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SUMMARY

The Washington State Department of Transportation (WSDOT) is proposing to construct the Interstate 405 (I-405), NE 8th Street to State Route 520 (SR 520) Improvement Project to improve safety and reduce congestion in the vicinity of the I-405 and SR 520 interchange within the City of Bellevue. This discipline report evaluates the noise and vibration effects during project construction and operation. This report evaluates two alternatives: the Build Alternative and the No Build Alternative.

Study Approach

Noise levels were measured at 25 locations in the study area, during the loudest hours of the day when traffic volumes are high but not congested. These measurements were used to validate the existing conditions (year 2005) computer model generated with the Federal Highway Administration (FHWA) Traffic Noise Model (TNM) Version 2.5. WSDOT used the TNM to predict noise levels for Year 2030 of the No-Build and Build Alternative. The project team also used traffic volumes and vehicle mixes from the Transportation Discipline Report and relevant design files to develop the noise models for this project. The team compared the results of the No Build and Build Alternative models to the existing conditions model to determine project effects.

All noise sensitive locations within the study area are residential or parkland. Traffic noise levels at residences and parklands follow the noise abatement criterion (NAC) of 67dBA. The NAC at exterior areas of the one former hotel property is 72 dBA. The I-405 Team evaluated mitigation measures at receptors where noise levels were modeled to approach within 1 dBA of or to exceed the NAC. We used WSDOT feasibility and reasonability criteria to determine whether the reduction in traffic noise will be substantial enough to warrant the cost of barrier construction or replacement.

Because roadway traffic with rubber tires generates low levels of vibration, construction activities are the most likely cause of noticeable vibration. Typical vibration levels for various construction activities were evaluated, to determine whether they have any potential to damage structures along the I-405, NE 8th Street to SR 520 Improvement Project. Due to the

location of the construction and operation of the project in relation to the Overlake Hospital Medical Center (OHMC) and Group Health Cooperative (GHC) medical facilities, WSDOT evaluated the effects from construction and operation to these facilities.

Existing Conditions

Some study area locations currently approach, meet, or exceed the NAC for sensitive receptors. Locations that currently approach, meet, or exceed 67 dBA include approximately 107 residences and one former hotel. The hotel has already been acquired to build the NE 10th Street Project and will be demolished. Nineteen of the residences exceed the NAC because of noise from local traffic on 112th Avenue NE, NE 12th Street and/or Northup Way.

Three existing noise walls are currently located parallel to I-405 and SR 520 within the project limits. Existing retaining walls, limited jersey barriers, and topography shield some residential areas from freeway noise.

Project Effects

With the Build Alternative by the year 2030, noise levels in the study area will decrease by 1 dBA, stay the same, or increase up to 13 dBA depending upon the noise receptor location, terrain, and surrounding development.

With the Build Alternative, 30 residences will go from being below the NAC to being at or above the NAC. Added to the existing 107 residences that are at or above the NAC, this makes a total of the 137 residences predicted to experience noise levels at or above the NAC of 67 dBA set for residences in 2030. If this project is not built, 123 residences would approach, meet, or exceed the NAC until at least 2030.

Construction activities will generate noise during the construction period. Construction will usually be carried out in several reasonably discrete steps, each with its own mix of equipment and its own noise characteristics. Adverse effects may result from construction noise levels generated by heavy equipment, including heavy trucks, excavators, jackhammers, and pile drivers. However, these noises will be temporary and will only occur during the construction period.

During operation of this project, vibration levels will continue to be similar to those currently occurring in the study area.

During construction, most of the Overlake Hospital Medical Center (OHMC) and Group Health Cooperative (GHC) campus can be affected by vibratory roller operations. The OHMC campus will also be affected during demolition of the NE 12th Street Bridge and caisson drilling between NE 8th Street and NE 12th Street. No substantial unavoidable adverse vibratory effects will occur during construction.

Measures to Avoid or Minimize Effects

Noise barriers were evaluated for all areas where noise levels are predicted to approach, meet, or exceed the NAC. One replacement noise barrier, Noise Barrier R1, is recommended for the I-405, NE 8th Street to SR 520 Improvement Project. Noise Barrier R1 already exists and will be moved to a new location under the Build Alternative, due to realignment of the I-405 travel lanes and the I-405 northbound to SR 520 eastbound on-ramp. This relocated noise barrier will ensure that noise levels are below the NAC at nine receptors (representing 18 residences) that benefit from the existing noise barrier. No other noise barriers were determined to be reasonable and feasible.

Construction noise will be reduced by installing mufflers on engines, using quiet equipment and/or construction methods, minimizing operation time, and locating equipment far from sensitive receptors such as residences.

Mitigation will be provided to control construction-related effects from vibratory rollers and hoe ram vibration. Mitigation could include using static rollers rather than vibratory rollers during earthmoving and compaction activities or increasing the distance from the medical campus to where vibratory rollers can safely be used, and coordinating demolition of the NE 12th Street Bridge foundations around OHMC theater operation or magnetic resonance imaging (MRI) activity.

Unavoidable Adverse Effects

For the Build Alternative, noise levels will approach, meet, or exceed the NAC at 30 locations (representing 137 residences) without the recommended noise barrier replacement, Noise Barrier R1. Noise levels will approach, meet, or exceed the NAC at 21 locations (representing 119 residences) with the recommended replacement noise barrier. For 96 of these

residences, the noise effects will be below 75 dBA and not considered to be substantial.

Three receptors that represent 24 residences will experience Tier 2 substantial noise levels (between 75 and 79 dBA) under the Build Alternative. These 24 residences are represented by Modeled Sites 37A, 37B, and 37C and experience 75-dBA noise levels under existing conditions. Noise levels at these four residences will increase to 76 dBA under the No Build Alternative and 77 dBA under the Build Alternative at each modeled site. A noise barrier (Noise Barrier N3) was evaluated in this area but is not recommended because it does not meet WSDOT feasibility and reasonability criteria. This 1-dBA increase in noise levels will not be perceptible.

With appropriate mitigation to reduce construction noise, construction of the I-405, NE 8th Street to SR 520 Improvement Project will not cause any substantial unavoidable adverse noise effects. This is in accordance with FHWA guidance, which stipulates that temporary construction noise effects cannot be substantial.

No substantial unavoidable adverse vibratory effects will occur during project construction and operation.

ACRONYMS AND ABBREVIATIONS

Term	Meaning
ANSI	American National Standards Institute
CAD	computer-aided drafting
dB	decibel
dBA	decibels in the A-weighted scale
DOT	U.S. Department of Transportation
DvB	Vibration velocity in decibel
Ecology	Washington State Department of Ecology
EDNA	Environmental Designation for Noise Abatement
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
GHC	Group Health Cooperative
HOV	high-occupancy vehicle
Hz	hertz
I-405	Interstate 405
IES	Institute of Environmental Science
ISO	International Standards Organization
Ldn	day/night sound level
Leq	equivalent A-weighted sound level
Leq (h)	equivalent A-weighted sound level averaged hourly
Lmax	maximum sound level
Lmin	minimum sound level
Ln	*n* represents the percentage of time that the sound level *L* is exceeded
MRI	magnetic resonance imaging
NAC	noise abatement criteria
OHMC	Overlake Hospital Medical Center
RE	residential equivalency
SEL	sound exposure level
SR 520	State Route 520
TNM	traffic noise model
VC-A	vibration criteria curve A (2,000 micro-in/sec)
VC-B	vibration criteria curve B (1,000 micro-in/sec)

Term	Meaning
VC-C	vibration criteria curve C (500 micro-in/sec)
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation

GLOSSARY

Term	Meaning
A-weight	A standard frequency weighting that simulates how humans perceive sound (dBA).
ambient noise	The totality of noise associated with a given environment, encompassing sounds from many sources near and far.
calibration	Adjustment of the noise measurement system so the measured sound level agrees with a reference sound level.
calibration check	A check of a noise meter for variations between the measured sound level and a reference level; no adjustment is made to the noise monitoring system.
decibel (dB)	A logarithmic-based unit of measure of sound pressure.
duration	The length of time of an event.
energy average	The average of two or more acoustic energies expressed on a common decibel logarithmic scale.
equivalent sound level (Leq)	The equivalent steady-state sound level in A-weighted decibels for a stated period of time, which contains the same acoustic energy as the actual time-varying sound level for the same period of time.
hertz (Hz)	A unit of frequency measured in cycles per second.
Lmax	Maximum sound level, in decibels. This is the maximum value of the noise level that occurs during a single event.
Lmin	Minimum sound level, in decibels. This is the minimum value of the noise level that occurs during a single event.
Ln	The A-weighted sound level, in decibels, that is exceeded *n* percent of the time in a given interval. For example, L10 is the A-weighted sound level exceeded 10 percent of the time over the given interval (usually 1 hour).
logarithm	The exponent that indicates the power to which a number must be raised to produce a given number. For example: if $B^2 = N$, 2 is the logarithm of N (to the base B), or $10^2 = 100$, and the logarithm of 100 (to the base 10) = 2. Also abbreviated to "log."
noise level	The sound pressure level, measured using a meter with an "A" frequency weighting and reported as dBA.
peak	The maximum sound level during a given time interval when the normal frequency and time weighting is not used.

Term	Meaning
sound exposure	A measure of the total sound energy of the actual sound during a given time interval. Unlike the sound exposure level, it is not expressed in decibels, but in units of Pascal squared-seconds.
sound exposure level	The level of a steady 1-second-long sound that contains the same energy as the actual (varied) sound over the total measurement duration. It is expressed in decibels. Sound exposure level is related to Leq, but all the energy is compressed within a 1-second period, rather than being spread over a stated period of time.
sound pressure level or noise level	A noise measurement that uses an A-weighting to modify the frequency response of the measuring instrument, so that it more closely mimics the frequency characteristics of the human ear.
vibration	A series of motions, which can be described in terms of the displacement, velocity, or acceleration.

SECTION 1 INTRODUCTION

What are the primary features of the I-405, NE 8th Street to SR 520 Improvement Project?

The proposed I-405, NE 8th Street to SR 520 Improvement Project is part of the overall I-405 corridor program designed to improve safety, reduce congestion, and add capacity along the I-405 corridor. The I-405, NE 8th Street to SR 520 Improvement Project extends approximately 1.4 miles north along I-405, from south of NE 8th Street to the SR 520 interchange, and approximately 1.6 miles east along SR 520, from the I-405 interchange to east of 124th Avenue NE.

The primary features of the I-405, NE 8th Street to SR 520 Improvement Project are presented below:

- Construct grade-separated ramps (referred to as braids) on northbound I-405 to separate the I-405 traffic exiting to SR 520 from traffic entering I-405 at NE 8th Street in downtown Bellevue;
- Construct a new three-lane eastbound collector-distributor lane on SR 520 to separate the on- and off-ramp traffic between I-405 and 124th Avenue NE;
- Reconstruct the NE 12th Street bridge over I-405;
- Construct an on-ramp from the NE 10th Street bridge (built prior to this project) to SR 520; and
- Reconfigure the ramps from SR 520 to southbound I-405.

What is the purpose of this report?

The purpose of this Noise and Vibration Discipline Report is to assess the potential noise and vibration effects of the I-405, NE 8th Street to SR 520 Improvement Project. This report also evaluates mitigation options to minimize the project's effects during its construction and operation.

What topics are included in noise?

The general topics included in this report begin with the basic principals of noise and vibration and how these environmental elements relate to the project. The report also presents the existing noise and vibration levels, and discusses project effects and measures to avoid or minimize noise and vibration effects.

Why do we consider noise as we plan this project?

Are you new to reading noise reports?

Environmental disciplines generally have vocabularies all their own. We encourage readers who are new to noise-related terminology to invest a few minutes now reviewing the Glossary and the Acronyms and Abbreviations list in the preceding sections. An understanding of the A-weighted decibel (dBA) and the equivalent A-weighted sound level (Leq) will be especially helpful in following our analysis of this important environmental element.

Sound is an element of daily life that when perceived as unpleasant, unwanted, or disturbingly loud, is called *noise*. The I-405 Team considered the effects of noise in order to understand the potential effect of this project's traffic and construction noise on public health and welfare.

Federal regulations (23 CFR 772) and the Washington State Department of Transportation (WSDOT)'s noise abatement criteria (NAC) require a noise analysis for projects that involve construction of a new highway, significantly change the horizontal or vertical alignment , or increase the number of through traffic lanes on an existing highway.

This proposed project will create additional travel lanes on I-405. Because congestion will be reduced, higher speeds will result during peak hours. This could increase noise levels at sensitive receptors in the study area, such as residences and parks. This noise analysis will determine whether mitigation measures such as noise barriers are warranted to buffer noise-sensitive areas from the roadway.

Because roadway traffic with rubber tires generates low levels of vibration, construction activities are the most likely cause of noticeable vibration. Typical vibration levels for various construction activities were generally evaluated, to determine whether they have any potential to damage structures along the I-405, NE 8th Street to SR 520 Improvement Project. The Overlake Hospital Medical Center (OHMC) and Group Health Cooperative (GHC) medical facilities were specifically evaluated for vibration effects from construction and future operation of the project.

What are the key messages from this report?

Under existing conditions, some study area locations already exceed the NAC, including approximately 107 residences and one former hotel. If this project is built, noise levels are expected to either stay the same, decrease by as much as 1 dBA, or increase by up to 13 dBA by the year 2030, depending on the receptor's location within the project study area. Three sensitive receptors represent 24 residences that already experience substantial noise effect levels (75 to 79 dBA) under

existing conditions, and will continue to do so under the Build Alternative.

If this project is built, 30 residences will go from being below the NAC to approaching (within 1 dBA of the NAC), meeting, or exceeding the NAC. When added to the approximately 107 residences that already approach, meet, or exceed the NAC (the hotel will already be removed from the area to build the NE 10th Street Bridge Crossing Project), a total equivalent of 137 residences are predicted to experience noise levels that approach, meet, or exceed the NAC of 67 dBA for residences in 2030.

During operation, vibration levels will continue to be similar to those currently occurring in the study area. During construction, various activities will create vibration. The potential for minor damage to fragile structures is limited to approximately 25 feet from most construction activities and 100 feet from pile driving. People will feel minor ground movement at greater distances. Since the construction activities are temporary and there is negligible potential for damage to fragile structures, this will not constitute a negative effect.

During construction, most of the OHMC and GHC campus can be affected by vibratory roller operations if the vibratory rollers are used within a certain distance of the campus. The OHMC campus will also be affected during demolition of the NE 12th Street Bridge and caisson drilling between NE 8th Street and NE 12th Street. The medical facilities that will be most affected are parts of the OHMC outpatient surgery at the ground floor of the existing Northwest Parking Garage, and the patient surgery area on the second floor of the existing Hospital Surgical Pavilion closest to I-405. GHC medical facilities will not be affected by these construction activities because of the distance from the proposed construction activities. All other construction equipment and activities will generate lower levels of vibration.

What measures are proposed to avoid or reduce effects?

One replacement noise barrier, Noise Barrier R1, is recommended for the I-405, NE 8th Street to SR 520 Improvement Project. Noise Barrier R1 already exists and will be relocated under the Build Alternative, due to realignment of

the I-405 travel lanes and the I-405 northbound to SR 520 eastbound on-ramp. This relocated noise barrier will ensure that noise levels are below the NAC at nine receptors (representing 18 residences) that benefit from the existing noise barrier.

Noise levels at 21 locations (representing 119 residences throughout the entire study area) will continue to approach, meet, or exceed the NAC with the noise abatement measures proposed for this project.

What will happen if we adopt the No Build Alternative?

If this project is not built, 16 residences will go from being below the NAC to approaching, meeting, or exceeding the NAC. Added to the 107 residences that already approach, meet, or exceed the NAC, a total of 123 residences are predicted to experience noise levels that approach, meet, or exceed the NAC of 67 dBA for residences in 2030. No noise abatement measures are proposed as part of the No Build Alternative.

SECTION 2 PROJECT DESCRIPTION

What is the intent of the I-405, NE 8th Street to SR 520 Improvement Project?

WSDOT is proposing to construct the I-405, NE 8th Street to SR 520 Improvement Project to improve safety and reduce congestion in the vicinity of the I-405 and SR 520 interchange within the city of Bellevue. The improvements will benefit the public by:

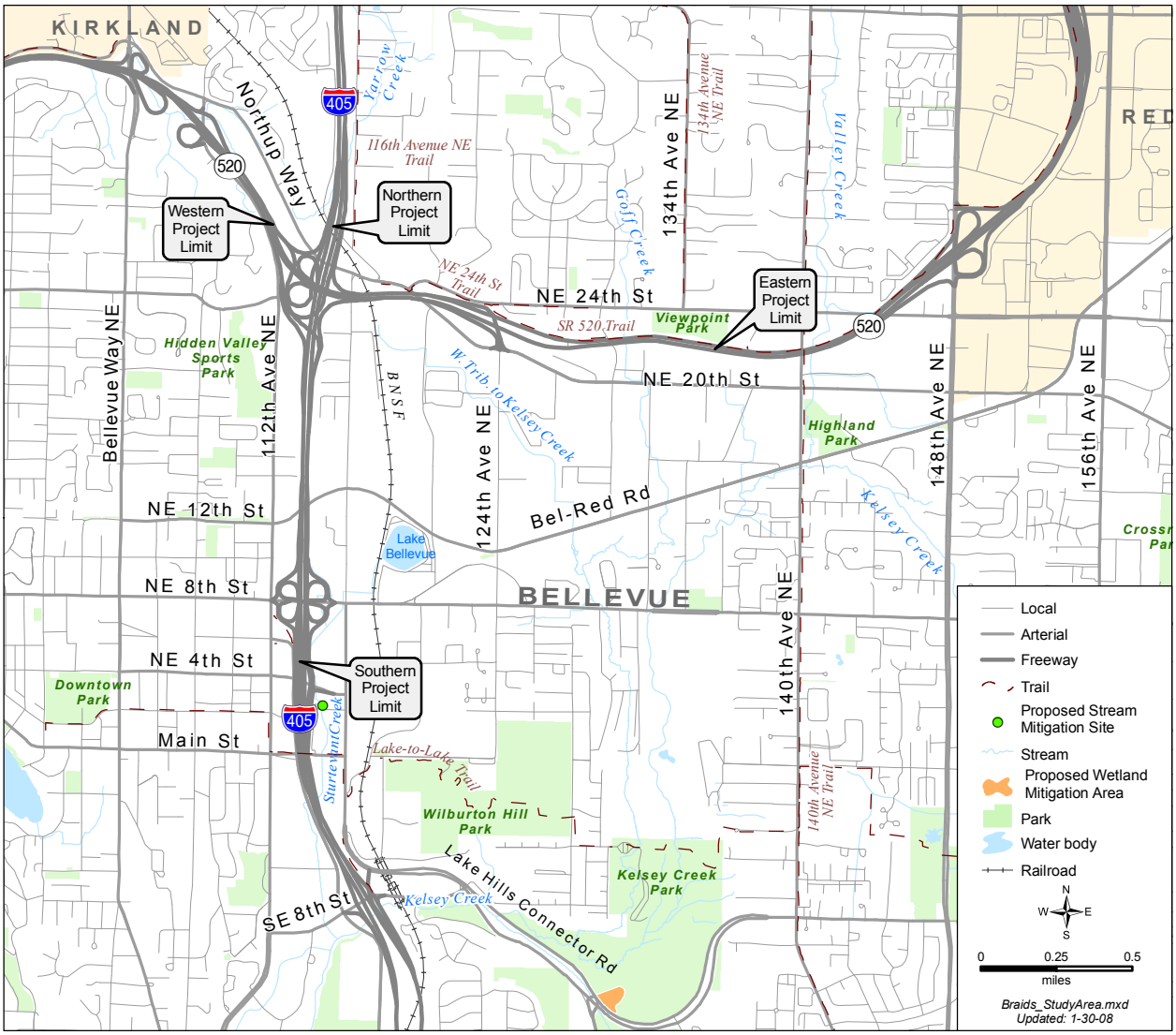
- Reducing congestion for the public and freight vehicles;
- Improving safety;
- Improving access and circulation to and from local streets; and
- Providing opportunities for environmental improvements.

The I-405, NE 8th Street to SR 520 Improvement Project extends approximately 1.5 miles north along I-405, from south of NE 8th Street to the SR 520 interchange, and approximately 1.6 miles east along SR 520, from the I-405 interchange to east of 134th Avenue NE (Exhibit 2-1).

What are the details of the I-405, NE 8th Street to SR 520 Improvement Project?

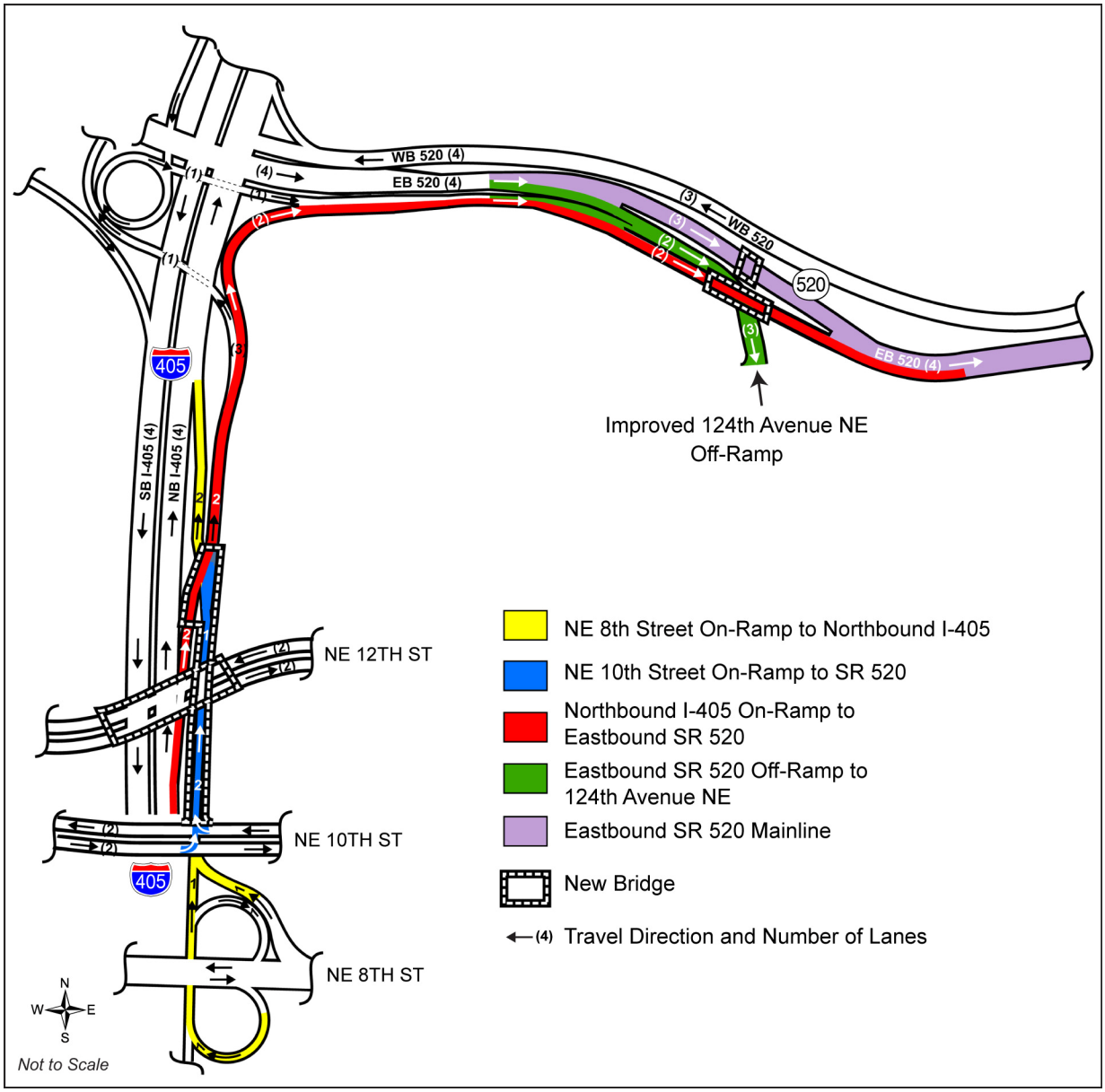
The proposed I-405, NE 8th Street to SR 520 Improvement Project is part of the overall I-405 Corridor Program Master Plan designed to improve safety and reduce congestion along the I-405 corridor. The I-405, NE 8th Street to SR 520 Improvement Project will improve safety and mobility by constructing grade-separated ramps on northbound I-405 to separate the I-405 traffic exiting to SR 520 from traffic entering I-405 at NE 8th Street in downtown Bellevue. On SR 520, a new eastbound collector-distributor lane will also be constructed to separate the on- and off-ramp traffic between I-405 and 124th Avenue NE (Exhibit 2-2). In addition, the ramps from SR 520 to southbound I-405 will be reconfigured to improve traffic flow.

Exhibit 2-1: Project Location and Vicinity



This discipline report analyzes two alternatives, the Build Alternative and the No Build Alternative. The proposed project improvements for the Build Alternative, from south to north on I-405, and west to east on SR 520, are described below. The No Build Alternative is described at the end of this section.

Exhibit 2-2: Proposed Lane Configuration on Northbound I-405 to Eastbound SR 520



Northbound I-405 to Eastbound SR 520 Improvements

- Reconfigure the existing northbound NE 4th Street on-ramp to become an auxiliary lane that exits to SR 520 and northbound I-405 as part of a two-lane exit ramp. See Exhibit 2-3.
- Reconstruct portions of the NE 8th Street on- and off-ramps to and from northbound I-405. The on-ramp will be reconstructed at a lower grade than the I-405 mainline.

What is an auxiliary lane?

An auxiliary lane is a lane added between interchanges—from one on-ramp to the next off-ramp. It is dedicated to traffic entering and leaving a freeway and provides motorists with more time and extra room to accelerate or decelerate and merge when getting on and off the freeway.

- Rebuild the NE 12th Street bridge crossing over I-405 to accommodate the new ramps.
- Construct a northbound on-ramp to SR 520 from a new NE 10th Street bridge crossing; the bridge crossing will be constructed as part of a separate project prior to constructing the on-ramp.
- Construct grade-separated ramps to divide traffic entering northbound I-405 from NE 8th Street and traffic exiting I-405 to SR 520.
- Construct grade-separated ramps to divide traffic entering eastbound SR 520 from northbound I-405 and traffic exiting eastbound SR 520 to 124th Avenue NE.
- Shift eastbound SR 520 mainline travel lanes toward the median.
- Extend the ramp from northbound I-405 to eastbound SR 520 on a collector-distributor system through the 124th Avenue NE interchange to merge with the existing eastbound SR 520 mainline just east of 134th Avenue NE.
- Reconstruct the 124th Avenue NE interchange off-ramp.
- Relocate an existing noise barrier. The new barrier will be approximately 1,585 feet long and 20 feet high.
- Construct several retaining walls needed to allow for the proposed widening of I-405.

What is a collector-distributor system?

Collector-distributor lanes are freeway lanes serving single or multiple interchanges that are physically separated from general freeway lanes. The purpose of collector-distributor lanes is to separate the traffic entering and exiting the freeway from the through traffic.

In the simplest form, all ramps that would normally touch the freeway are instead shifted outwards to the collector distributor lanes. There is still weaving, but it is no longer on the main lanes.

SR 520 to Southbound I-405 Improvements

- Reconfigure the ramps from SR 520 to southbound I-405 to improve traffic flow. The westbound SR 520 to southbound I-405 ramp will become a dedicated auxiliary lane, and on-ramp traffic will no longer be required to immediately merge with southbound I-405 mainline traffic. The eastbound SR 520 to southbound I-405 ramp will merge with the dedicated auxiliary lane.

Southbound I-405 to SR 520 Improvements

- Realign the southbound I-405 to eastbound SR 520 loop ramp.
- Realign eastbound SR 520 to match the proposed improvements.

Exhibit 2-3: Project Features - Sheet 1 of 6

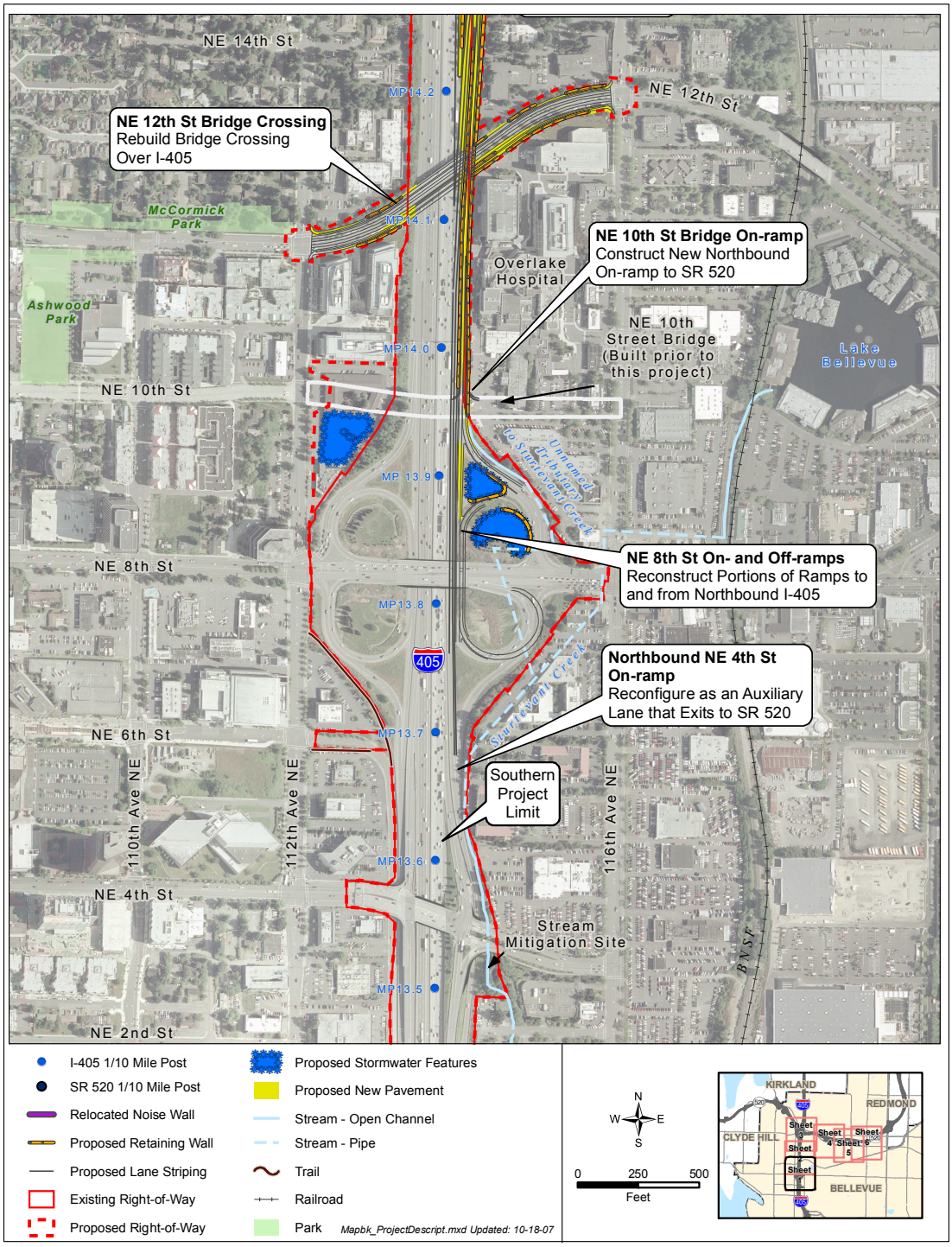
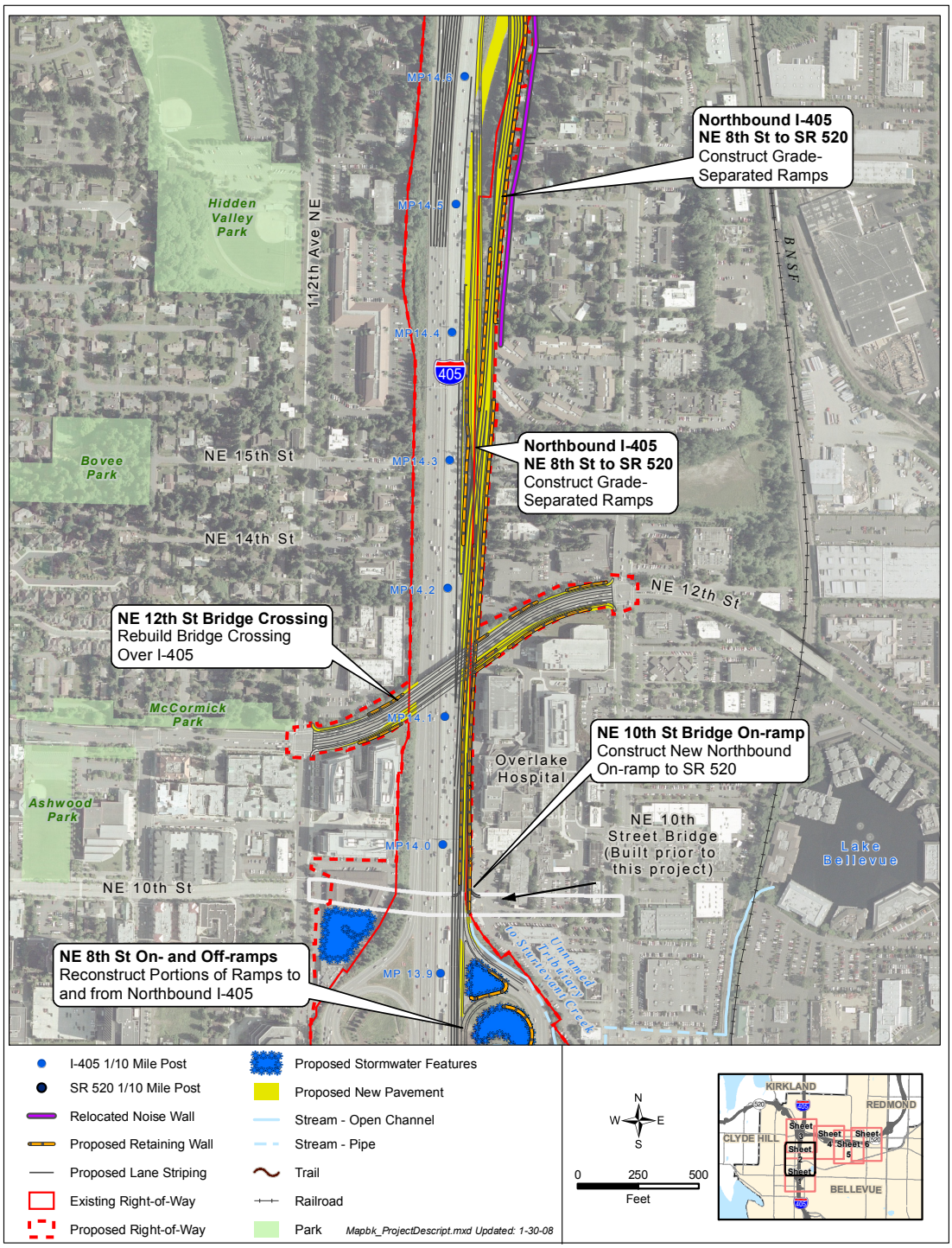



Exhibit 2-3: Project Features - Sheet 2 of 6