Attachment 9

NE 4th Street/ 120th Avenue NE Corridor Project

Noise and Vibration Technical Report

prepared for
City of Bellevue

prepared by
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Acronyms and Abbreviations

City	City of Bellevue
dB	Decibels
dBA	A-weighted decibels for sound energy averages
EPA	U.S. Environmental Protection Agency
FHWA	U.S. Federal Highway Administration
FTA	U.S. Federal Transit Administration
Leq	Equivalent sound level
Leq(h)	Hourly equivalent sound level
L_v	Velocity level in decibels
mph	Miles per hour
NAC	Noise Abatement Criteria
PPV	Peak particle velocity
Project	Bellevue 120th Avenue NE Widening Corridor Project
rms	Root mean square
TNM	Traffic Noise Model
V	Velocity amplitude in inches/second
VdB	Vibration decibels
V^{ref}	10^{-6} inches/second
WSDOT	Washington State Department of Transportation

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Executive Summary

The City of Bellevue (City) proposes to implement arterial street transportation improvements to NE 4th Street and 120th Avenue NE in Bellevue, Washington. The improvements along the combined corridors are referred to as the NE 4th Street/120th Avenue NE Corridor Project. The project corridor is located approximately 1 mile east of Downtown Bellevue. Major transportation connections in the project vicinity include Interstate 405 (I-405) and State Route 520 (SR 520). A noise and vibration technical report was prepared for the proposed project to document potential effects.

Land use surrounding the NE 4th Street/120th Avenue NE Project corridor is primarily characterized by moderate-density commercial developments with a mix of institutional, residential, retail, and office uses. Land uses directly adjacent to the project corridor consist of automobile dealerships, small strip malls, office buildings, medical offices, and parking lots. Residential communities are located on both the east and west sides of the project corridor in the southern portion of the study area. Open space near the project corridor includes Wilburton Hill Community Park to the southeast and Bel-Red Mini Park to the east in the central portion of the project corridor. No building permits have been filed to develop noise-sensitive uses to date in the study area.

No significant effects to noise and vibration are anticipated as part of this project. A summary of the effects of noise and vibration are detailed below.

Noise

Fifteen sites representing 257 residential units, one recreation area, and one church were modeled to represent noise-sensitive receptors within the study area. Four additional sites represent first row commercial businesses along NE 4th Street and 120th Avenue NE. Existing noise levels and future noise levels without the project do not approach or exceed the Federal Highway Administration (FHWA) noise abatement criteria (NAC) at any modeled locations. Noise levels would exceed the FHWA NAC in 2040 with the project, with both Option 1 and Option 2 at All Saints Episcopal Church at 1307 120th Avenue NE. Mitigation measures to reduce traffic noise at this site were evaluated but they would not effectively reduce exterior traffic noise levels. However, depending on interior traffic noise levels at the church, soundproofing may be feasible to reduce interior noise at this location.

It should also be considered that generally, a structure with closed windows and doors would reduce the exterior noise levels by 25 decibels inside the structure. At All Saints Episcopal Church, this would lead to interior noise levels being roughly 43 dBA and well below the NAC.

Residences located west of 120th Avenue NE would not experience increased traffic noise levels with or without the project in the year 2040. Residences east

of 120th Avenue NE between NE 5th Street and NE Bel-Red Road would experience increase traffic noise levels of 1 dBA without the project in the year 2040 and 1 to 3 dBA with the project in the year 2040.

Maximum (peak) noise levels from construction equipment would range from 69 to 93 dBA at 50 feet. Construction noise at locations farther away would decrease at a rate of 6 dBA per doubling of distance from the source. Because various equipment would be turned off, idling, or operating at less than full power at any time and because construction machinery is typically used to complete short-term tasks at any given location, average L_{eq} noise levels during the day would be less than the maximum noise levels and within City of Bellevue construction noise limits. Nearby noise-sensitive receptors would experience temporary noise effects during project construction. Mitigation measures may be considered to reduce temporary noise effects during construction.

Prior to final project design, it is recommended that the final project elevations be reviewed for roadways and all associated design elements, including retaining walls and any localized ground disturbance. It is recommended to compare final project elevations to surveyed elevations at apartment and condominium complexes east of 120th Avenue NE between NE 8th Street and NE Bel-Red Road as noise levels at these locations are within 1 dBA of approaching the FHWA NAC.

Vibration

Ground-borne vibration could be a concern for occupants of nearby buildings during construction activities associated with the project. However, it is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. Most common sources of ground-borne vibration are trains, buses on rough roads, and construction activities such as blasting, pile driving, and operating heavy earth-moving equipment.

Vibration impacts would only occur if vibration-sensitive land uses are present in the immediate vicinity of the project. The survey of nearby land uses did not identify any vibration-sensitive uses within the immediate project area. Therefore, no substantial vibration impacts are predicted to occur as a result of operation of the project.

Five structures are within 25 feet of project construction zone along 120th Avenue NE. None of the five structures is considered sensitive to vibration; therefore, no substantial vibration effects are predicted to occur from construction. Mitigation measures should be considered, however, to reduce temporary vibration effects during construction.

1.0 Introduction

1.1 Purpose of this Report

This *Noise and Vibration Technical Report* is being prepared as part of the NE 4th Street/120th Avenue NE Corridor Project for the City of Bellevue (City). The project proposes to extend NE 4th Street east from its current terminus at 116th Avenue NE to a new intersection with 120th Avenue NE, and widen and realign 120th Avenue NE north from the new intersection with NE 4th Street to Northup Way.

The purpose of this report is to describe the existing noise environment and evaluate existing and future predicted traffic noise levels at noise-sensitive sites in the study area. Mitigation measures are evaluated, as are the effects of temporary construction noise and vibration.

1.1.1 Noise Variance

Because construction is expected to be completed during daytime hours (7 a.m. to 10 p.m.) and within City of Bellevue construction noise limits, mitigation would not be required**.** For construction outside of daytime hours, a noise variance may be required by the City if project construction noise is predicted to exceed the City's noise limits or if nighttime construction is required to maintain daytime traffic flow or schedule requirements.

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2.0 Proposed Project

2.1 Project Overview

The City of Bellevue (City) proposes to implement arterial street transportation improvements to NE 4th Street and 120th Avenue NE in Bellevue, Washington. The improvements along the combined roadway corridors are referred to as the NE 4th Street/120th Avenue NE Corridor Project. The project corridor is located approximately 1 mile east of Downtown Bellevue. Major regional transportation connections and facilities in the project vicinity include Interstate 405 (I-405) to the west and State Route 520 (SR 520) to the north.

The project extends from the intersection of NE 4th Street with 116th Avenue NE eastward to 120th Avenue NE and then northward along 120th Avenue NE to Northup Way. Key project elements include—the extension of NE 4th Street from its existing terminus with 116th Avenue NE eastward to 120th Avenue NE; widening of existing 120th Avenue NE from the proposed intersection with NE 4th Street northward to Northup Way; and the realignment of a new segment of 120th Avenue NE between NE 8th Street and NE Bel-Red Road. Figure 2-1 shows the project study area.

The NE 4th Street/120th Avenue NE Corridor Project is one of a number of high priority transportation investments that make up the City of Bellevue's Mobility and Infrastructure Initiative. This initiative was formed to address unprecedented growth in Downtown Bellevue and to support planned growth in the Bel-Red, Spring District, and Wilburton areas.

Other key projects included in the initiative that would complement the proposed project include the following:

- NE 5th Street neighborhood project improvements
- NE 6th Street Extension from 112th Avenue NE to 120th Avenue NE
- NE 15th/NE 16th multi-modal corridor improvements north of NE 12th Street (also supporting Sound Transit's East Link Project)
- 124th Avenue NE improvements from NE 8th Street to Northup Way.

For each of these projects, new travel lanes, non-motorized facilities, signal enhancements, illumination, and various structure and utility relocations would be included.

Figure 2-1. Project Study Area

2.2 Project Purpose and Need

The purpose of the proposed project is to achieve the following:

- Support and accommodate the City's adopted future land use changes and resulting travel demands.
- Improve local traffic circulation.
- Bring corridor features into compliance with current and proposed design standards and guidelines.
- Prepare the project corridor to support connections to planned transit facilities, specifically Sound Transit's East Link Project light rail alignment.

Collectively, the proposed project elements (see Figure 2-2) would enhance area-wide mobility by adding capacity to support the expected growth in travel demand, constructing critical missing links in the City's traffic distribution network, and easing congestion in other travel corridors. Moreover, the project would provide planned pedestrian and bicycle facilities, as well as enhanced connections to transit facilities identified in City plans.

It would improve access for other modes to local recreational facilities, businesses, and the planned Link light rail stations at NE 8th Street and 118th Avenue NE and between NE 15th and NE 16th Streets just east of 120th Avenue NE.

In summary, the proposed project would meet the following objectives:

- To provide acceptable level of service at existing and planned study area intersections to meet anticipated long-term travel demands.
- To improve access and connectivity with the regional and local transportation networks.
- To enhance long-term traffic operations over time by incorporating design standards that serve a variety of transportation modes, including the needs of large trucks and freight vehicles, as well as buses.
- To improve quality of life by improving mobility and transportation choice, particularly for transit, bicycle, and pedestrian traffic.

As shown in preliminary traffic analysis work for the NE 4th Street extension and the widening and realignment of 120th Avenue NE, the project elements would enhance the Wilburton/NE 8th Street and Bel-Red Subareas as well as the region in terms of travel mobility and access to neighborhoods and businesses. This is primarily the result of new and enhanced connections across the Burlington Northern Santa Fe (BNSF) corridor and NE 8th Street, respectively. The proposed project also provides expanded arterial street capacity and driveway consolidation along 120th Avenue NE. The project termini are logical because they bracket the extent of the expected future development in the Wilburton/

NE 8th Street and Bel-Red Subareas and would complement adjacent roadway improvements and planned light rail transit facilities.

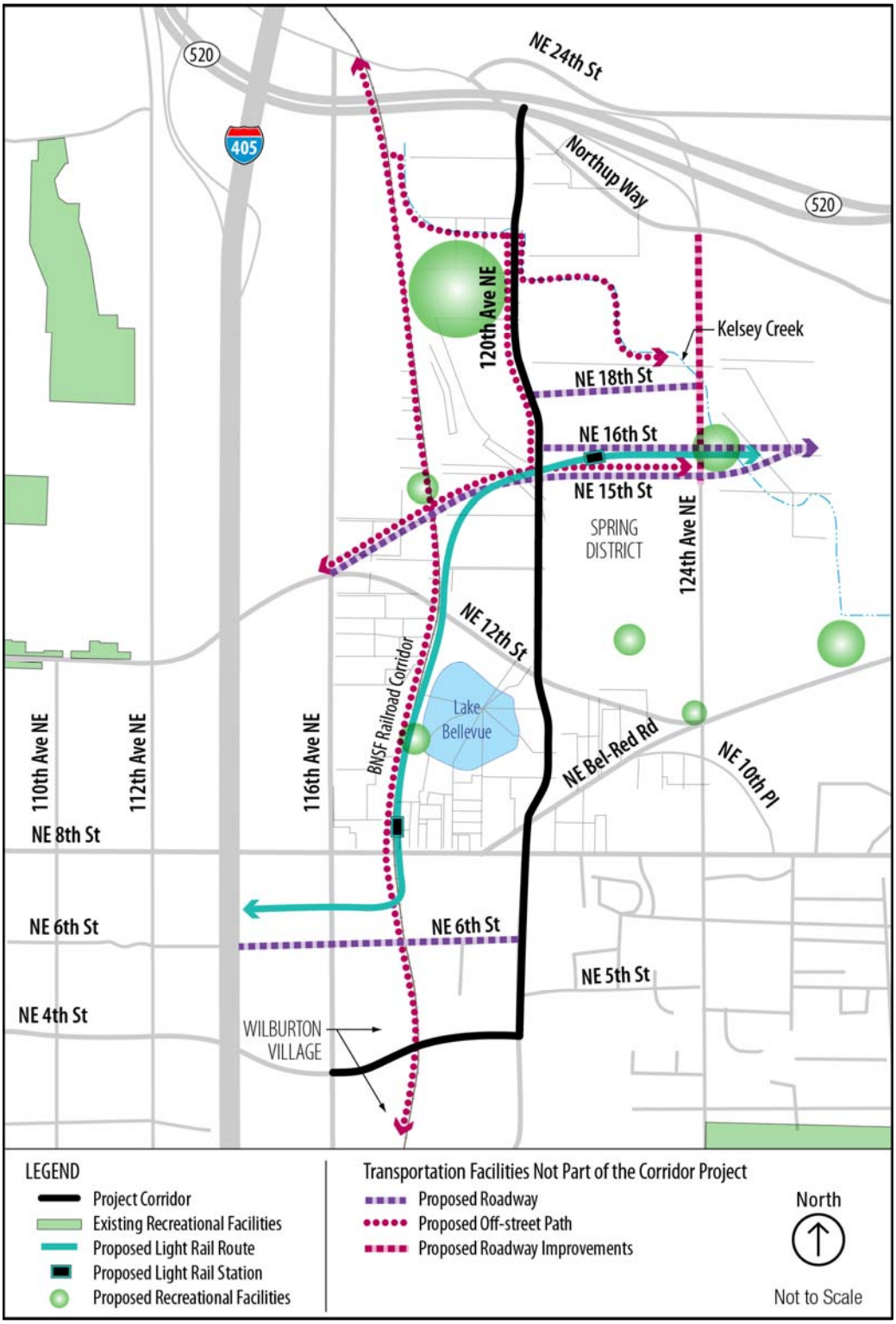

Figure 2-2. Planned Transportation Connections in the Study Area

2.3 Corridor Improvements

2.3.1 Programmed Corridor Improvements

This corridor is comprised of two projects currently listed in the regional and state transportation improvement programs. These projects are described below.

- **NE 4th Street Extension (116th to 120th Avenues NE)**—Construct a new four to five lane roadway with arterial standard curb, gutter, sidewalk (including planting strips) and five-foot bike lanes on both sides. The project includes a new signalized intersection at 120th Avenue NE and illumination, landscaping, and stormwater drainage/detention. The extension will be designed to accommodate future development and uses of the BNSF corridor.
- **120th Avenue NE Corridor—NE 4th Street to Northup Way**
  - From NE 4th to NE 18th Streets—Widen to five lanes with a two-way center turn lane; provide bike lanes along selected segments; install continuous sidewalks to arterial standards; realign the roadway between NE Bel-Red Road and NE 8th Street; and improve intersections (including additional turn lanes) at NE 8th, NE 12th, and NE 16th Streets.
  - From NE 18th Street to Northup Way—Widen to four lanes with arterial standard sidewalk and a separated multi-use path on the west side. The project will be constructed in phases. Federal funding awarded to improvements, including bike lanes, planned between NE 4th and NE 8th Streets.

This revised description was submitted to Puget Sound Regional Council [PSRC] April 8, 2011 for the June 2011 Amendment to the Statewide Transportation Improvement Program (STIP).

2.3.2 Proposed Corridor Improvements

Specific design elements include the following:

- Extend NE 4th Street as a five-lane roadway from 116th Avenue NE to 120th Avenue NE. There are two minor alignment options under consideration for this proposed roadway extension east of the BNSF corridor. Impacts of both options are considered in this analysis.
- Widen 120th Avenue NE to five travel lanes from the NE 300 block to the planned NE 15th Street intersection.
- Extend 120th Avenue NE south of NE Bel-Red Road to NE 8th Street. The existing section of NE Bel-Red Road from NE 8th Street east to 120th Avenue NE, roughly 300 feet long, would be abandoned.
- Widen 120th Avenue NE to four lanes north of NE 18th Street to just south of Northup Way with a transition section occurring between NE 15th and NE 18th Streets.

- Construct improvements that support the planned new intersections at NE 15th/16th and NE 18th Streets and Sound Transit's East Link light rail line that would pass under 120th Avenue NE.
- Install continuous sidewalks and bicycle facilities designed to arterial street standards on NE 4th Street and 120th Avenue NE north to NE 15th Street. North of NE 15th Street, a two-way bicycle trail would be located on the west side of the roadway to allow connection with planned regional trails west, north, and east of 120th Avenue NE. Sidewalks will still be present on both sides of 120th Avenue NE north of NE 15th Street.
- Install planting strip(s) on both sides of the roadways and create other green spaces where possible.
- Install stormwater conveyance, detention, water quality treatment facilities, and use natural drainage practices to the extent practicable.
- Connect with and minimize effects to wetlands and open space areas, including a planned community park near Northup Way.
- Provide other project elements, including illumination, landscaping, structural retaining walls, traffic signals, and new and relocated utilities.

The five-lane roadway design is proposed for both the extension of NE 4th Street from 116th Avenue NE to 120th Avenue NE and the widening/realignment of 120th Avenue NE north to NE 15th Street. This proposed roadway cross-section is shown in Figure 2-3. The roadway would be designed to meet City standards for an urbanized arterial that has four through travel lanes—two 11-foot-wide lanes in each direction. A center 12-foot-wide, two-way, left-turn lane would allow turning movements to adjacent properties. Generally, a 5-foot-wide bike lane would be provided on each side of the roadway adjacent to the curb. A 4- to 5-foot-wide planter strip is proposed between the curb and the 8-foot-wide sidewalk. However, the size and location of the sidewalks, bicycle facilities, and planter strips vary somewhat along the corridor to accommodate natural drainage practices, retaining walls, and existing buildings.

As mentioned earlier, this analysis addresses the potential impacts of two minor alignment options for the extension of NE 4th Street east of the BNSF corridor. The alignment for Option 1 is farther north than that of Option 2. The Option 1 alignment would require acquisition of a portion of the southern side of the Best Buy building and displace access to the loading dock located on the west side of the building. Negotiations with the property owner are ongoing and may include construction of a building addition on the north side of the existing structure and/or realignment of the loading dock access to the north of the building. Option 2, roughly 55 feet south of the Option 1 alignment, would not require acquisition of any portion of nearby buildings, but would displace a substantial amount of parking on the Home Depot property as well as displace the Best Buy building's access to the loading dock area. Again, negotiations are ongoing with the property owners and mitigation may include construction of a new loading

dock access for the Best Buy property on the north side of the existing structure and/or a new parking garage on the Home Depot property. Note, the design for improvements along 120th Avenue NE south of NE 8th Street do not assume either option has been selected, but rather improvements are based on existing curb cuts for the driveway access to parking for the Best Buy and Home Depot properties.

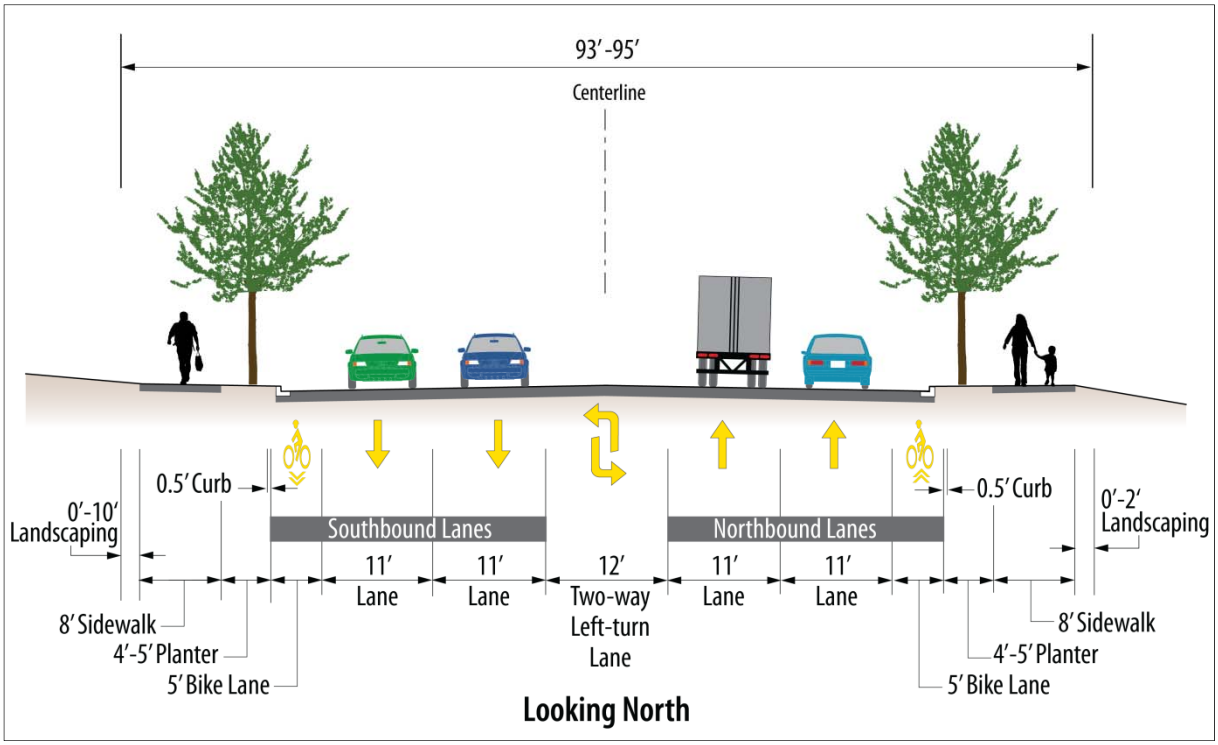

Figure 2-3. Typical Section—Five-lane Roadway Design

A four-lane roadway section is proposed for 120th Avenue NE from NE 18th Street to just south of Northup Way with a transition section occurring between NE 15th and NE 18th Streets. At the intersection at Northup Way, the cross-section would again be five lanes to allow for adequate turning movement capacity. This proposed four-lane cross-section is show in Figure 2-4. The roadway would be designed to meet City standards for an urbanized arterial that has three travel lanes—two 11-foot-wide lanes northbound and one southbound. The two directions of travel would be separated by a 12-foot-wide two-way, left-turn lane that would permit turning movements to adjacent properties. A 5-foot-wide planter strip is proposed between the curb and the 8-foot-wide sidewalk on the east side of the street. A variable-width planter strip is proposed for each side of a two-way, 10-foot-wide bike trail and 8-foot-wide sidewalk that would be constructed on the west side of the street. There would be no bike lanes in the roadway north of NE 18th Street.

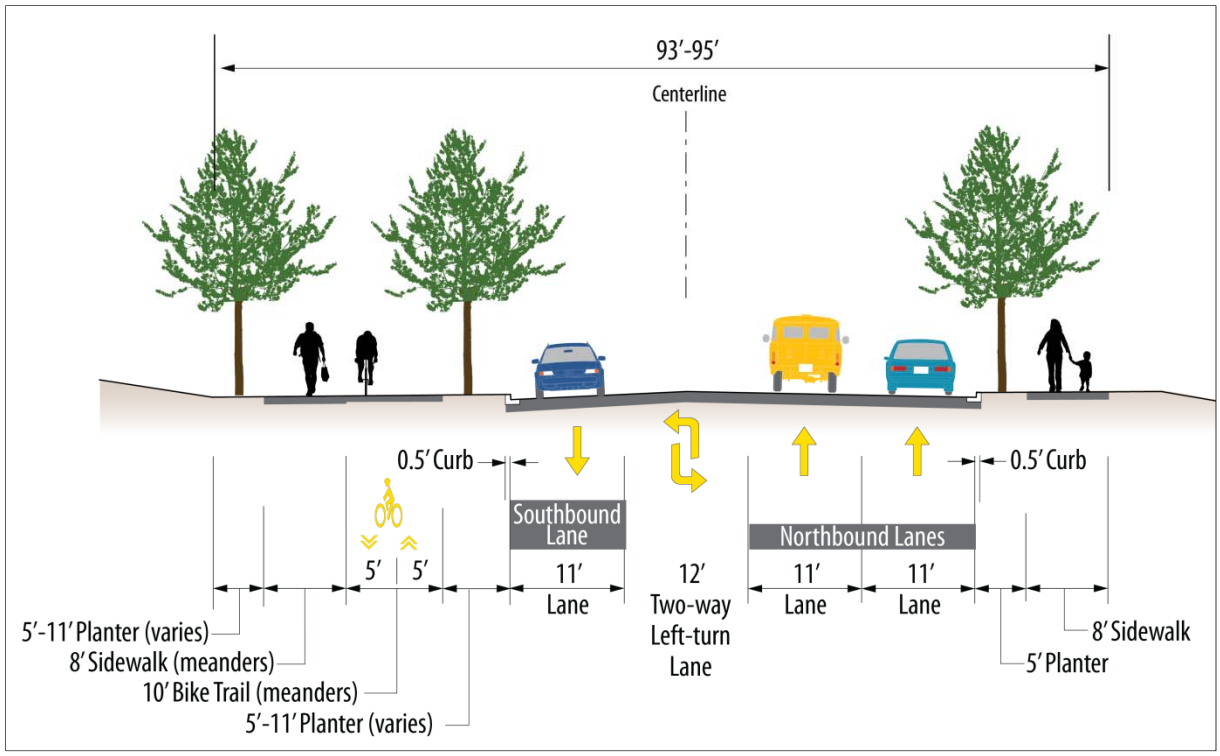

Figure 2-4. Typical Section—Four-lane Roadway Design

Both of the proposed roadway cross-sections also include the use of retaining walls, which would further increase the width of the required right-of-way beyond 95 feet. Retaining walls are proposed at numerous locations along the corridor and they would be located on both sides of the roadway. They would be used for both cut walls and fill walls. When retaining walls are required, these structures would generally be located immediately adjacent to the sidewalk. The width of the retaining walls would vary depending on the design, but would be a maximum of about 3 feet in width. To the outside of the retaining walls, the soil would be graded to a 2:1 slope. To ensure the City has access to the retaining walls for maintenance and repair, the acquired right-of-way would include the re-graded area to the outside of the retaining walls. This re-graded area would likely be a minimum of 10 feet. As such, the acquired right-of-way width could be 121 feet or more where retaining walls are needed on both sides of the roadway.

Note, the term "right-of-way," as used in this report, includes both right-of-way owned by the City and permanent easements (i.e., the complete footprint of the project).

2.4 Project Construction

2.4.1 Construction Duration and Phasing

Project construction would be phased and is expected to be completed from early 2012 to at least 2016 to match the programming of local, state, and federal funding sources. Each phase would last approximately 12 to 15 months. The planned phases, which may be further sub-divided into construction stages, are:

- Phase 1—120th Avenue NE widening between approximately the NE 300 block north to NE 7th Street.
- Phase 2—120th Avenue NE new construction between NE 8th Street and NE Bel-Red Road, and realignment and widening between approximately NE Bel-Red Road north to NE 12th Street.
- Phase 3—NE 4th Street extension between 116th Avenue NE east to 120th Avenue NE.
- Phase 4—120th Avenue NE widening between approximately NE 12th Street north to NE 16th Street.
- Phase 5—120th Avenue NE widening between NE 16th Street north to Northup Way.

Based on the Wilburton/NE 8th Street and Bel-Red Subarea Plans, it is essential that all phases of the NE 4th Street/120th Avenue NE Corridor Project be implemented in order to meet the purpose and need of the project. The City has committed to constructing all phases of the project, with cross sections appropriate to meet the multi-modal demand anticipated in the next 20 years. In addition, construction of the project phases could occur sequentially or some phases could overlap.

2.4.2 Construction Approach

The approach to project construction along the corridor differs. The following paragraphs describe the varying approaches to construction.

The improvements for NE 4th Street consist of constructing a new roadway, and would not involve working within an existing operable roadway. Construction for this phase would include clearing the full roadway right-of-way; grading; installing utilities and the roadway gravel base; constructing the curb, gutter and sidewalks; paving the roadway; and installing illumination/signals and landscaping. The construction activities would not disrupt existing traffic patterns along NE 4th Street, 116th Avenue NE, or 120th Avenue NE. However, the construction zone for NE 4th Street may extend somewhat into the existing roadways (116th and 120th Avenues NE) in order to connect new and existing pavements and existing and planned utilities at these locations.

Generally, the construction along 120th Avenue NE from the NE 300 block to NE 7th Street would widen the existing roadway on both sides of the existing centerline. Construction in this area would occur along an operational roadway.

The improvements in this area would be sequenced to manage potential traffic impacts. Every effort would be made to keep one lane open for traffic in each direction along 120th Avenue NE during all construction stages. All City requirements limiting roadway construction activities (e.g., seasonal, time of day, access) would be enforced. Construction activities would be closely coordinated with adjacent property owners and businesses to minimize disruptions to the greatest extent possible.

Construction of the realignment and widening of 120th Avenue NE between the intersection at NE 8th Street and about NE 12th Street would occur along an operational roadway. Thus, the construction in this area is anticipated to occur in the following manner:

- Contractor mobilization
- Install traffic control and temporary erosion control measures
- Relocate and/or install utilities
- Roadway Side 1—retaining walls, grading, paving, signals, and illumination
- Roadway Side 2—retaining walls, grading, paving, signals, and illumination
- Construction zone landscaping, restoration, and clean up.

The corridor could not be closed during construction though both directions of travel may be constrained to perhaps only a single lane. Use of NE Bel-Red Road between NE 8th Street and 120th Avenue NE, however, would be closed at the start of roadway construction. With this road closure, construction could occur unhampered for the new roadway. Parcels along this portion of the alignment would be fully acquired and construction activities would not affect adjacent businesses. Traffic on NE Bel-Red Road east of 120th Avenue NE would continue to be able to travel north on 120th Avenue NE during construction. To the north of NE Bel-Red Road, the roadway alignment is generally shifted eastward. Construction work would likely start on the eastern half of the expanded right-of-way. When completed, traffic would be shifted to the new roadway, while the western portion of the roadway is constructed. All construction sequencing would be planned to minimize impacts to traffic and adjacent businesses.

Lastly, construction along the remaining northern portion of 120th Avenue NE from NE 12th to just south of Northup Way would also widen the existing roadway on both sides of the existing centerline. The improvements along 120th Avenue NE would be sequenced to manage potential traffic impacts. Every effort would be made to keep one lane open for traffic in each direction along 120th Avenue NE during all construction stages. All City requirements limiting roadway construction activities (e.g., seasonal, time of day, access) would be enforced. Construction activities would be closely coordinated with adjacent property owners and businesses to minimize disruptions to the greatest extent possible.

2.5 Project Funding

The total cost of the proposed project improvements based on the final City Council Direction for the 2011-2017 General Capital Improvement Plan would be between an estimated $67.3 and $67.6 million, depending on the selected option for extending NE 4th Street. Construction would cost approximately $32 million and right-of-way acquisition would cost roughly $35 million.

Funding for the overall project would likely include monies from the following sources:

- Federal grants
- State Transportation Improvement Board funding
- State Local Revitalization Financing funding
- Local contributions from transportation-dedicated sources, long-term general obligation bonds, impact fees, and other private participation programs including possible local improvement districts.

The specific mix of federal, state, and local funding contributions for each construction phase could differ.

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3.0 Methods

3.1 Methods Used in this Analysis

The analysis of noise impacts in the project area is based on the noise caused by the project compared with existing noise levels to determine if sensitive noise receptors would experience traffic noise levels that exceed the NAC and if any substantial noise increases would occur. Construction noise effects are described based on maximum noise levels of construction equipment published by the U.S. Environmental Protection Agency (EPA). Mitigation measures are discussed, where appropriate, to avoid or reduce potential noise effects.

Ambient noise levels were measured to describe the existing noise environment, determine the noise levels above which impacts would occur, and to identify major noise sources in the project area. Noise levels in the project area are typical of an urban location. Noise that would result from the project was modeled at noise-sensitive uses nearest the project alignment.

Vibration impacts were evaluated qualitatively based on the type of construction equipment likely to be used and nearby land uses.

3.1.1 Background of Noise

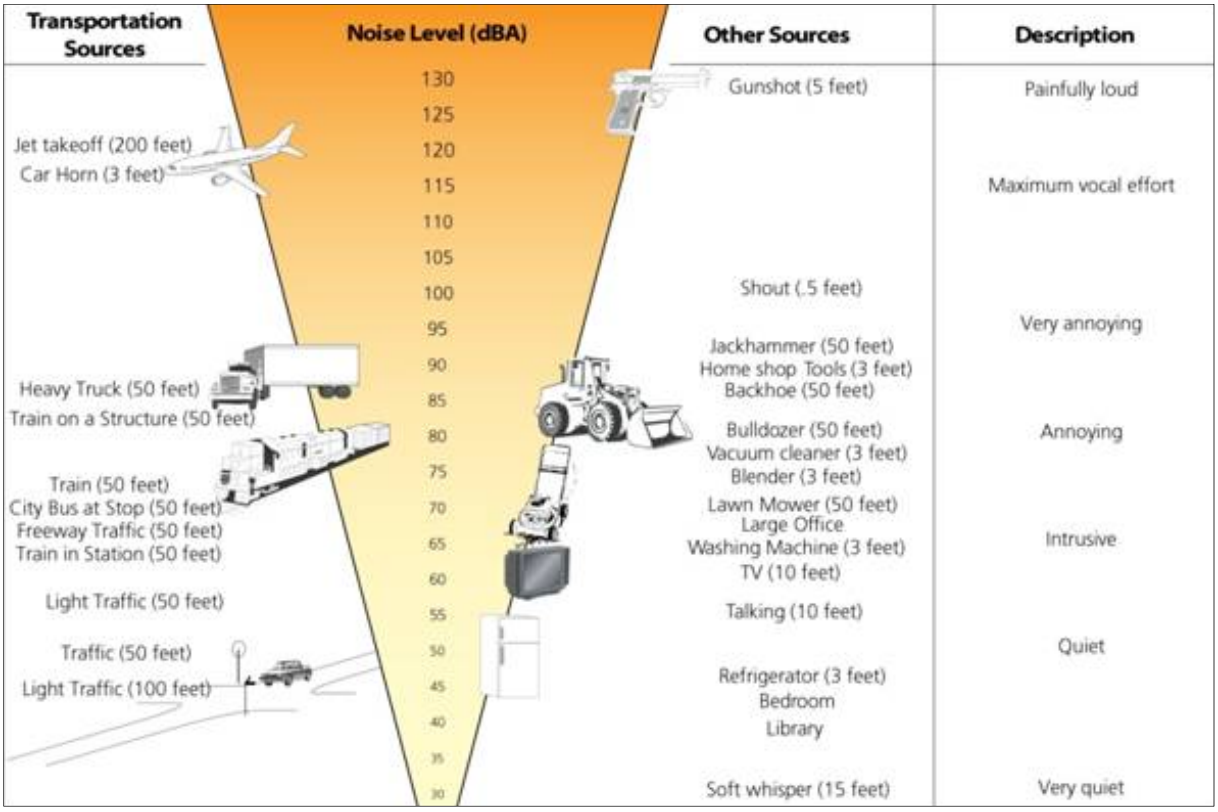
Characteristics of Sound

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure, called *sound pressure*. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA 1974). Magnitude measures the physical sound energy in the air. The range of magnitude, from the faintest to the loudest sound the ear can hear, is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness, compared to physical sound measurement, refers to how people subjectively judge a sound. This varies from person to person. Magnitudes of typical sound levels are presented in Figure 3-1.

Because of the logarithmic decibel scale, a doubling of the number of noise sources (e.g., the number of cars operating on a roadway) increases noise levels by 3 dBA. A 10-fold increase in the number of noise sources will add 10 dBA. As a result, a noise source emitting a noise level of 60 dBA combined with another noise source of 60 dBA yields a combined noise level of 63 dBA (not 120 dBA). The human ear can barely perceive a 3-dBA increase, but a 5- or 6-dBA increase is readily noticeable and sounds as if the noise is about one and one-half times as loud. A 10-dBA increase appears to be a doubling of the noise level to most listeners.

The propagation of noise can be greatly affected by terrain and the elevation of the receiver relative to the noise source. Noise travels in a straight line-of-sight path between the source and the receiver. The addition of a berm or other area of

high terrain will reduce the noise energy arriving at the receiver. Breaking the line of sight between the receiver and the highest noise source results in a noise reduction of approximately 5 dBA.



Source: Federal Transit Administration (FTA), 1995; EPA, 1971; EPA 1974

Figure 3-1. Typical Sound Levels

Noise levels decrease with distance from the noise source. For a line source, such as a roadway, noise levels decrease 3 dBA over hard ground (e.g., concrete or pavement) or 4.5 dBA over soft ground (e.g., grass) for every doubling of distance between the source and the receptor. For a point source, such as construction sources, noise levels will decrease between 6 and 7.5 dBA for every doubling of distance from the source.

Sound Level Descriptors

A widely used descriptor for environmental noise is the equivalent sound level (L_{eq}). The L_{eq} can be considered a measure of the average noise level during a specified period of time. It is a measure of total noise, or a summation of all sounds during a time period. It places more emphasis on occasional high noise levels that accompany general background noise levels. L_{eq} is defined as the constant level that, over a given period of time, transmits to the receiver the same amount of acoustical energy as the actual time-varying sound. L_{eq} measured over

a one-hour period is the hourly L_{eq} ($L_{eq}[h]$), which is used for highway noise impact and abatement analyses.

Noise Regulations and Impact Criteria

Applicable noise regulations and guidelines provide a basis for evaluating potential noise effects. For federally funded highway projects, traffic noise effects occur when predicted $L_{eq(h)}$ noise levels approach or exceed the NAC established by the FHWA (23 CFR 772), or substantially exceed existing noise levels (U.S. Department of Transportation, 1982 and 1995, FHWA, HEP-41). The FHWA expects that "substantially exceed" be defined by the state. WSDOT defines substantial noise effects as traffic noise levels that are at least 10 dBA over existing sound levels, and severe noise effects at 30 dBA over existing sound levels. Severe noise effects also occur if predicted future noise levels exceed 80 dBA or more at outdoor activity areas as the result of a project.

The FHWA NAC exterior $L_{eq(h)}$ noise levels for various land activity categories are summarized in Table 3-1. For sites where serenity and quiet are of extraordinary significance and necessary for its public need, the noise criterion is 57 dBA; there are very few of these sites identified in the U.S. For residences, parks, schools, churches, and similar areas, the noise criterion is 67 dBA. For developed lands, the noise criterion is 72 dBA. WSDOT considers a noise effect to occur if predicted $L_{eq(h)}$ noise levels approach within 1 dBA of the noise mitigation criteria in Table 3-1; thus, if an outdoor noise level was 66 dBA or higher, it would approach or exceed the FHWA noise mitigation criterion of 67 dBA for residences (activity category B).

Table 3-1. FHWA Noise Abatement Criteria

Activity Category	Leq (h) (dBA)	Description of Activity Category
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (exterior)	Developed lands, properties, or activities not included in Category A or B above.
D	-	Undeveloped lands.
E	52 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Source: U.S. Department of Transportation 1982.

The City has adopted a qualitative noise standard with Municipal Code Chapter 9.18, Noise Control. The standard limits any noise, sound, or signal that unreasonably disturbs the comfort, peace, or repose of another person or persons. Construction noise is exempt from this qualitative standard between 7 a.m. and 10 p.m.

Noise Regulations and Impact Criteria

If noise levels that approach or exceed the noise abatement criteria are predicted, noise abatement must be evaluated as part of a project. A variety of mitigation methods can effectively reduce traffic noise impacts. If impacts are predicted, noise levels could be reduced by implementing traffic management measures, acquiring land as buffer zones or for construction of noise barriers or berms, realigning the roadway, or installing noise insulation for public or nonprofit institutional structures.

3.1.2 Vibration

Vibration is an oscillatory motion, which can be described in terms of displacement, velocity, or acceleration. There is no net movement of the vibration element, and the average of any of the motion descriptors is zero because the motion is oscillatory. Displacement is the easiest descriptor to understand. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed. Although displacement is easier to understand than velocity or acceleration, it is rarely used for describing ground-borne vibration. This is because most transducers used for measuring ground-borne vibration use either velocity or acceleration and, more importantly, the response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration.

Vibration Descriptors

One of the several different methods that are used to quantify vibration amplitude is peak particle velocity (PPV), which is defined as the maximum instantaneous positive or negative peak of the vibration signal. PPV is often used to monitor blasting vibration because it is related to the stresses that are experienced by buildings. Although PPV is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human response. It takes time for the human body to respond to vibration signals. In a sense, the human body responds to average vibration amplitude. Because the net average of a vibration signal is zero, the root mean square (rms) amplitude is used to describe the "smoothed" vibration amplitude. The rms of a signal is the average of the squared amplitude of the signal. The average is typically calculated over a 1-second period. The rms amplitude is always less than the PPV and is always positive. The PPV and rms velocity are normally described in inches per second in the U.S. and in meters per second in the rest of the world. Although it is not universally accepted, decibel notation is in common use for vibration. Decibel notation compresses the range of numbers required to describe vibration. The vibration velocity level in decibels is defined as the following:

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

where "L_v" is the velocity level in decibels,

"V" is the rms velocity amplitude, and

"V_{ref}" is the reference velocity amplitude.

A reference must always be specified whenever a quantity is expressed in terms of decibels. All vibration levels in this report are referenced to 1 x 10^{-6} inches per second. Although not a universally accepted notation, the abbreviation VdB is used in this document to indicate vibration decibels to reduce the potential for confusion with sound decibels.

Typical Vibration Levels

In contrast to airborne noise, ground-borne vibration is not a phenomenon that most people experience every day. The background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans, which is around 65 VdB (Figure 3-2). Most perceptible indoor vibration is caused by sources within buildings, such as operation of mechanical equipment, movement of people, or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. Pile driving is a common source of vibration. The vibration from traffic is rarely perceptible if the roadway is smooth. The range of interest is from approximately 50 to 100 VdB.

Background vibration is usually well below the threshold of human perception and is of concern only when the vibration affects very sensitive manufacturing or research equipment. Electron microscopes and high-resolution lithography equipment are examples of equipment that is highly sensitive to vibration and may be disturbed by vibration levels greater than approximately 65 VdB. Although the perceptibility threshold is about 65 VdB, human response to vibration is not usually substantial unless the vibration exceeds 70 VdB. This is a typical level 50 feet from a rapid transit or light rail system. Buses and trucks rarely create vibration that exceeds 70 VdB unless there are bumps in the road.

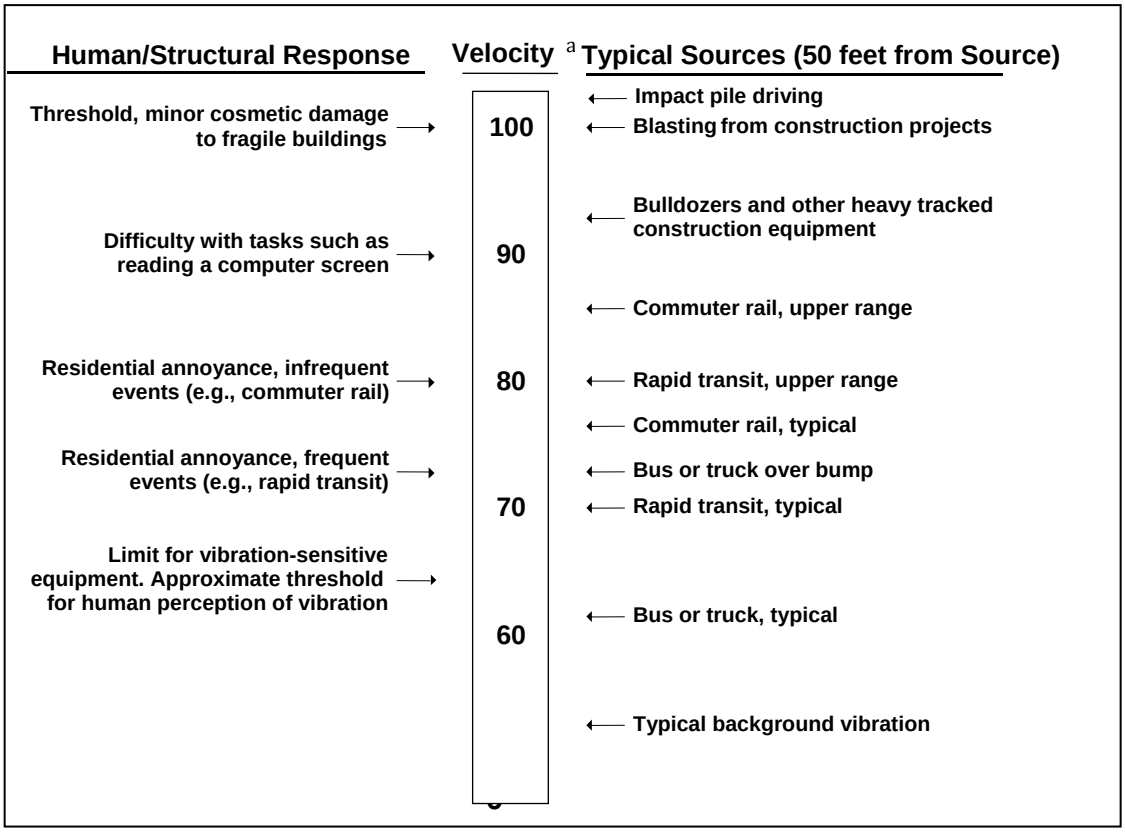
Effects of Vibration

Ground-borne vibration can be a concern for occupants of nearby buildings during project construction. However, it is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. The most common sources of ground-borne vibration are trains, buses on rough roads, and construction activities such as blasting, pile driving, and operating heavy earth-moving equipment.

The effects of ground-borne vibration include perceptible movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, vibration can damage buildings. Building damage is not a factor for normal transportation projects, with the occasional exception of blasting, pile driving, and demolition of structures, which may occur during construction.

The rumbling sound caused by the vibration of room surfaces is called ground-borne noise. The annoyance potential of ground-borne noise is usually

characterized using the A-weighted sound level. Although the A-weighted level is almost the only metric used to characterize community noise, there are potential problems with characterizing low-frequency noise using A-weighting. This is because of the non-linearity of human hearing, which causes sounds dominated by low-frequency components to seem louder than broadband sounds that have the same A-weighted level. The result is that ground-borne noise with a level of 40 dBA sounds louder than 40-dBA broadband noise. This is accounted for by setting the limits for ground-borne noise lower than for broadband noise.



Source: U.S. Department of Transportation 1995.
Note: *RMS vibration velocity level in VdB relative to 10^{-6} inches per second.

Figure 3-2. Common Vibration Sources and Levels

Vibration Effect Criteria

Criteria for construction ground vibration must address both:

- The potential for disturbance and annoyance to building occupants, and
- The potential for damage to nearby buildings and other nearby structures.

Temporary vibration effects may occur in the local area during construction as a consequence of blasting or the use of pile drivers, jackhammers, hoe rams, soil compactors, and other heavy construction equipment. Buildings near the construction site respond to these vibrations with varying results, ranging from perceptible effects at the lowest levels, low rumbling sounds and noticeable vibrations at moderate levels, and slight damage at the highest levels. Ground vibrations from construction activities rarely reach the levels that can damage structures but can achieve moderate levels in buildings very close to a site. Impact pile drivers generally cause the highest vibration levels compared to other types of equipment. During the project's construction, mitigation measures should be applied to minimize the potential for harm to nearby structures.

Detailed information on the proposed construction methods, the specific construction activity, the types of construction equipment, the characteristics of underlying soils, and the existing conditions and the use of buildings is required for a precise assessment of potential effects. Field review of building types and construction and measurement of existing vibration levels at sensitive sites are also required to determine the potential sensitivity of the buildings near the construction site.

Vibration Criteria

FHWA, WSDOT, and the City do not have specific vibration impact criteria. If construction dictates transient or impact vibration equipment, project-specific vibration criteria would be developed in coordination with the City to prevent vibration damage to nearby structures.

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4.0 Existing Conditions

4.1 Land Use and Zoning

The project corridor is located in the western portions of the Wilburton/ NE 8th Street and Bel-Red Subareas within the City of Bellevue, King County, Washington.

The Washington State Legislature enacted the Growth Management Act in 1990 "to create a method for comprehensive land use planning involving citizens, counties, cities, and the private sector that would prevent uncoordinated and unplanned growth." The project is subject to the following regional and City plan policies:

- The Puget Sound Regional Council Transportation 2040 Multicounty Policies
- The City of Bellevue Comprehensive Plan
- The City of Bellevue Wilburton/NE 8th Street Subarea Plan
- The City of Bellevue Bel-Red Subarea Plan

4.1.1 Land Use

Land use in the project study area is primarily characterized by moderate-density commercial developments with a mix of institutional, residential, retail, and office uses. Land uses directly adjacent to the project corridor consist of automobile dealerships, vacant lots, retail and big-box retail stores, a post office, small strip malls, office buildings, medical offices, parking lots, and large warehouses.

Limited residential land uses are located throughout the corridor. The Westside Apartments at 500 121st Place NE and the Oasis Condominiums at 680 122nd Avenue NE are multi-family residential complexes located northeast of the eastern terminus of the proposed extension of NE 4th Street and are more than a block east of the existing intersection of NE 5th Street with 120th Avenue NE in the project corridor. Both residential complexes currently experience noise levels common in a typical urban area, including traffic noise from side streets, arterials in the immediate area, and I-405, which is less than a half-mile to the west. In addition, both complexes are located at least 250 feet from the proposed eastern-most edge of the project corridor. Another cluster of residences is located farther north on the eastern side of the project corridor. Two apartment complexes are within the triangular intersection of NE 8th Street and NE Bel-Red Road, roughly at and east of 122nd Avenue NE. Both Brierwood, located at 12022 NE 8th Street, and the Midlakes Apartments, located at 12028 NE 8th Street, are two-story apartment buildings. Four additional two-story condominium buildings are also located at 12107 NE Bel-Red Road. Finally, there is the Lake Bellevue Village located to the west of 120th Avenue NE, just south of NE 12th Street, which consists of three two- and three-story

condominiums. This condominium community includes a shopping complex that offers various services and amenities to nearby residents.

The only church in the project study area is All Saints Episcopal Church at 1307 120th Avenue NE. The church is located within a commercial development adjacent to the project corridor.

Open space near the project corridor includes Wilburton Hill Community Park at 12053 Main Street, located to the south and east of the southern portion of the project corridor. Bel-Red Mini Park is located east of the project corridor at 124th Avenue NE and NE Bel-Red Road.

4.1.2 Zoning

The project corridor is directly adjacent to seven different zoning districts, as shown in Figure 4-1. Table 4-1 identifies the various land uses permitted in those zoning districts.

In May 2009, the City adopted a zoning ordinance for the Bel-Red Subarea in support of City and regional initiatives to attract new mixed-use development. One of the purposes of this effort was to plan for future smart growth in the Bel-Road Subarea, including pedestrian and bike-friendly access and transit-oriented development associated with the future light rail corridor.

4.1.3 Noise

Project-area traffic is a mix of small vehicles through the area to businesses and homes and heavy truck and bus trips to and from transportation and distributions facilities located throughout the area.

4.1.4 Vibration

Five structures are within 25 feet of project construction. All five buildings house commercial businesses that do not involve vibration-sensitive uses. The five structures are summarized below:

- Mixed commercial masonry building constructed in 1994 is located at the southwest corner of 120th Avenue NE and NE 8th Street (11919 NE 8th Street).
- Shell Service Station (fuel pump canopy located within 25 feet of construction) constructed in 1990 is located at the southeast corner of 120th Avenue NE and NE 8th Street (12001 NE 8th Street).
- Safeway warehouse is a masonry structure built in 1968 and is located east of 120th Avenue NE and north of NE 12th Street with no street address available on site at the time of this report.

Attachment 9

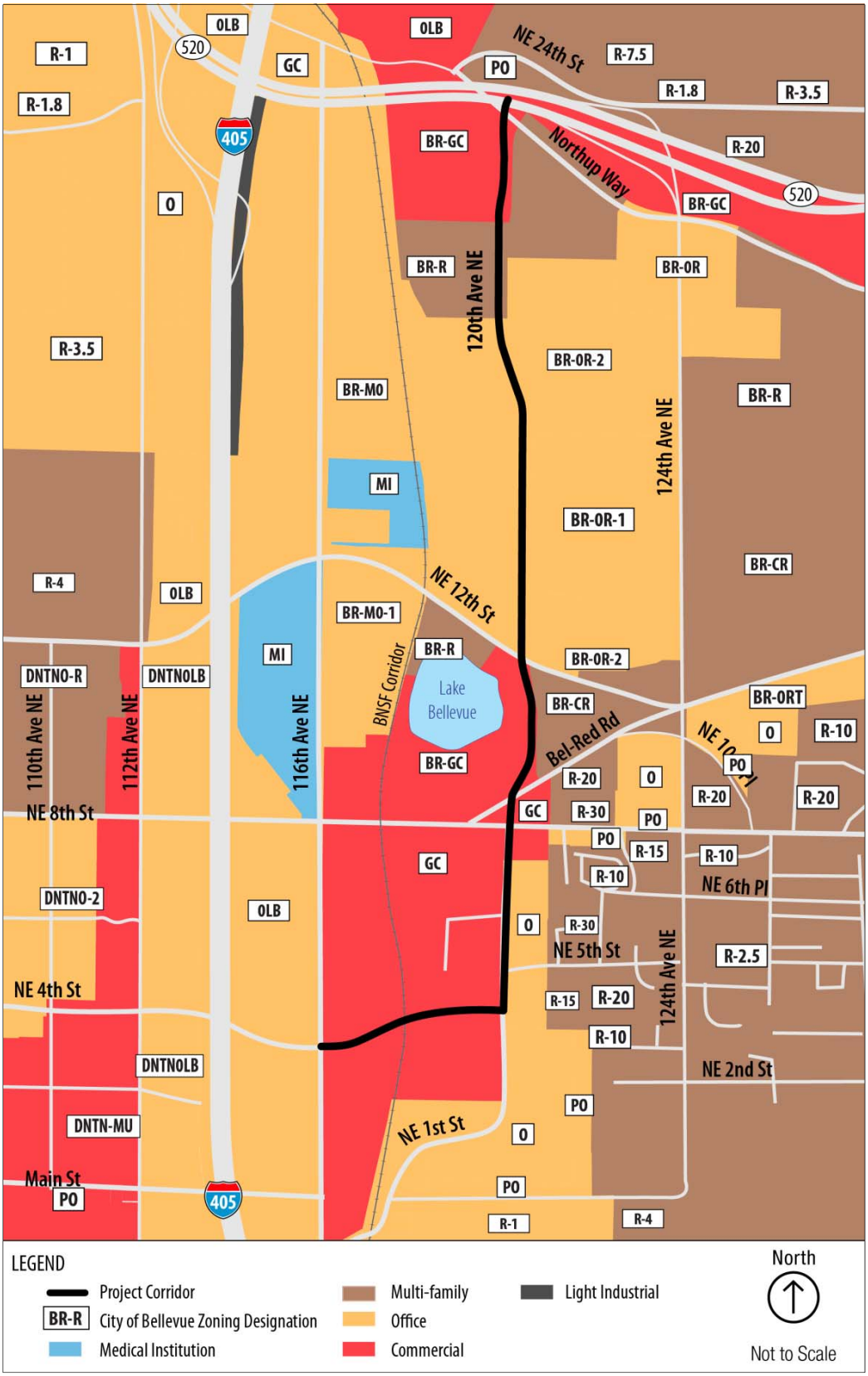

Figure 4-1. Study Area and Surrounding Zoning/Land Use

Table 4-1. Land Use and Zoning Districts

Abbreviation	Zoning District	Purpose
GC	General Commercial	To provide for the location of a wide variety of business activities that provide goods and services to other businesses and the general public.
O	Office	To provide for the location of business, financial, administrative, and professional services.
BR-OR-1	Bel-Red Subarea—Office/ Residential Node 1	To provide an area for a mix of office, housing, and retail uses within the core of a nodal area, with office as the predominant use. The district is limited in extent to provide the level of intensity appropriate for areas close to the highest levels of transit service within the Bel-Red area.
BR-OR-2	Bel-Red Subarea—Office/ Residential Node 2	To provide an area for a mix of office, housing, and retail uses, with office as the predominant use. The district is located within a node but outside the node's core, and building heights provide for a transition between the node's core and areas outside the node.
BR-R	Bel-Red Subarea— Residential	To provide an area for residential uses. Limited retail and service uses are permitted secondary to residential use to provide the amenity of shopping and services within easy walking distance of residential structures.
BR-CR	Bel-Red Subarea— Commercial Residential	To provide an area for a mix of housing, retail, office, and services. Multiple uses are encouraged on individual sites, in individual buildings, and in the district as a whole.
BR-GC	Bel-Red Subarea— General Commercial	To provide an area for a wide variety of business activities that provides goods and services to other businesses and the general public.

Source: Excerpted from the City of Bellevue, Ordinance 5874
Note: *A minimum density of 10 units per acre shall be achieved for new single-family dwelling units. This requirement does not apply to work-live units.

- Grainger warehouse is a mixed-material structure built in 1999 at 2221 120th Avenue NE. Grainger is located west of 120th Avenue NE approximately 500 feet south of Northup Way.
- Mixed commercial masonry building constructed in 1983 is located at the southeast corner of the intersection of 120th Avenue NE and Northup Way (12021 Northup Way).

4.2 Existing Noise Environment

4.2.1 Noise Measurements

Ambient noise levels were measured for 15-minute periods at seven locations near the project area (Figure 4-2) to describe the existing noise environment, identify major noise sources in the project area, validate the noise prediction model, and characterize the background environmental noise levels (Table 4-2).

Attachment 9

Figure 4-2. Locations of Measured and Modeled Noise Receptors

Table 4-2. Noise Measurement Data

Measurement Location Number	Description	Measured Noise Level (dBA Leq)	Modeled Noise Level (dBA leq)	Difference between Measured and Modeled Noise Level (dBA Leq)
1[1]	Church	61	61	0
2[1]	Condominiums at Lake Bellevue	59	59	0
3[1]	Condominiums at NE Bel-Red Road	60	60	0
4[1]	Apartments at NE 8th Street	56	57	+1
5[2]	Commercial	63	63	0
6[2]	Commercial	54	53	-1
7[2]	Commercial	61	60	-1

[1] Parsons Brinckerhoff, August 5 and 10, 2010.
[2] Landau Associates, December 3, 2009.

Measurements were taken on December 3, 2009 by Landau Associates and on August 5 and 10, 2010, by Parsons Brinckerhoff. All measurements were taken with calibrated Larson Davis Model 820 or Norsonic 118 noise meters that comply with ANSI S1.4 Standard for a Type I accuracy instrument. The metrological conditions were ideal for taking noise measurements. Measurement locations represent larger clusters of noise-sensitive receptors near the proposed project. Existing noise levels were subsequently modeled at 12 locations that represent noise-sensitive uses in the study area and first row commercial businesses in the area, and shown in Figure 4-2.

Noise measurement locations were only used to calibrate the noise model and were not used for predicting noise levels at noise-sensitive locations because traffic volumes and speeds are generally not consistent with loudest hour conditions.

4.2.2 Noise Modeling

FHWA's Traffic Noise Model (TNM®) Version 2.5 computer model (FHWA 2004) was used to predict $L_{eq(h)}$ traffic noise levels. TNM® was used to predict noise levels at discrete, but representative, points by considering interactions between different noise sources on the propagation of noise. The model predicts the traffic noise level at a receiver location resulting from a series of straight-line roadway segments. Noise emissions from free-flowing traffic depend on the number of automobiles, medium trucks, heavy trucks, motorcycles, and buses per hour; vehicular speed; and reference noise emission levels of specified vehicles. TNM® considers the effects of intervening barriers, topography, trees, and atmospheric absorption of sound.

By intent and design, noise from sources other than traffic is not included. Therefore, when non-traffic noise such as aircraft noise is considerable in an area, the TNM® modeled results can be slightly less than the measured noise levels. For this reason, the results from the noise measurements were used to calibrate the TNM® model by comparing the predicted and measured noise levels

at the seven measurement locations using the traffic count data obtained during the measurement periods. These traffic counts reflect the conditions present during the period of the measurement and therefore help to ensure the model is producing accurate sound-level predictions. The calibration process proved to be successful because the differences between measured and modeled noise levels at the receptors were within +/- 1 dBA, as shown in Table 4-2. A match between measurement and modeled sound levels this close indicates that no calibration adjustment of the model is necessary in accordance with FHWA policy.

Base maps were exported as DXF files and imported into the TNM®. Major roadways, retaining walls, terrain lines, building rows, and sensitive receptors were digitized into the model. The proposed roadway alignments were added to the model from electronic design files and design drawings. The proposed design speed on 120th Avenue NE is 35 miles per hour (mph).

4.2.3 Existing Traffic Noise Levels

Much of the land use in the noise study area is light industrial and commercial. Residences in the noise study area are located along Lake Bellevue and east of 120th Avenue NE between NE 8th Street and NE Bel-Red Road. A church is located along 120th Avenue NE, north of NE 12th Street, and a private swimming pool is located within the Lake Bellevue condominium complex. Roadway traffic along 120th Avenue NE is the dominant source of noise north of NE 12th Street. Roadway traffic from NE 8th Street and NE 12th Street is the dominate source of noise south of NE 12th Street.

The modeled traffic noise levels for the existing conditions along the noise study area range from 49 to 64 dBA $L_{eq,}$ as shown in Table 4-3. The locations of the receptors can be seen on Figure 4-2. No modeled sites currently approach or exceed the FHWA NAC.

4.2.4 Future Traffic Noise Levels

Traffic noise levels at noise-sensitive receptors under future No Build conditions are predicted to increase by approximately 1 to 5 dBA L_{eq} over existing conditions. 2040 future noise levels without the project would not approach or exceed the FHWA NAC at all modeled locations.

For the future Build condition, traffic noise levels along the proposed roadway improvements are predicted to increase by approximately 1 to 9 dBA L_{eq} over existing conditions. The 2040 Future Build conditions would exceed the FHWA NAC at one church (Table 4-4). This exceedance is largely due to the proximity of this noise-sensitive site in relation to future traffic volumes on 120th Avenue NE and 120th Avenue widening bringing traffic closer to the site.

Table 4-3. Existing Noise Modeling Data

Modeled Site Number	Number of Residential Units Represented by the Receptor	WSDOT NAC Criteria Leq(h) dBA	Existing Traffic Noise Level Leq(h)dBA	Leq dBA Equal to or Exceeding NAC
1	Church	66	59	No
2	24 Residences	66	60	No
3	18 Residences	66	61	No
4	10 Residences	66	57	No
5	Commercial	71	63	No
6	Commercial	71	53	No
7	Commercial	71	60	No
A	Recreation	66	59	No
B	14 Residences	66	64	No
C	14 Residences	66	64	No
D	18 Residences	66	63	No
E	14 Residences	66	49	No
F	14 Residences	66	53	No
G	42 Residences	66	52	No
H	17 Residences	66	59	No
I	52 Residences	66	55	No
J	20 Residences	66	53	No
K	Commercial	71	52	No
L	Commercial	71	57	No

Source: Parsons Brinckerhoff, August 11, 2010.

Table 4-4. Existing and Future Noise Modeling Data

Site Number	Number of Residential Units Represented by the Receptor	WSDOT NAC Criteria Leq(h) dBA	Existing Traffic Noise Level Leq(h)dBA	2040 No Build Traffic Noise Level Leq(h)dBA	Difference from Existing Noise Level Leq(h)dBA	2040 Build (Options 1 & 2) Traffic Noise Level Leq(h)dBA	Difference from Existing Noise Level(h) dBA
1	Church	66	59	64	5	**68**	9
2	24 Residences	66	60	60	0	62	2
3	18 Residences	66	61	62	1	64	3
4	10 Residences	66	57	59	2	59	2
5	Commercial	71	63	66	3	68	5
6	Commercial	71	53	57	4	61	8
7	Commercial	71	60	62	2	65	5
A	Recreation	66	59	59	0	60	1
B	14 Residences	66	64	64	0	65	1
C	14 Residences	66	64	64	0	65	1
D	18 Residences	66	63	64	1	65	2
E	14 Residences	66	49	51	2	52	3
F	14 Residences	66	53	55	2	56	3
G	42 Residences	66	52	53	1	54	2
H	17 Residences	66	59	61	2	61	2
I	52 Residences	66	55	56	1	57	2
J	20 Residences	66	53	56	3	59	6
K	Commercial	71	52	53	1	57	5
L	Commercial	71	57	58	1	62	5

Source: Parsons Brinckerhoff, April 8, 2011.
Note: **Bold** indicates an affected receptor according to NAC

4.3 Existing Vibration Environment

Existing vibration levels in the project area are typical of an urban environment, with trucks and buses operating on existing roadways. Current vibration levels are not known to disturb residents or businesses in the project area. Five structures are within 25 feet of project construction along 120th Avenue NE. None of the five structures is considered sensitive to vibration.

A detailed discussion of the geologic setting of the project area is presented in the *Geotechnical Report* (Shannon & Wilson, 2010).

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5.0 Environmental Effects

5.1 Direct Effects on Noise

Direct effects are caused by the action and occur at the same time and place as the project.

5.1.1 Noise Effects during Operation

No Build

Modeling for the No Build Alternative indicates that predicted traffic noise levels at all sensitive noise receptors in the noise study area would not approach or exceed the FHWA NAC in the year 2040.

Build

Modeling for the Build Alternative indicates that noise levels would exceed the NAC at the All Saints Episcopal Church in the year 2040 with Option 1 and Option 2. Noise levels at all noise-sensitive sites do not approach or exceed the FHWA NAC criteria under both Options of the Build Alternative. Increased traffic noise levels exceed the NAC criteria at the church, which is a result of its proximity to the widened roadway and increased traffic volumes on 120th Avenue NE.

5.1.2 Noise Effects during Construction

As noted in Chapter 2.0, the project will be constructed in phases beginning no earlier than early 2012 and extending to at least 2016.

No Build

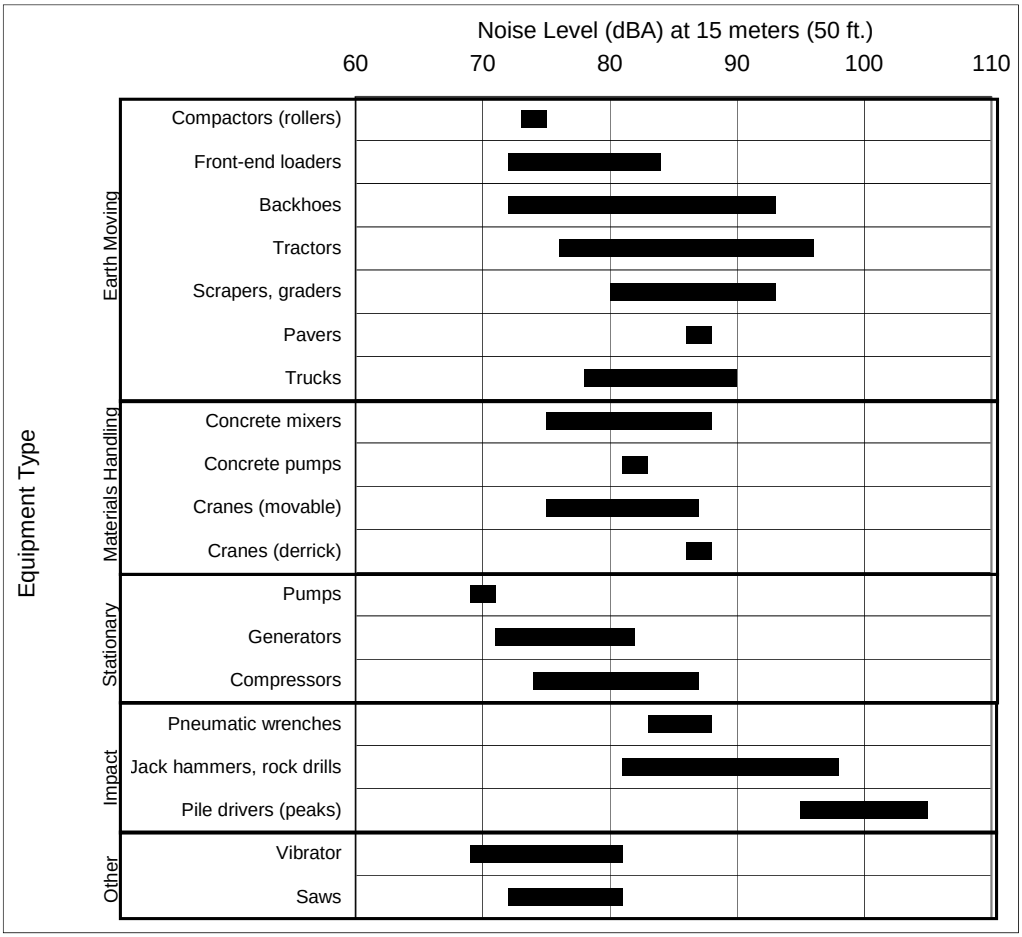
The project would not be constructed under the No Build Alternative and thus would not result in construction noise.

Build

Project construction would generate noise during construction. Construction would usually be carried out in several reasonably discrete steps, each with its own mix of equipment and its own noise characteristics. Roadway construction would involve clearing, cut-and-fill (grading) activities, removing old roadways, importing and compacting fill, and paving.

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

Construction noise would be intermittent. Noise levels would depend on the type, amount, and location of construction activities. The type of construction methods followed would establish maximum noise levels for the equipment used. The amount of construction activity would define how often noise would occur. The proximity of construction equipment to adjacent properties would affect the noise levels of the receptors. Maximum noise levels for construction equipment for the Build Alternative would range from 69 to 93 dBA at 50 feet (Figure 5-1). Pile drivers shown in Figure 5-1 would not be used during project construction.



Source: EPA 1971.

Figure 5-1. Construction Equipment Noise Ranges

5.1.3 Vibration Effects during Construction

Vibration is usually measured as a rms velocity level L_v, which is reported in VdB referenced to a vibration level of 1 micro inch/second. Humans can perceive vibration levels above approximately 65 VdB. The threshold for minor damage to fragile buildings is approximately 100 VdB. Buses and trucks frequently generate approximately 65 VdB at 25 feet. Heavy construction equipment, such as large bulldozers and loaded trucks, frequently generate between 85 and 87 VdB at

25 feet. No potentially fragile buildings are within 25 feet of proposed construction activities; therefore, no vibration damage is expected to buildings during construction. Any cast-iron water mains within 100 feet or other fragile utility lines within 25 feet could be affected by vibrations caused by impact equipment, such as pavement breakers (jackhammers). No fragile utility lines were identified within 25 feet of project construction. Limits on construction activities are discussed in Section 5.4, Mitigation Measures. Mitigation would minimize the risk of vibration damage during construction.

5.1.4 Vibration Effects during Operation

Vibration levels that would cause disturbance of land use or structural damage are not anticipated as part of the project.

5.2 Indirect Effects on Noise and Vibration

Indirect effects are associated with a project and occur later in time or farther removed in distance; but they are still reasonably foreseeable (e.g., induced land development from highway projects). No additional indirect effects on noise would occur because all foreseeable projects in the area are included in the 2040 traffic modeling used to generate the analysis. No indirect effects on vibration would occur in the foreseeable future.

5.3 Cumulative Effects on Noise and Vibration

Cumulative effects result from the incremental effects of the action when added to other past, present, and reasonably foreseeable actions, regardless of the agency or person initiating the other actions. At this time, reasonably foreseeable projects in the area include the following:

- Spring District—Wright Runstad & Company, in joint venture with Shorenstein Properties, LLC, has planned the development of the Spring District, a 36-acre mixed-use urban neighborhood within the Bel-Red Corridor. The Spring District will consist of up to 1,000 multi-family residences, more than 3 million square feet of office space, and several high-density buildings that will provide retail services. The proposed development will be located at the northeast corner of 120th Avenue NE and NE 12th Street.
- Sound Transit's East Link Project—This project will consist of an electric light rail train system that will connect areas between Seattle and Overlake Transit Center in Redmond. It is anticipated that the system will have a station just east of 120th Avenue NE and between NE 15th Street and NE 16th Street. This project is expected to be completed between 2016 and 2021.
- Construction of light rail will result in the acquisition of property at 1445 120th Avenue NE. Since not all of the property will be used for the light rail track, some portion of it will be redeveloped. As this is already a

commercial property, the nature of the land use is unlikely to change significantly.

- NE 15th/NE 16th Streets Corridor—The NE 15th/NE 16th Streets Corridor will be constructed from NE 12th Street through to Northup Way near NE 15th/NE 16th Streets. The East Link light rail project will be located in this corridor crossing 120th Avenue NE and east towards 124th Avenue NE.
- 124th Avenue NE Improvements—124th Avenue NE will be improved to support proposed developments in the Bel-Red subarea. The anticipated traffic flow pattern from Downtown to eastbound State Route 520 is NE 4th Street to 120th Avenue NE to NE 15th/NE 16th Streets to 124th Avenue NE to State Route 520.

The NE 4th Street/120th Avenue NE Corridor Project is part of the larger Wilburton/NE 8th Street and Bel-Read Subarea planning efforts and is included in these plans. Redevelopment of this area is intended to change its nature from a commercial/industrial area to one that consists of mixed-use smart growth, including residential transit-oriented development. From a community standpoint, this would be considered a beneficial effect, as community centers are developed around the future light rail stations at 120th Avenue NE and at 130th Avenue NE. Each of these transit-oriented development areas will contain its own mixture of commercial and residential facilities and provide pedestrian and bicycle facilities to connect these communities, both internally and with each other.

No additional cumulative effects on noise would occur because all foreseeable projects in the area are included in the 2040 traffic modeling used to generate the analysis. No indirect effects on vibration would occur in the foreseeable future.

5.4 Mitigation Measures

5.4.1 Operational Noise Mitigation

Because predicted traffic noise levels are expected to exceed WSDOT noise criteria limits for some receivers, mitigation measures are warranted for consideration. Noise abatement is to be considered only where frequent human use occurs and where a lower noise level would provide benefits (U.S. DOT, 1982).

One church (Figure 4-2) is predicted to experience operational effects by traffic noise under the Build Alternative in 2040.

Evaluation of Mitigation Measures

Several different traffic noise abatement measures are evaluated whenever traffic noise impacts are expected. For example, noise generated from long-term operation of the project can be reduced by implementing traffic management measures, acquiring land as buffer zones, realigning the roadway, soundproofing public or nonprofit institutional structures, and constructing noise barriers or

berms. These measures were evaluated for their potential to reduce noise impacts from the project.

Any specific mitigation measure recommended as part of the project must be feasible and reasonable. In this context, feasible means the physical ability to implement the noise mitigation measure in such a manner as to provide an acceptable noise reduction benefit, while reasonable means being able to implement the mitigation measure at an acceptable cost.

Traffic management measures include modification of speed limits, traffic control devices, and restricting or prohibiting truck traffic. Restricting truck use on the new roadways could reduce noise levels at nearby receivers because trucks are louder than cars. The speed limit of the new facility is expected to be 35 mph. Reducing the speed could reduce noise in the project area but would conflict with mobility through the study area and would be counter to the purpose of the new facility. Therefore providing a substantial noise reduction through traffic management measures would not be feasible.

Acquiring land for noise buffer purposes at the affected sites would require relocating residences and would require the City to purchase additional right-of-way. Typically, residences within 500 feet of roadways are exposed to varying amounts of roadway noise. Relocating the affected receptors and purchasing right-of-way would be unreasonably expensive for the purpose of noise mitigation.

Creation of noise buffers could reduce the potential for future development along the roadways that are incompatible with traffic noise. Areas within the project area that are currently undeveloped or abandoned could remain as such to avoid noise from the new facility.

The project's horizontal alignment is already designed to avoid displacing any residences in the noise study area. Changes in the horizontal alignment could cause residential displacements and could shift traffic noise to other sensitive receptors. The vertical alignment is constrained by the need to match surrounding roadway grades. Locating the Build Alternative alignment on a completely new alignment is likely not possible and could be prohibitively expensive. Even if found to be possible, doing so would provide only marginal improvement (i.e., less than 5 dBA L_{eq}). Therefore, realigning the roadway is not reasonable for noise mitigation.

Due to access limitations caused by driveways at All Saints Episcopal Church, evaluation of noise barriers is not an option to effectively reduce traffic noise. Noise barrier placement along this area of 120th Avenue NE would not be able to block the line of sight from the church to the roadway, thus not effectively reducing traffic noise by at least 5 dBA.

Insulation of buildings could be feasible at All Saints Episcopal Church as this remedy, in accordance with FHWA and WSDOT policy, only applies to public or non-profit institutional buildings such as schools, churches, or libraries. All Saints Episcopal Church may be able to receive government-sponsored funding for

installation of noise insulation. Interior noise levels would need to be measured to determine if traffic noise levels inside the facility meet the FHWA NAC. Generally, a structure with closed windows and doors would reduce the exterior noise levels by 25 decibels inside the structure. At All Saints Episcopal Church, this would lead to interior noise levels being roughly 43 dBA and well below the NAC.

If interior traffic noise levels are above the NAC, soundproofing the church may be a feasible way to reduce traffic noise at this location.

5.4.2 Operational Vibration Mitigation

No mitigation is proposed because no effects are anticipated.

5.4.3 Construction Noise Mitigation

Because construction is expected to be completed during daytime hours (7 a.m. to 10 p.m.) and within City of Bellevue construction noise limits, mitigation would not be required**.** For construction outside of daytime hours, a noise variance may be required by the City if project construction noise is predicted to exceed the City's noise limits or if nighttime construction is required to maintain daytime traffic flow or schedule requirements.

5.4.4 Construction Vibration Mitigation

Impact equipment should not be used for pavement removal or placement of piles within 100 feet of known fragile cast-iron water mains or within 25 feet of other fragile underground utilities or historic buildings.

6.0 References

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Parsons Brinckerhoff 2010 — Parsons Brinckerhoff 2010. *Bellevue 120th Avenue NE Widening Project, Transportation Technical Report.* Seattle, WA.

Shannon & Wilson 2010 — Shannon & Wilson 2010. *Bellevue 120th Avenue NE Widening Project, Geotechnical Report.* Seattle, WA.

USEPA 1971 — U.S. Environmental Protection Agency, 1971. *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*. Washington, D.C.

USEPA 1974 — U.S. Environmental Protection Agency, 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. Report Number 550/9-74-004.

WSDOT 2006 — WSDOT, 2006. *Traffic Noise Analysis and Abatement Policy and Procedures.* Olympia, Washington.

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Attachment 9

Appendix A
Traffic and Noise Modeling Output Files

Attachment 9

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Attachment 9

Traffic Data

Table A-1. Noise Measurement Data

Roadway	Direction of Travel	Speeds	Existing Condition 2010				No Build 2040				Build 2040 (Options 1 and 2)			
			Total	Autos	Medium Trucks	Heavy Trucks	Total	Autos	Medium Trucks	Heavy Trucks	Total	Autos	Medium Trucks	Heavy Trucks
NE 4th Street	EB	35	0	0	0	0	0	0	0	0	1240	1178	25	37
NE 4th Street	WB	35	0	0	0	0	0	0	0	0	1530	1454	31	46
NE 5th Street	WB	30	50	48	1	2	210	200	4	6	380	361	8	11
NE 8th Street (west)	EB	35	1525	1449	31	46	2470	2347	49	74	1520	1444	30	46
NE 8th Street (east)	EB	35	1320	1254	26	40	1970	1872	39	59	1495	1420	30	45
NE 8th Street (east)	WB	35	1235	1173	25	37	1640	1558	33	49	1585	1506	32	48
NE 8th Street (west)	WB	35	1770	1682	35	53	1250	1188	25	38	1965	1867	39	59
NE Bel-Red Rd (west)	EB	30	250	238	5	8	955	907	19	29	0	0	0	0
NE Bel-Red Rd (east)	EB	30	214	203	4	6	145	138	3	4	140	133	3	4
NE Bel-Red Rd (east)	WB	30	145	138	3	4	345	328	7	10	265	252	5	8
NE Bel-Red Rd (west)	WB	30	580	551	12	17	1275	1211	26	38	0	0	0	0
NE 12th Street (west)	EB	35	1000	950	20	30	670	637	13	20	835	793	17	25
NE 12th Street (east)	EB	35	995	945	20	30	810	770	16	24	970	922	19	29
NE 12th Street (east)	WB	35	1095	1040	22	33	1160	1102	23	35	1485	1411	30	45
NE 12th Street (west)	WB	35	1060	1007	21	32	1235	1173	25	37	1155	1097	23	35
120th Ave NE (S of 4th)	NB	35	0	0	0	0	645	613	13	19	615	584	12	18
120th Ave NE (S of 4th)	SB	35	0	0	0	0	560	532	11	17	390	371	8	12
120th Ave NE (N of 4th)	NB	35	605	575	12	18	1105	1050	22	33	1340	1273	27	40
120th Ave NE (N of 4th)	SB	35	470	447	9	14	1095	1040	22	33	1435	1363	29	43
120th Ave NE (N of 8th)	NB	35	0	0	0	0	0	0	0	0	1270	1207	25	38
120th Ave NE (N of 8th)	SB	35	0	0	0	0	0	0	0	0	1720	1634	34	52
120th Ave NE (N of Bel-Red)	NB	35	180	171	4	5	665	632	13	20	1540	1463	31	46
120th Ave NE (N of Bel-Red)	SB	35	390	371	8	12	985	936	20	30	1760	1672	35	53
120th Ave NE (N of 12th)	NB	35	180	171	4	5	705	670	14	21	1070	1017	21	32
120th Ave NE (N of 12th)	SB	35	250	238	5	8	625	594	13	19	1395	1325	28	42

Source: Parsons Brinckerhoff, 2011.

Attachment 9

Noise Modeling Output Files
Validation Output File

PB 14-Apr-11
P. Romero TNM 2.5
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: 160195C
RUN: Bellevue 120th - Validation
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Increase over existing Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Noise Reduction Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
	3	1	18	0	60.4	66	60.4	10 ----	60.4	0	8	-8
	2	5	24	0	59.4	66	59.4	10 ----	59.4	0	8	-8
	1	8	0	0	60.5	66	60.5	10 ----	60.5	0	8	-8
	4	16	10	0	56.7	66	56.7	10 ----	56.7	0	8	-8
	5	19	0	0	62.8	66	62.8	10 ----	62.8	0	8	-8
	6	27	0	0	52.8	66	52.8	10 ----	52.8	0	8	-8
	7	29	0	0	60.1	66	60.1	10 ----	60.1	0	8	-8

Dwelling Units	# DUs	Noise Reduction Min dB	Noise Reduction Avg dB	Noise Reduction Max dB
All Selected	52	0	0	0
All Impacted	0	0	0	0
All that meet NR Goal	0	0	0	0

Attachment 9

Existing Conditions 2010 Output File

PB 14-Apr-11
P. Romero TNM 2.5
RESULTS: SOUND LEVELS Calculated with TNM 2.5
PROJECT/CONTRACT: 160195C
RUN: Bellevue 120th - Existing Conditions
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH
Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calc'd - Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
	3	1	18	0	60.9	66	60.9	10	----	60.9	0	8	-8
D		3	18	0	62.9	66	62.9	10	----	62.9	0	8	-8
	2	5	24	0	60.2	66	60.2	10	----	60.2	0	8	-8
A		6	0	0	58.9	66	58.9	10	----	58.9	0	8	-8
	1	8	0	0	59	66	59	10	----	59	0	8	-8
C		10	14	0	63.9	66	63.9	10	----	63.9	0	8	-8
B		13	14	0	64.2	66	64.2	10	----	64.2	0	8	-8
E		14	14	0	49.4	66	49.4	10	----	49.4	0	8	-8
F		15	14	0	53.4	66	53.4	10	----	53.4	0	8	-8
	4	16	10	0	57	66	57	10	----	57	0	8	-8
G		17	42	0	51.6	66	51.6	10	----	51.6	0	8	-8
	5	19	0	0	62.9	66	62.9	10	----	62.9	0	8	-8
	6	20	0	0	53.3	66	53.3	10	----	53.3	0	8	-8
	7	21	0	0	60.1	66	60.1	10	----	60.1	0	8	-8
H		23	17	0	59.4	66	59.4	10	----	59.4	0	8	-8
I		24	52	0	54.5	66	54.5	10	----	54.5	0	8	-8
J		25	20	0	53.1	66	53.1	10	----	53.1	0	8	-8
K		26	0	0	52.2	66	52.2	10	----	52.2	0	8	-8
L		27	0	0	56.7	66	56.7	10	----	56.7	0	8	-8

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	257	0	0	0
All Impacted	0	0	0	0
All that meet NR Goal	0	0	0	0

Attachment 9

No Build 2040 Output File

PB 14-Apr-11
P. Romero TNM 2.5
RESULTS: SOUND LEVELS Calculated with TNM 2.5
PROJECT/CONTRACT: 160195C
RUN: Bellevue 120th - No Build
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calc'd - Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	
	3	1	18	0	62.2	66	62.2	10 ----	62.2	0	8	-8
D		3	18	0	63.7	66	63.7	10 ----	63.7	0	8	-8
	2	5	24	0	60.2	66	60.2	10 ----	60.2	0	8	-8
A		6	0	0	58.8	66	58.8	10 ----	58.8	0	8	-8
	1	8	0	0	63.6	66	63.6	10 ----	63.6	0	8	-8
C		10	14	0	64.1	66	64.1	10 ----	64.1	0	8	-8
B		13	14	0	64.3	66	64.3	10 ----	64.3	0	8	-8
E		14	14	0	50.9	66	50.9	10 ----	50.9	0	8	-8
F		15	14	0	55	66	55	10 ----	55	0	8	-8
	4	16	10	0	58.8	66	58.8	10 ----	58.8	0	8	-8
G		17	42	0	53	66	53	10 ----	53	0	8	-8
	5	19	0	0	65.6	66	65.6	10 ----	65.6	0	8	-8
	6	20	0	0	57.4	66	57.4	10 ----	57.4	0	8	-8
	7	21	0	0	61.6	66	61.6	10 ----	61.6	0	8	-8
H		23	17	0	61	66	61	10 ----	61	0	8	-8
I		24	52	0	56.3	66	56.3	10 ----	56.3	0	8	-8
J		25	20	0	55.8	66	55.8	10 ----	55.8	0	8	-8
K		26	0	0	53.4	66	53.4	10 ----	53.4	0	8	-8
L		27	0	0	57.7	66	57.7	10 ----	57.7	0	8	-8

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	257	0	0	0
All Impacted	0	0	0	0
All that meet NR Goal	0	0	0	0

Attachment 9

Build 2040 Option 1 Output File

PB 15-Apr-11
P. Romero TNM 2.5
RESULTS: SOUND LEVELS Calculated with TNM 2.5
PROJECT/CONTRACT: 160195C
RUN: Bellevue 120th - Build
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH
Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calc'd - Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
	3	1	18	0	64.3	66	64.3	10 ----	64.3	0	8	-8
D		3	18	0	65	66	65	10 ----	65	0	8	-8
	2	5	24	0	62.3	66	62.3	10 ----	62.3	0	8	-8
A		6	0	0	59.5	66	59.5	10 ----	59.5	0	8	-8
	1	8	0	0	67.5	66	67.5	10 Snd Lvl	67.5	0	8	-8
C		10	14	0	64.8	66	64.8	10 ----	64.8	0	8	-8
B		13	14	0	64.5	66	64.5	10 ----	64.5	0	8	-8
E		14	14	0	52	66	52	10 ----	52	0	8	-8
F		15	14	0	56.3	66	56.3	10 ----	56.3	0	8	-8
	4	16	10	0	58.5	66	58.5	10 ----	58.5	0	8	-8
G		17	42	0	53.6	66	53.6	10 ----	53.6	0	8	-8
	5	19	0	0	68.1	66	68.1	10 Snd Lvl	68.1	0	8	-8
	6	20	0	0	61.1	66	61.1	10 ----	61.1	0	8	-8
	7	21	0	0	65.4	66	65.4	10 ----	65.4	0	8	-8
H		22	17	0	61	66	61	10 ----	61	0	8	-8
I		23	52	0	57.4	66	57.4	10 ----	57.4	0	8	-8
J		24	20	0	58.9	66	58.9	10 ----	58.9	0	8	-8
K		25	0	0	56.8	66	56.8	10 ----	56.8	0	8	-8
L		26	0	0	61.8	66	61.8	10 ----	61.8	0	8	-8

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	257	0	0	0
All Impacted	0	0	0	0
All that meet NR Goal	0	0	0	0

Attachment 9

Build 2040 Option 2 Output File

PB 15-Apr-11
P. Romero TNM 2.5
RESULTS: SOUND LEVELS Calculated with TNM 2.5
PROJECT/CONTRACT: 160195C
RUN: Bellevue 120th - Build Opt 2
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calc'd - Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
	3	1	18	0	64.3	66	64.3	10 ----	64.3	0	8	-8
D		3	18	0	65	66	65	10 ----	65	0	8	-8
	2	5	24	0	62.3	66	62.3	10 ----	62.3	0	8	-8
A		6	0	0	59.5	66	59.5	10 ----	59.5	0	8	-8
	1	8	0	0	67.5	66	67.5	10 Snd Lvl	67.5	0	8	-8
C		10	14	0	64.8	66	64.8	10 ----	64.8	0	8	-8
B		13	14	0	64.5	66	64.5	10 ----	64.5	0	8	-8
E		14	14	0	52	66	52	10 ----	52	0	8	-8
F		15	14	0	56.3	66	56.3	10 ----	56.3	0	8	-8
	4	16	10	0	58.5	66	58.5	10 ----	58.5	0	8	-8
G		17	42	0	53.6	66	53.6	10 ----	53.6	0	8	-8
	5	19	0	0	68.1	66	68.1	10 Snd Lvl	68.1	0	8	-8
	6	20	0	0	61.1	66	61.1	10 ----	61.1	0	8	-8
	7	21	0	0	65.5	66	65.5	10 ----	65.5	0	8	-8
H		22	17	0	61	66	61	10 ----	61	0	8	-8
I		23	52	0	57.4	66	57.4	10 ----	57.4	0	8	-8
J		24	20	0	58.9	66	58.9	10 ----	58.9	0	8	-8
K		25	0	0	57.1	66	57.1	10 ----	57.1	0	8	-8
L		26	0	0	62.3	66	62.3	10 ----	62.3	0	8	-8

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	257	0	0	0
All Impacted	0	0	0	0
All that meet NR Goal	0	0	0	0

Attachment 9

Appendix B
Noise Modeling Files

[Appendix B is provided on the attached CD.]

Attachment 9

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