emphasis for growth near transit centers, with the 130th Street station designated as an urban center. In addition, additional neighborhood center units would be located in close proximity to transportation-related noise sources as shown in **Exhibit 3.2-18** in **Section 3.2 Air Quality & GHG Emissions**. Consistent across all alternatives, the highest amount of projected growth would be within the Downtown Regional Center and First Hill/Capitol Hill Regional Center. The Preferred Alternative has the highest housing growth compared to Alternatives 1 through 4 and would be the same as Alternative 5. As a result, the proportion of citywide growth that would be located in close proximity to transportation-related noise sources is the lowest (40%) under this alternative while the total amount of collective growth would be the greatest. Only a portion of each center or village is within the 1,000-feet buffer, so the potentially affected portion of the new residents would be smaller. The Preferred Alternative would place the greatest number of units within the 1,000-foot buffer when compared to the other alternatives.

130th/145th Station Area

Noise impacts at the Station Area would be substantial under the Preferred Alternative, less than only Alternative 5, which includes the strategies for encouraging housing growth in Alternatives 2, 3, and 4 plus some additional changes to existing regional center and urban center boundaries and changes to place type designations. Under this alternative, an urban center would be created on both the west and east sides of I-5 at the Sound Transit light rail station. As a result, the 130th/145th Station Area would experience higher traffic noise and stationary source noise increases than Alternatives 1 through 4 and less than Alternative 5.

3.5.3 Mitigation Measures

Incorporated Plan Features

The City will update its Comprehensive Plan policies for land use, transportation, and others with an opportunity to increase noise compatibility with sensitive receptors in proximity to significant transportation and industrial noise sources.

Regulations & Commitments

City noise regulations establish exterior sound level limits for various land use zones with the limits varying depending on the source zone and the receiving zone (**Exhibit 3.5-5**). These limits are intended to result in acceptably low interior noise levels for residences and other sensitive noise receptors. City noise regulations also address construction noise, limiting the times during the day when construction noise, both impact and non-impact, can exceed exterior noise limits (**Exhibit 3.5-6**).

Other Potential Mitigation Measures

Measures to Reduce Construction-Related Noise and Vibration Impacts

In addition to restrictions on the hours of construction in accordance with the Seattle Noise Ordinance, other mitigation that could be applied includes:

- Installing barriers to shield noise sensitive receptors and enclosing stationary work
- Selecting haul routes to avoid noise sensitive areas
- Using fully baffled compressors, or preferably electric compressors
- Using fully mufflered construction equipment
- Use low-noise emission equipment
- Monitor and maintain equipment to meet noise limits
- Prohibit aboveground jack hammering and impact pile driving during nighttime hours.

To reduce potential moderate adverse noise impacts from impact pile driving activities adjacent to noise-sensitive land uses (within 50 feet) or moderate adverse vibration impacts to historic structures, the One Seattle Comprehensive Plan could consider adoption of a policy recommending the Seattle Noise Ordinance be updated to require best practices for noise control, including "quiet" pile-driving technology (such as pre-drilling of piles, use of sonic or vibratory drivers instead of impact pile drivers, where feasible); and using temporary sound walls or cushion blocks to dampen impact noise from pile driving).

Measures to Reduce Land Use Compatibility Noise Impacts

Although mitigation measures are not required due to a lack of significant adverse impact findings, to reduce the potential for exposure of residences and other noise-sensitive land uses to incompatible environmental noise, the One Seattle Plan could consider adoption of a policy that recommends that residences and other noise-sensitive land uses (i.e., schools, day care) be separated from freeways, railways, ports, and other active industrial facilities where exterior noise environments exceed 65 dBA L_{dn}. If sensitive land uses are proposed in such areas, a policy addressing the need for additional mitigation strategies could be considered to achieve an interior noise performance standard of 45 dBA L_{dn}. The types of implementation measures that could help to accomplish this include:

- Coordination with WSDOT on sound wall construction where major highways pass through residential areas.
- Use of appropriate building materials such as walls and floors with an STC rating of 50 or greater as necessary to achieve this performance standard.
- Site design measures, including use of window placement to minimize window exposure toward noise sources, avoid placing balcony areas in high noise areas, and use of buildings as noise barriers.
- Use of acoustically rated building materials (insulation and windows).

In addition, zoning land use criteria or boundaries could be established, while meeting other planning goals, to limit the proximity of new residential development to known or anticipated sources of high noise levels.

3.5.4 Significant Unavoidable Adverse Impacts

Under all studied alternatives, increased residential and employment growth could result in increased traffic volumes, though the resulting noise increases are not anticipated to exceed 3dBA, the threshold of change that is perceptible. The location of noise sensitive receivers (e.g., residential uses) near traffic, rail, or industrial noise sources could occur under all alternatives, particularly Alternatives 4 and 5 and the Preferred Alternative. Implementation of residential noise mitigation described in the previous subsection should adequately reduce noise experienced by noise-sensitive receivers. With the application of mitigation measures described above, no significant unavoidable adverse noise impacts would occur under any of the alternatives.

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