

Salmon Creek Interchange Project Environmental Assessment

Final
Noise Discipline Report
May 2009



Prepared for:

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and

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The final discipline reports for the Salmon Creek Interchange Project were completed in April and May 2007. These reports were reevaluated in November 2008. The data in these reports is based on the project's level of design at that time. Since the completion of the discipline reports, the project design has progressed, which has resulted in slight modifications to some analysis contained in the reports. The most current data and analysis was used to complete the environmental assessment (EA) to evaluate the project's effects. Therefore, some data and analysis presented in the EA may differ from what was presented in the discipline reports.

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LIST OF ACRONYMS

dB	decibel
dBA	A-weighted decibel scale
FHWA	Federal Highway Administration
Leq	equivalent sound level
mph	miles per hour
MSE	mechanically stabilized earth
NAC	noise abatement criteria
NB	northbound
NEPA	National Environmental Policy Act
PGIS	pollution-generating impervious surface
PGPS	pollution-generating pervious surface
ROW	right-of-way
RTC	Regional Transportation Council
TNM	Traffic Noise Model
WSDOT	Washington State Department of Transportation
WDOE	Washington State Department of Ecology
WSU	Washington State University

SUMMARY

How was noise evaluated in the project area?

Existing ambient noise levels in the project area were monitored using a Larson-Davis Model 820 sound level meter. Concurrent traffic counts on nearby roadways were taken during noise measurements for use in validating the traffic noise prediction model. The Federal Highway Administration (FHWA) Traffic Noise Model (TNM) was then used to predict existing condition and future-year (2030) build condition noise levels using traffic volumes from the traffic study prepared for the project.

Noise effects were identified using the criteria and thresholds specified in the Washington State Department of Transportation's (WSDOT's) Traffic Noise Analysis and Abatement Policy and Procedures (WSDOT, 2006a).

Following the effect analysis, mitigation measures for reducing noise effects were identified and evaluated using WSDOT's guidelines for determining feasibility, reasonableness, and cost effectiveness.

How much noise currently exists in the project area?

The existing noise environment is dominated by traffic, especially along Interstate 205 (I-205) and Interstate 5 (I-5). Existing noise levels along surface streets such as NE Tenney Road, NE 10th Avenue and NE 134th Street are lower because of reduced traffic volumes and lower speed limits. Noise effects under the existing condition were predicted at residential developments adjacent to the interstate system, especially in the vicinity of NE 149th Street to NE 179th Street, on the east side of I-5.

At first-row residences nearest to I-205 and I-5, existing noise levels ranged from 66 to 80 dBA depending on proximity to the freeway. Noise levels at a number of residences in these areas exceed the WSDOT impact threshold under the existing conditions. At residential locations next to collectors, such as NE 10th Avenue, and arterials, such as NE 139th Street, existing noise levels were lower (ranging from 52 to 67 dBA). There were few exceedances of the WSDOT impact threshold at residences next to arterials under the existing condition.

How would construction activities affect noise levels?

Construction activities would increase noise in the immediate vicinity of the construction area. Depending on the nature of the construction activity, equipment operations can vary from intermittent to fairly continuous. Locations within approximately 1,900 feet of a construction site could experience occasional noise levels greater than 60 dBA. Areas within approximately 750 feet of a construction site could experience episodes of noise levels greater than 70 dBA. Such episodes of high noise levels may occur during daytime or nighttime hours due to restrictions on closures of I-5 and I-205 to complete necessary construction work and may result in noise effects when construction activities are located directly adjacent to sensitive noise receptors (such as individual residences).

How would noise be affected if the project were not constructed?

If the project were not constructed, noise levels in the future would increase as traffic volumes increased. In general, noise levels would increase by approximately 1 to 4 dBA depending on location and the increase in traffic volumes.

What measures are proposed to avoid or minimize effects to noise during construction?

To reduce temporary noise effects associated with construction, contractors would be required to comply with all state and local regulations relating to construction noise. Some construction activities, such as paving and bridge demolition and construction, are anticipated to occur during nighttime hours to minimize effects to the traveling public and to increase safety. Nighttime construction activities may exceed the maximum permissible noise levels as defined in WAC 173-60-040. To address this, the project may require the use of a noise variance from WAC 173-60-040 maximum permissible environmental noise levels. The variance would be needed for more than a 30 day period. Additional measures could be incorporated into contract specifications to help reduce the effects of construction noise.

What measures are proposed to avoid or minimize effects during operation?

Sound walls were evaluated for noise mitigation and were recommended at four locations in the project study area:

- One sound barrier adjacent to the residential development at NE 143rd Street near the southbound I-5 off-ramp to southbound I-205.
- Two sound barriers adjacent to the residential development near NE 149th Street on the east side of I-5.
- One sound barrier adjacent to the residential developments between NE 173rd Street and NE 165th Street on the east side of I-5.

1.0 INTRODUCTION

Traffic noise effects associated with construction of the Salmon Creek Interchange Project were evaluated using noise models and methodologies approved by the Federal Highway Administration (FHWA) and the Washington State Department of Transportation (WSDOT). Noise effects were identified at residential and commercial locations within approximately 500 feet of the proposed project improvements. Where appropriate, sound walls or other abatement measures were evaluated to mitigate noise effects, and recommendations were made regarding the construction of sound walls.

1.1 Project Vicinity

The project is located north of Vancouver, Washington in unincorporated Clark County (Exhibit 1). The freeway system in the area includes I-205, which splits south from I-5 just north of NE 139th Street. I-205 extends southeast through Clark County and crosses over the Columbia River into Oregon near the Portland International Airport. I-205 continues south and rejoins I-5 south of Portland, Oregon. The I-5 corridor extends south into Vancouver, Washington and across the Columbia River, through downtown Portland and across the Willamette River.

1.2 Project Study Area

The Salmon Creek Interchange Project study area (see Exhibit 2) is bounded by NE 129th Street to the south, the NE 179th Interchange of I-5 to the north, NW 2nd Court to the west and NE 29th Avenue to the east. The project study area encompasses two interstate highway systems (I-5 and I-205). Land uses within the project study area include residential (both single family homes and multifamily complexes), commercial and retail services, light industrial or manufacturing, and the Legacy Hospital on the east side of I-205.

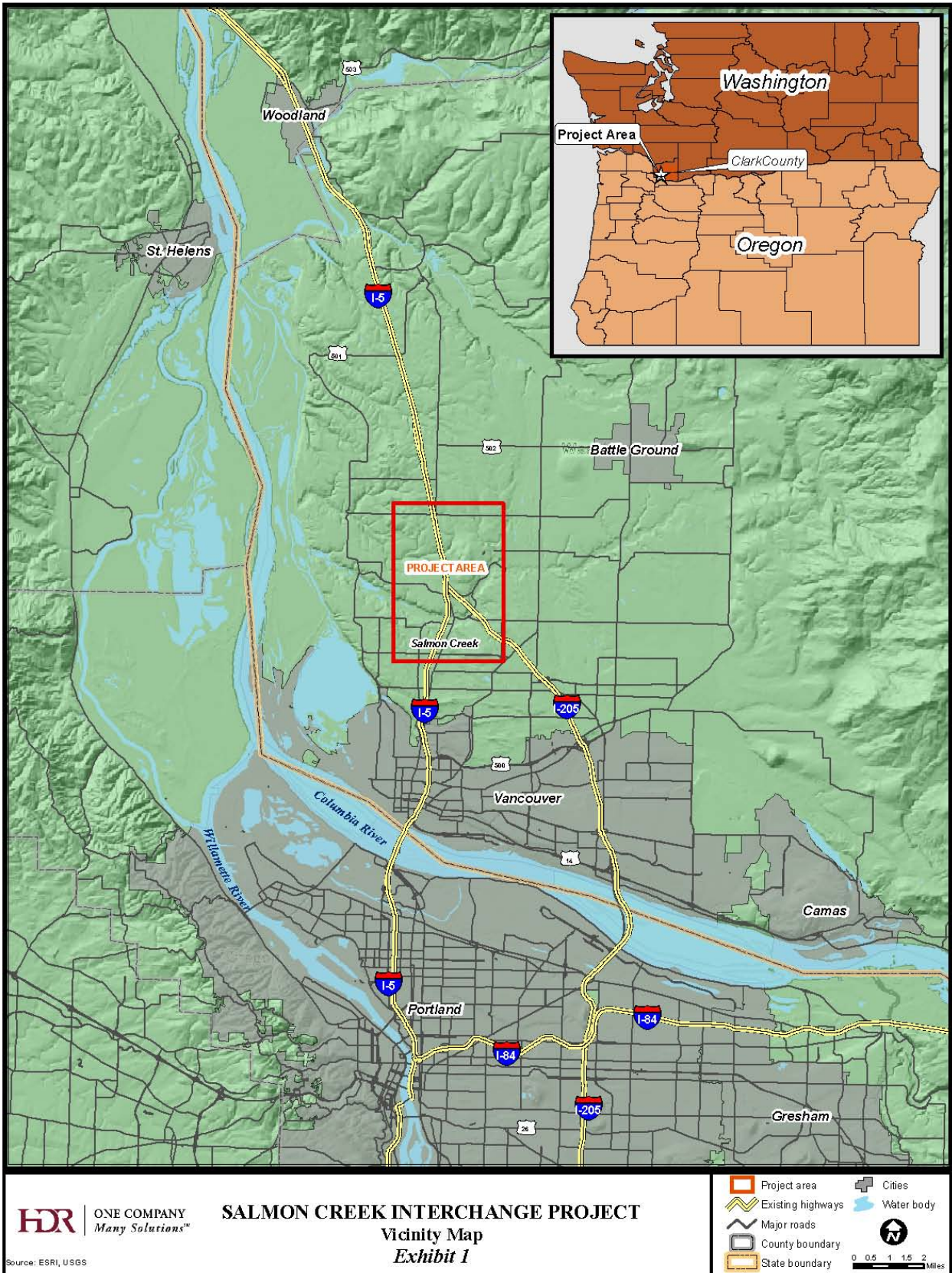
1.3 Project Limits

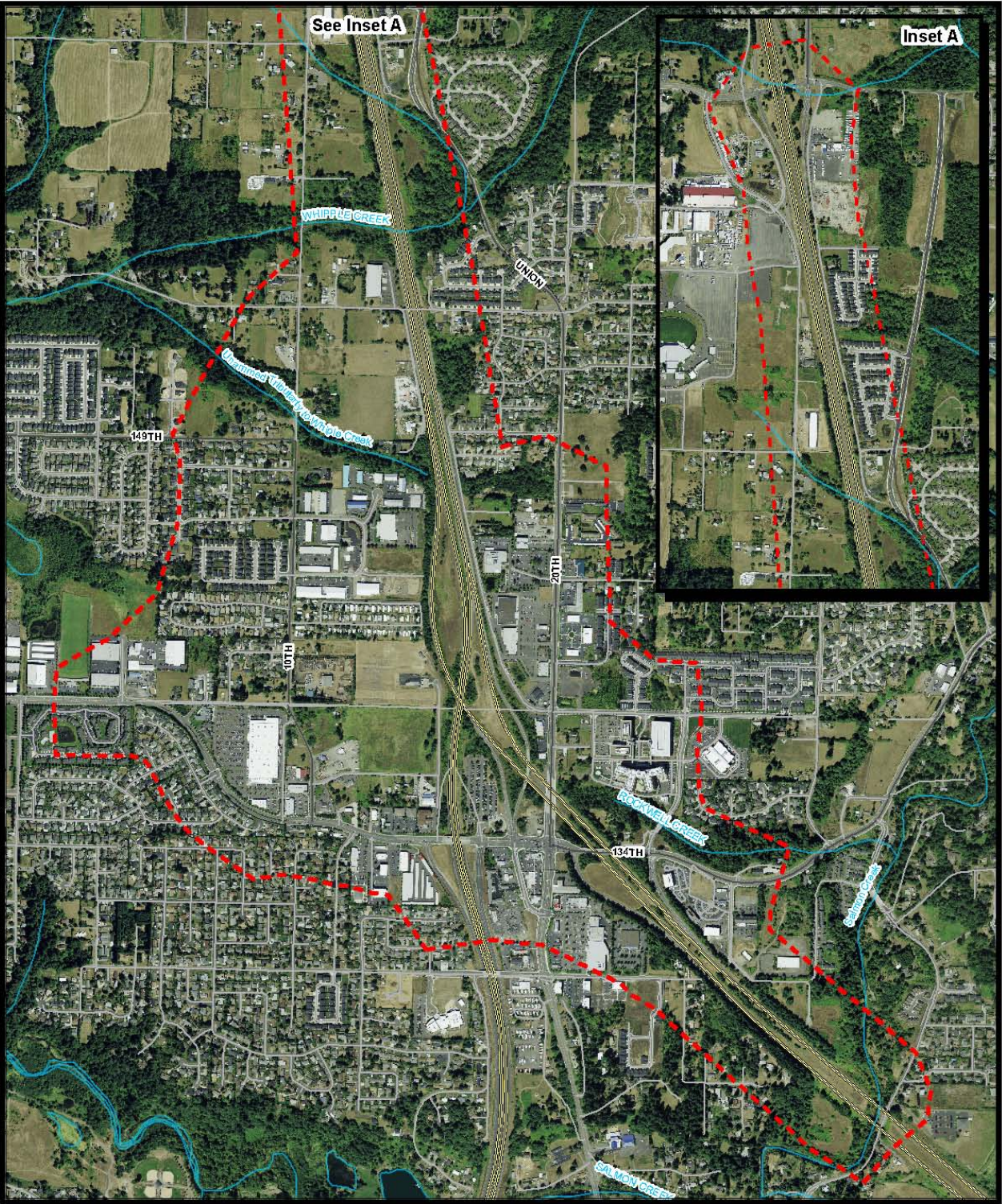
The northernmost limit of the project is located approximately at I-5 milepost 10.6. The southernmost limit of the project is located approximately at I-205 milepost 36.1. The latitude and longitude of the approximate center of the project is 22 39' 23 W and 45 43' 50 N respectively. The project is located in Township 3N, Range 1E, and Sections 14, 15, 22, 23, 24, 25, 26, and 27.

1.4 Existing Roadway Configuration

The existing Salmon Creek Interchange at NE 134th Street is an arterial interchange located at the junction of I-5 and I-205. Full movements are provided to and from NE 134th Street and I-5 and I-205. The interchange is an integral part of several transportation systems, including the I-5 and I-205 corridors. These corridors are heavily utilized by motorists and serve as major freight and regional commute routes. The existing Salmon Creek Interchange serves a large portion of central and west Clark County, including the north Salmon Creek, Mount Vista, and north Hazel Dell areas, as well as the Vancouver campus of Washington State University (WSU).

NE 134th Street is a multilane arterial roadway with numerous at-grade signalized intersections spaced in close proximity to each other.





 ONE COMPANY <i>Many SolutionsSM</i>	SALMON CREEK INTERCHANGE PROJECT Project Study Area <i>Exhibit 2</i>	 Project Study Area	 Streams
		 Highway	 Major Road
<small>Source: WSDOT, Clark County</small>		 Minor Road	

1.5 The Proposed Build Alternative

The Salmon Creek Interchange Project, also referred to as the Proposed Build Alternative, is proposed to be built in two phases to allow the project to be built as funding becomes available. It is anticipated that funding for Phase 1 of the Salmon Creek Interchange project would come from a combination of state and local transportation funds and federal grants. Phase 2 is unfunded; however, Phase 2 improvements are implicit in the County's Capital Facilities Plan and State of Washington Transportation Plan.

The time estimated for Phase 1 construction completion is approximately 3.5 years (2013). Phase 2 construction is expected to begin in 2015 and last approximately 2.5 years (2017), provided funding becomes available. The following subsections describe Phase 1 and Phase 2 improvements. Exhibit 3 provides a map of the proposed Phase 1 and Phase 2 improvements.

1.5.1 Phase 1 Improvements

1.5.1.1 Interstate Improvements

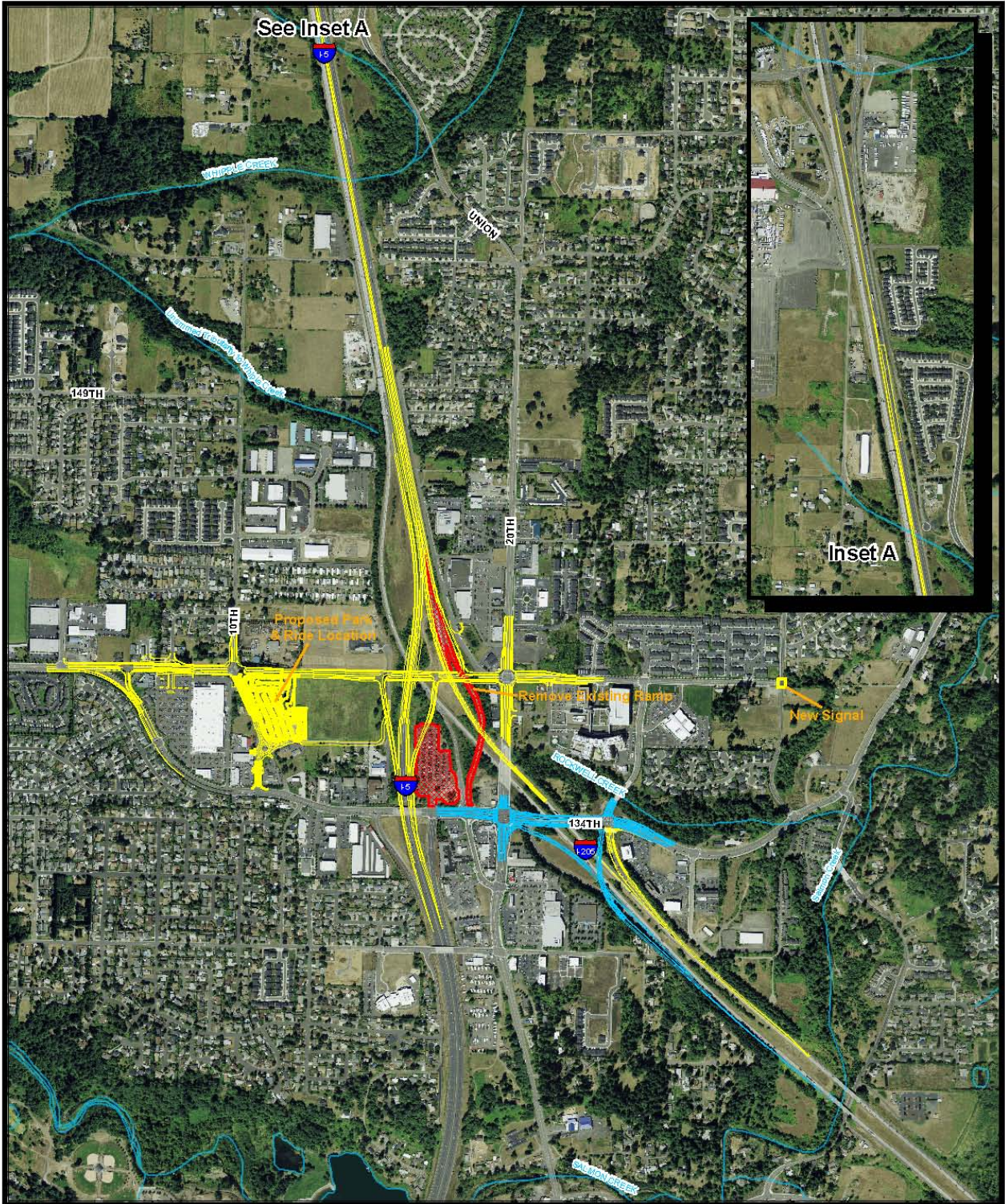
Phase 1 improvements to I-5 and I-205 would include the following components:

- A new interchange at NE 139th Street and I-5 would be constructed over I-5 and I-205.
- The on-ramp from NE 134th Street to I-5/I-205 northbound would be removed and relocated to NE 139th Street. The existing I-205 southbound off-ramp and northbound Highway 99 legs would remain. The NE 134th Street westbound right-turn lane at the intersection would be removed as the northbound on-ramp would be demolished.
- The existing I-205 northbound off-ramp to NE 134th Street would be widened to provide a two-lane off-ramp with an exit only auxiliary lane on I-205 northbound.
- A new I-5 northbound auxiliary lane from the I-205 merge area to an auxiliary lane approaching the NE 179th Street interchange would be constructed in the existing median of I-5.
- A new I-5 bridge over I-205 southbound would be constructed and would be wide enough to accommodate the expansion of I-5 to three lanes in both directions in the future.
- Northbound I-205 would be realigned to the west at NE 139th Street to accommodate vertical clearance requirements with NE 139th Street.

1.5.1.2 Local Roadway Improvements

Improvements to the local roadway system associated with Phase 1 of the project would include:

- The C-Tran Park-and-Ride would be relocated from NE 134th Street to a new location near the SE corner of NE 139th Street and NE 10th Avenue. Riders would access the Park-and-Ride from NE 136th Street. Buses would access the Park-and-Ride from NE 139th Street. The associated frontage along NE 136th Street would be improved. The signal at the existing Park-and-Ride location across from the I-5 northbound off-ramp at NE 134th Street would be modified.



 ONE COMPANY <i>Many Solutions™</i>	SALMON CREEK INTERCHANGE PROJECT Proposed Build Alternative <i>Exhibit 3</i>	 Phase 1	 Streams
		 Phase 2	 Removal
<small>Source: WSDOT/Dark County Public Works September 2008</small>			

- NE 139th Street would be widened to a minimum of two lanes in each direction with bike lanes, a sidewalk on the south side, and a median from NE Tenney Road to the main driveway entrance of Legacy Hospital (west of 23rd Avenue). A new segment of NE 139th Street from NE 10th Avenue to NE 20th Avenue, which passes over I-5 and I-205, would be constructed on walls and structure and contain the necessary channelization. New signals would be installed on NE 139th Street at the intersections of NE Tenney Road, NE 10th Avenue, and NE 29th Avenue.
- NE 20th Avenue and NE 139th Street would be redesigned with double left turn lanes and right turn lanes in all directions. The existing traffic signal would be replaced to accommodate the additional lanes at this intersection.
- NE 139th Street and NE Tenney Road would be redesigned to a signalized modified “T” configuration with NE 139th Street being the main through route. The eastbound NE 139th Street traffic would have a two-lane slip lane to NE Tenney Road.
- NE 16th Avenue would be realigned to the west to accommodate the I-5 southbound on-ramp from NE 139th Street.
- Access from NE 17th Avenue to NE 139th Street would be closed with the construction of the onramp from NE 139th Street to I-205 northbound. Access to the commercial property between NE 17th Avenue and NE 20th Avenue would be from NE 20th Avenue. Residential traffic would use NE 150th Street to travel from NE 20th Avenue to NE 17th Avenue.
- NE 10th Avenue would be widened from NE 134th Street to NE 141st Street to one lane in each direction bike lanes, sidewalks, and turn lanes at the signalized intersection of NE 10th Avenue and NE 139th Street. A roundabout would be at the intersection of NE 10th Avenue and NE 136th Street. Modifications would be made to the curb return from NE 134th Street westbound to NE 10th Avenue northbound.

1.5.2 Phase 2 Improvements

1.5.2.1 Interchange Improvements

A new southbound on-ramp from NE 134th Street at NE 23rd Avenue to I-205 southbound and a northbound NE 20th Ave to southbound I-205 slip ramp would be constructed as part of the Phase 2 improvements. A slip ramp is a ramp where vehicles do not have to stop or yield to enter the ramp (i.e., No signal, stop sign, or yield sign is located at the ramp/cross-road intersection). The existing slip ramp I-205 southbound from NE 134th Street would be removed.

1.5.2.2 Local Roadway Improvements

Phase 2 improvements to the local roadway system would include the following:

- NE 134th Street from NE 20th Avenue to NE 23rd Avenue would be widened.
- The NE 134th Street/NE 20th Avenue intersection would be improved.

1.5.3 Proposed Build Alternative Stormwater Management

The Salmon Creek Interchange Project would create approximately 23.5 acres of new pollution-generating impervious surface (PGIS). Stormwater runoff from the new impervious surface or an equivalent area would receive water quality treatment and flow control. The project would also retrofit approximately 26 acres of existing PGIS for stormwater treatment within the project area and remove approximately 9 acres of existing PGIS. Proposed stormwater treatment facilities would be constructed in conjunction with interchange and local roadway improvements associated with Phase 1 and Phase 2.

Stormwater treatment facilities would include ecology embankments, detention facilities, and combined treatment wetland/detention facilities. Stormwater flow control and quality treatment would be provided according to WSDOT's 2008 Highway Runoff Manual (HRM), which has been deemed equivalent to the revised 2005 Stormwater Management Manual for Western Washington (Washington State Department of Ecology [WDOE], 2005). Additional design references and guidelines would be used as they apply for local jurisdictional requirements, particularly those guidelines established by Clark County.

The proposed storm conveyance system located within the WSDOT right-of-way (ROW) would continue to utilize grass-lined ditches, pipes, overland flow, and culverts to convey stormwater runoff toward treatment facilities prior to discharging to surface water features (Whipple Creek, Salmon Creek, and Rockwell Creek) through existing outfalls. No new outfalls to these existing surface water features are anticipated at this time.

The proposed stormwater conveyance system located outside of WSDOT ROW (i.e., Clark County jurisdiction) would consist of closed pipe systems, culverts, ditches, swales, and sheet flow.

1.6 The No Build Alternative

The No Build Alternative is defined as actions that would occur should the Proposed Build Alternative not occur. These are conditions that currently exist, as well as programmed and funded projects within the project study area (Exhibit 2). The No Build Alternative includes ongoing routine maintenance and short term minor construction necessary for continued operation of existing WSDOT and Clark County transportation facilities and minor safety improvements, as required, within the project study area.

1.7 Foreseeable Projects

A foreseeable project includes past, present, or other reasonably foreseeable funded projects within the project study area and funded or unfunded projects adjacent to the project study area that, together with the proposed project, may have a cumulative effect on the environment. These include:

- Widening of I-5 to three through traffic lanes in each direction from NE 134th Street to I-205's merge.
- Auxiliary lanes on I-5 between the I-205 merge and NE 179th Street, and between NE 179th Street and SR 502/I-5 interchange
- Widening of I-205 to three traffic lanes in each direction south of NE 134th Street.
- Completing the I-5/139th Street "diamond interchange" by moving the current I-205 southbound off-ramp to 134th Street over to I-5 and having it intersect NE 139th

Street at the same location as the southbound on-ramp to I-5, and realigning the northbound on-ramp to I-5/I-205 to opposite the northbound off-ramp from I-5.

- Widening the Phase 1 proposed northbound off-ramp to 139th Street to three lanes: two left-turn lanes, and one right-turn lane.
- NE Hwy 99, 119th Street from NE 122nd Street, Bridge Replacement (project received bridge replacement funding and was completed in late summer 2008).
- Upgrades to existing traffic signals and signal coordination (equipment upgrades and/or signal interconnections) along NE/NW 139th Street and Skyview High School, NW 2nd Avenue, NE 3rd Avenue, NE 20th Avenue, and NE 23rd Avenue; Tenney Road at NE 136th Street/Fred Meyer and at NE 10th Avenue; NE 134th Street at NE 27th Avenue, NE 29th Avenue, and NE Salmon Creek Avenue; Highway 99/NE 20th Avenue at Safeway; and Highway 99 at NE 129th Street.
- New signals are anticipated to be installed at the following locations prior to Phase 1: NW 21st Avenue at NW Bliss Road/Hathaway, NW 139th Street at NW 11th Avenue, NW Bliss Road at NW 36th Avenue, existing WSU entrance and Salmon Creek Avenue, and the proposed new WSU entrance onto Salmon Creek Avenue.
- I-205–Mill Plain Exit–112th Connector: This project would provide a direct connection to NE 112th Avenue from the off-ramp of northbound I-205 to westbound Mill Plain Boulevard. The addition to the existing northbound I-205 off-ramp to westbound Mill Plain Boulevard would give drivers a direct connection to NE 112th Avenue, completely bypassing Mill Plain Boulevard. This project is now under construction with an expected completion date of late 2009.
- I-205–Mill Plain Interchange to NE 18th Street: Stage 1 would construct a segment of a new off-ramp that would eventually connect I-205 to NE 18th Street, and would be included with the construction of the I-205–Mill Plain–112th Connector project, which began construction in June 2008. Stage 2 would construct a partial interchange at I-205/NE 18th Street, and would include a system of grade-separated on- and off-ramps between Mill Plain Boulevard and NE 18th Street.
- I-5–SR 501 Ridgefield Replacement Interchange: This project would improve safety and mobility by replacing the existing I-5 interchange at SR 501 in Ridgefield, widening SR 501 to two lanes in each direction and adding new turn lanes at the interchange, making improvements to the SR 501/56th Place and Pioneer Street/65th Avenue intersections, and adding bike lanes and sidewalks for pedestrian travel. Project design, environmental analysis and right of way acquisition would be complete in 2010.
- SR 502–Widening from I-5 to Battle Ground: This project would widen SR 502 from two to four lanes from I-5 east into the city of Battle Ground. Construction is currently scheduled to begin in 2012.
- I-5/99th C-TRAN Park-and Ride: completed in late 2007.
- Completion of the Pioneer Street extension from 65th Avenue in Ridgefield to NE 10th Avenue (also known as 85th Avenue in Ridgefield; completion expected 2012).
- Widening of 10th Avenue between NE 141st Street to NE 149th Street to one lane in each direction, center turn lane, sidewalks, bike lanes, and planter strips (anticipated construction start date is 2015). A separate environmental review process would occur for this project.

- 179th Street improvements from NE 10th Avenue to 29th Avenue. This project would construct a principal arterial - 2 travel lanes each direction, center turn lane or median, bike lanes, sidewalks, and planter (anticipated construction start date is 2016). A separate environmental review process would occur for this project.
- Construction of a new interchange on I-5 at SR-502, near 219th Street (completed fall 2008).
- Washington State University Campus Expansion: Anticipated completion year is 2028.
- Commercial development at former Waste Management site: Anticipated completion date is unknown at this time.

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2.0 CHARACTERISTICS OF NOISE

Sound travels through the air as waves of minute air pressure fluctuations caused by vibration. In general, sound waves travel away from the noise source as an expanding spherical surface. As a result, the energy contained in a sound wave is spread over an increasing area as it travels away from the source. This results in a decrease in loudness at greater distances from the noise source.

Sound-level meters measure the actual pressure fluctuations caused by sound waves and record separate measurements for different sound frequency ranges. The decibel (dB) scale used to describe sound is a logarithmic scale that accounts for the large range of sound pressure levels. Most sounds consist of a broad range of sound frequencies. Several frequency weighting schemes have been used to develop composite decibel scales that approximate the way the human ear responds to noise levels. The A-weighted decibel (dBA) scale is most widely used for this purpose. Typical A-weighted noise levels for various types of sound sources are summarized in Table 1 below.

Table 1. A-Weighted Sound Levels and Human Response		
Sound Source	dBA*	Response Criteria
Carrier deck jet operation	140	Limit amplified speech
Limit of amplified speech	130	Painfully loud
Jet takeoff (200 feet) Auto horn (3 feet)	120	Threshold of feeling and pain
Riveting machine Jet takeoff (2,000 feet)	110	
Shout (0.5 foot) New York subway station	100	Very annoying
Heavy truck (50 feet) Pneumatic drill (50 feet)	90	Hearing damage (8-hour exposure)
Passenger train (100 feet) Helicopter (in-flight, 500 feet) Freight train (50 feet)	80	Annoying
Freeway traffic (50 feet)	70	Intrusive
Air conditioning unit (20 feet) Light auto traffic (50 feet)	60	
Normal speech (15 feet)	50	Quiet
Living room Bedroom Library	40	
Soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	
	10	Just audible
	0	Threshold of hearing

* Typical A-weighted sound levels taken with a sound-level meter and expressed as decibels on the scale. The "A" scale approximates the frequency response of the human ear.

Source: U.S. Council on Environmental Quality 1970

Varying noise levels are often described in terms of the equivalent sound level (L_{eq}). Equivalent sound levels are used to develop single-value descriptions of average noise exposure over stated periods of time. The L_{eq} data used for these average noise exposure descriptors are generally based on A-weighted sound level measurements. Most often, units of hourly L_{eq} values are used to describe traffic noise.

The logarithmic nature of decibel scales is such that individual decibel ratings for different noise sources cannot be added directly to give the sound level for the combined noise source. For example, two noise sources that produce equal decibel ratings at a given location would produce a combined noise level that is 3 dB greater than either sound alone. When two noise sources differ by 10 dB, the combined noise level would be 0.4 dB greater than the louder source alone. People generally perceive a 10 dB increase in a noise source as a doubling of loudness. For example, a 70 dB sound level would be perceived by an average person as twice as loud as a 60 dB sound. People generally cannot detect differences of 1 to 2 dB between noise sources. Under ideal listening conditions, differences of 2 or 3 dB can be detected by some people. A 5 dB change would probably be perceived by most people under normal listening conditions.

When distance is the only factor considered, sound levels from isolated point sources of noise typically decrease by approximately 6 dB for every doubling of distance from the noise source. When the noise source is a continuous line (for example, vehicle traffic on a highway), sound levels decrease by about 3 dB for every doubling of distance away from the roadway. In traffic studies, an attenuation rate of 4.5 dB per doubling of distance is often used when the roadway is at ground level and the intervening ground is effective in absorbing sound (for example, ground vegetation, scattered trees, clumps of bushes). When the roadway is elevated, 3 dB noise attenuation per doubling of distance is used because the sound-absorbing effects of the intervening ground are limited.

Noise levels at different distances can also be affected by factors other than the distance from the noise source. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can increase or decrease noise levels. Atmospheric conditions (wind speed and direction, humidity levels, and temperatures) can also affect the degree to which sound is attenuated over distance.

Reflections off topographical features or buildings can sometimes result in higher sound levels (lower sound attenuation rates) than would normally be expected. Temperature inversions and altitude changes in wind conditions can also diffract and focus a sound wave to a location at considerable distance from the noise source. Focusing effects are usually noticeable only for very intense noise sources, such as blasting operations. As a result of these factors, the existing noise environment can be highly variable depending on local conditions.

3.0 METHODOLOGY USED

This report has been prepared using guidance provided in the WSDOT Environmental Procedures Manual (2008a).

3.1 FHWA Noise Standards

The Federal Noise Control Act of 1972 (Public Law 92-574) requires that all federal agencies administer their programs in a manner that promotes an environment free from noises that could jeopardize public health or welfare.

FHWA has adopted criteria for evaluating noise effects associated with federally funded highway projects and determining whether such effects are sufficient to justify funding noise abatement measures. The FHWA Noise Abatement Criteria (NAC) are summarized in Table 2.

Activity Category	L _{eq} Noise Levels (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 Categories A or B above
D	—	Undeveloped lands
E	52 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums

Source: USDOT, 1995

3.2 WSDOT Noise Standards

The WSDOT Traffic Noise Analysis and Abatement Policy and Procedures (WSDOT, 2006a) states that noise effect analyses are required for all federally-aided and state-funded highway construction projects that construct new highways or reconstruct existing highways by substantially changing either the horizontal or vertical alignment, or by increasing the number of through travel lanes. All federally-aided highway noise analyses must be prepared in accordance with 23 CFR 772, “Procedures for Abatement of Highway Traffic Noise and Construction Noise.” State-funded WSDOT projects are also developed in accordance with these requirements.

A traffic noise effect occurs when a predicted traffic noise level approaches or exceeds the NAC listed above in Table 2 for a specific Activity Category, or when the predicted traffic noise level substantially exceeds the existing noise level. As implemented by WSDOT, a design year noise level within 1-dBA of the NAC is considered to approach the NAC. This effectively reduces the FHWA NAC by 1-dBA so that residential effects occur at 66 dBA, and commercial effects occur at 71 dBA. A design year noise level greater than or equal to the NAC is considered to exceed the NAC, and a 10 dBA increase over existing noise levels is considered to substantially exceed the NAC. The criteria are applied to the peak noise impact hour.

3.3 Method of Analysis

The following methods were used to assess traffic noise effects associated with the proposed project:

- Existing activities, developed lands, and undeveloped lands for which development is planned, designed, or programmed and that could be affected by noise from the proposed project improvements were identified from field surveys and aerial photographs.
- Short term (15 minute) sound level measurements typical of existing conditions were collected at selected representative locations throughout the project study area and used to characterize the existing noise environment adjacent to the proposed project improvements, and to validate the noise model.
- Traffic noise levels under the existing condition, the No Build Alternative, and the Proposed Build Alternative were predicted using the FHWA Traffic Noise Model (TNM), Version 2.5 (FHWA, 2004).
- Project-related traffic noise effects were identified using the relative and absolute criteria specified in WSDOT's Traffic Noise Analysis and Abatement Policy and Procedures (WSDOT, 2006a).
- Mitigation measures for reducing noise effects were identified and evaluated using WSDOT's guidelines for determining feasibility, reasonableness, and cost effectiveness.

This discipline report does not evaluate noise resulting from transit modifications due to the relocation of the C-Tran Park-and-Ride; however, the transit noise evaluation is included in a memorandum included in Appendix D.

3.4 The Traffic Noise Model

Project-related traffic noise levels were modeled using the FHWA Traffic Noise Model (TNM), Version 2.5. TNM estimates acoustic intensity at receiver locations based on the level of sound energy generated from a series of straight-line roadway segments. Where appropriate, the effects of local shielding from existing structures, vegetation, terrain, and other adjustment factors can be included in the model to provide a higher level of detail and accuracy.

Because the Salmon Creek Interchange Project would extend over a relatively large area, the project area was divided into segments to facilitate the noise modeling. In addition, the focus of the analysis was on those areas with existing, or planned and approved residential developments where noise abatement measures may be warranted. Noise levels were modeled to reflect existing traffic conditions and expected traffic conditions in 2030 with the Proposed Build Alternative. Peak hour traffic volumes used in the model were based on traffic information provided by the traffic consultant for the project, and vehicle speeds were based on posted roadway speed limits as specified in the WSDOT noise policy. These assumptions resulted in a conservative (that is, worst-case) effect assessment.

The noise model also requires assumptions about the percentage of automobiles (two-axle, four-tire vehicles), medium trucks (two-axle, six-tire vehicles), and heavy trucks (three or more axles) using each individual roadway. Vehicle mixes vary depending on the roadway segment, time of day, and proximity to commercial or light industrial land uses. Vehicle mixes for each roadway were determined from videotaped traffic volumes made during each field monitoring period.

4.0 AFFECTED ENVIRONMENT

4.1 Identification of Land Uses in Project Study Area

Land uses adjacent to the project corridor are a mix of residential, commercial, and light industrial uses.

4.1.1 Segment 1: NE Tenney Road/NE 134th Street Area

Land uses adjacent to NE Tenney Road are primarily residential on the south side of NE Tenney Road and commercial on the north side of the roadway. East of NE 10th Avenue, NE Tenney Road becomes NE 134th Street, and land uses become more commercial near I-5.

Land uses adjacent to NE 139th Street from NE Tenney Road to NE 10th Avenue include residential and commercial developments on both sides of the roadway. East of NE 10th Avenue, NE 139th Street ends in a gravel road with several residences and commercial businesses scattered nearby. This low density development transitions to vacant land near I-5.

4.1.2 Segment 2: NE 10th Avenue Area

Land uses in the NE 10th Avenue area are a mix of residential and commercial uses between NE 134th Street and NE 141st Street. Between NE 134th Street and NE 139th Street, land uses are predominantly commercial on both sides of the road. North of NE 139th Street, land uses are a mix of residential and commercial with a more concentrated residential development just north of NE 139th Street.

4.1.3 Segment 3: I-205 Area

Land uses adjacent to I-205 from the southern terminus of the project to NE 134th Street are a mix of scattered, low-density residences on both sides of the freeway interspersed with vacant land. On the west side of I-205 near the southern terminus, residences are located on a bluff about 40 to 50 feet above I-205. Near the NE 134th Street interchange, land uses on both sides of the roadway are predominantly commercial, with motels located next to the I-205 northbound off-ramp and near the NE 20th Avenue/ NE 134th Street intersection. Between the NE 134th Street interchange and NE 139th Street, the majority of land uses on both sides of I-205 are mostly commercial. There are several isolated residences on NE 134th Street east of I-205 near NE 20th Avenue. There are also several residences on NE 20th Avenue near NE 139th Street, as well as near the northbound I-205 off-ramp to NE 134th Street.

4.1.4 Segment 4: I-5 (Southern Area)

Land uses adjacent to I-5 on the west side of the freeway north of the proposed NE 139th Street extension include a residential development on NE 143rd Street, and commercial uses north of NE 144th Street. East of I-5, land uses on NE 139th Street are primarily commercial on both sides of the roadway.

4.1.5 Segment 5: I-5 (Northern Area)

Land uses adjacent to I-5 from NE 144th Street to NE 179th Street are a mix of commercial businesses near NE 144th Street that transition to higher density residential developments north of NE 149th Street, especially on the east side of I-5. Segment 5 also includes Northwood Park on the east side of I-5, just south of NE 165th Street; and the Clark County Fairgrounds on the west side of I-5, just north of NE 164th Street.

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5.0 EFFECT ANALYSIS

5.1 Noise Monitoring

Noise monitoring was conducted throughout the project corridor to characterize the existing noise conditions at locations near to where the proposed project improvements would be constructed. The monitored sound levels were also used to validate the noise model prior to modeling with project-related traffic volumes. Ambient noise monitoring was conducted using a Larson-Davis Model 820 sound level meter. Instrument calibration was verified with a Larson-Davis acoustic calibrator before each measurement session. At each monitoring position, the meter was held by a tripod that placed it approximately 5 feet above the ground.

Short term (15 minute) noise monitoring was conducted at 14 locations throughout the project area. Noise monitoring was conducted between 9:30 AM and 3:30 PM on August 17 and 18, 2005. During the monitoring period, the skies were cloudy with slight breezes. Sound level monitoring locations are shown in Exhibit 4 through Exhibit 9 of Appendix A, Noise Model Receptor Locations (ML-1 through ML-12).

Table 3 shows the results of noise monitoring at each location. Monitored noise levels approached or exceeded the WSDOT residential noise abatement criteria of 66 dBA at seven locations (ML-1, ML-1b, ML-2, ML-3, ML-7, ML-11, and ML-12) due to the proximity of the monitoring location to either I-5 or I-205. Monitored noise levels at all other locations were below the residential NAC and ranged from 53 to 65 dBA.

Table 3. Noise Monitoring Data

Monitoring Location	Site Description	Date	L _{eq}	Approach or Exceeds Residential NAC (66 dBA)?
ML-1	Residences – west end of NE 154th Street	8/17/2005	69	Yes
ML-1a	Residences – NE 173rd Street	8/17/2005	65	No
ML-1b	Residences – NE 167th Street and NE Union Road	8/17/2005	72	Yes
ML-2	Residences – west end of NE 150th Street and NE 17th Avenue	8/17/2005	77	Yes
ML-3	Residence – north of Kaiser Permanente building (14513 NE 17th Avenue)	8/17/2005	77	Yes
ML-4 ^a	Commercial – near NE 148th Street and NE 10th Avenue	8/18/2005	64	No
ML-5 ^a	Hansen Meadows development – NE 144th Street and NE 9th Avenue	8/18/2005	56	No
ML-6 ^a	Residences – near 14308 NE 10th Avenue	8/18/2005	65	No
ML-7	Residences – east end of NE 143rd Street	8/18/2005	66	Yes
ML-8	Residences – corner of NE 139th Street and NE 7th Court	8/18/2005	57	No
ML-9	East end of NE 139th Street	8/18/2005	53	No
ML-10	Comfort Inn Motel – NE 20th Avenue and NE 134th Street	8/17/2005	63	No
ML-11	Residences – east end of NE 129th Street	8/17/2005	66	Yes
ML-12	Residences – east end of NE 150th Street	8/17/2005	69	Yes

^a – These monitoring locations are located on a portion of NE 10th Avenue that was initially included in the project design, but is no longer part of the project.

6.0 OPERATIONAL EFFECTS

The goal of the noise effect analysis was to determine if the noise levels predicted with the proposed project would approach or exceed the applicable NAC (66 dBA for residential locations or 71 dBA for commercial establishments) or result in a 10 dBA increase over existing noise levels (a substantial increase according to WSDOT criteria). To achieve this goal, both modeled noise levels (model receptors) and field measurements (monitored levels) were included in the TNM noise model to characterize noise effects throughout the project study area. To ensure model accuracy, monitored noise levels were calibrated to within 2 dBA of the field measurements before modeling with traffic forecast volumes.

Table 4 through Table 8 summarize results of the noise effect analysis for each segment of the proposed project. Each table shows a different roadway segment in the study area and the noise levels at receptor locations that could be affected by traffic associated with the proposed project. Supporting documentation generated by the traffic noise model is included in Appendix B, Traffic Noise Model Files.

6.1 Segment 1: NE Tenney Road/NE 134th Street Area

Modeled sound levels and project-related effects for the NE Tenney Road/NE 134th Street area are shown in Table 4 (see Exhibit 5 for receptor locations).

Table 4. Modeled Noise Levels (dBA): Segment 1 – Tenney Road/NE 134th Street Area									
Receptor	No. of Dwelling Units	Existing Conditions		No Build Alternative (2030)			Proposed Build Alternative (2030)		
		Existing Sound Level (L _{eq})	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?
ML-8	4	60	No	62	2	No	70	10	Yes
ML-9	1	57	No	60	3	No	62	5	No
TR-1	6	59	No	61	2	No	60	1	No
TR-2	5	55	No	57	2	No	56	1	No
TR-3	7	58	No	59	1	No	58	0	No
TR-4	5	54	No	56	2	No	55	1	No
TR-5	4	54	No	56	2	No	54	0	No
TR-6	5	52	No	55	3	No	54	2	No
TR-7	5	55	No	57	2	No	56	1	No
TR-8	3	54	No	57	3	No	56	2	No
TR-9	3	61	No	63	2	No	61	0	No
TR-10	5	60	No	62	2	No	61	1	No
TR-11	2	66	Yes	68	2	Yes	67	1	Yes
TR-12	1 (commercial)	67	No	70	3	No	70	3	No
TR-13	1	62	No	65	3	No	63	1	No
TR-14	1 (commercial)	65	No	67	2	No	66	1	No
TR-15	1 (commercial)	64	No	67	3	No	66	2	No
TR-16	1	64	No	67	3	Yes	65	1	No
TR-17	1 (Public Library)	59	No	61	2	No	65	6	No
TR-18	1	55	No	55	2	No	61	6	No

ML = Monitoring location

TR, NE, SO, NO = Noise model receptor location, see Exhibit 5 for receptor locations

6.1.1 Existing Conditions

Under existing conditions, noise levels along NE Tenney Road range from 52 to 67 dBA. Existing noise levels in the residential development on the west side of NE Tenney Road (TR-1 to TR-10 in Exhibit 5) are relatively low (52 to 61 dBA) because of a 10-foot privacy wall that borders the development and screens traffic noise from NE Tenney Road. As shown in Table 4, the residential NAC is exceeded at one location on NE Tenney Road (TR-11). TR-11 is a residence just east of NE 10th Avenue that is not screened by the privacy wall that serves the rest of the residential development. There are no exceedances of the commercial NAC under existing conditions in this segment.

6.1.2 No Build Alternative

Under the No Build Alternative, noise levels in Segment 1 would increase by 1 to 3 dBA over existing conditions due to increased traffic volumes on surface streets. Noise effects under the No Build Alternative would be the same as under existing conditions.

6.1.3 Proposed Build Alternative (2030)

Project-related improvements in Segment 1 include intersection improvements at the NE 139th Street/NE Tenney Road intersection, widening of NE 139th Street to two lanes in each direction, and construction of a new segment of NE 139th Street from NE 10th Avenue to NE 20th Avenue east of I-5 and I-205 (see Exhibit 5).

Under the Proposed Build Alternative, sound levels would increase by 0 to 10 dBA over existing conditions due to increased traffic volumes on local streets and widening of NE 139th Street. Widening of NE 139th Street would move traffic lanes closer to existing residences on or near NE 139th Street, which would increase noise levels by up to 10 dBA (TR-18 and ML-8 in Exhibit 5). Under the Proposed Build Alternative, the residential NAC would be approached or exceeded at one receptor location (TR-11) representing two residences on NE 134th Street (TR-11).

Noise levels at residences in the development adjacent to NE Tenney Road (TR-1 through TR-10) would increase by 0 to 2 dBA over existing conditions due to increased traffic volumes on NE Tenney Road. However, there would be no exceedances of the residential NAC in this development.

6.2 Segment 2: NE 10th Avenue Area

Modeled sound levels and project-related noise effects for the NE 10th Avenue area are shown in Table 5 (see Exhibit 6 for receptor locations). The project improvements along NE 10th Avenue have been reduced since sound levels were modeled. Receptors ML-4 through ML-6, and NE-1 through NE-16 are no longer adjacent to the proposed improvements and are, therefore, not considered part of the project.

Receptor	No. of Dwelling Units	Existing Conditions		No Build Alternative (2030)			Proposed Build Alternative (2030)		
		Existing Sound Level (L _{eq})	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?
ML-4 ^a	1	67	No	71	4	Yes	N/A	N/A	N/A
	Commercial								
ML-5 ^a	3	59	No	63	4	No	N/A	N/A	N/A
ML-6 ^a	3	67	Yes	71	4	Yes	N/A	N/A	N/A
NE-1 ^a	2	57	No	60	3	No	N/A	N/A	N/A
NE-2 ^a	2	55	No	58	3	No	N/A	N/A	N/A
NE-3 ^a	2	61	No	64	3	No	N/A	N/A	N/A
NE-4 ^a	3	56	No	59	3	No	N/A	N/A	N/A
NE-5 ^a	2	63	No	66	3	No	N/A	N/A	N/A
NE-6 ^a	1	61	No	65	4	No	N/A	N/A	N/A
NE-7 ^a	2	55	No	58	3	No	N/A	N/A	N/A
NE-8 ^a	2	62	No	66	4	Yes	N/A	N/A	N/A
NE-9 ^a	4	58	No	61	3	No	N/A	N/A	N/A
NE-10 ^a	4	65	No	69	4	Yes	N/A	N/A	N/A
NE-11 ^a	3	57	No	61	4	No	N/A	N/A	N/A
NE-12 ^a	5	58	No	61	3	No	N/A	N/A	N/A
NE-13 ^a	5	54	No	58	4	No	N/A	N/A	N/A
NE-14 ^a	4	62	No	66	4	Yes	N/A	N/A	N/A
NE-15 ^a	4	57	No	60	3	No	N/A	N/A	N/A
NE-16 ^a	4	57	No	60	3	No	N/A	N/A	N/A
NE-17	5	53	No	56	3	No	57	4	No
NE-18	4	64	No	68	4	Yes	66	2	Yes

ML = Monitoring location

TR, NE, SO, NO = Noise model receptor location, see Exhibit 6 for receptor locations

^a These receptors are no longer adjacent to the project improvements along NE 10th Avenue and are, therefore, not considered part of this project

6.2.1 Existing Conditions

Under existing conditions, noise levels at receptor locations along NE 10th Avenue range from 53 to 67 dBA. Under existing conditions, the residential NAC would be exceeded at one location (ML-6) representing three residences adjacent to NE 10th Avenue.

6.2.2 No Build Alternative

Under the No Build Alternative, noise levels in Segment 2 would increase by 3 to 4 dBA over existing conditions due to increased traffic volumes in the future. Under the No Build Alternative the commercial NAC would be exceeded at one receptor location (ML-

4). The residential NAC would be exceeded at five receptor locations (ML-6, NE-8, NE-10, NE-14, and NE-18) representing approximately 17 residences.

6.2.3 Proposed Build Alternative (2030)

Under the Proposed Build Alternative, NE 10th Avenue would be improved by adding a center turn lane between NE 139th Street and NE 141st Street, effectively moving the existing roadway approximately 20 feet closer to residences along the roadway.

As shown in Table 5, under the Proposed Build Alternative, noise levels at receptor locations along NE 10th Avenue would increase by 2 to 4 dBA over existing conditions due to increased traffic volumes and the addition of a center-turn lane. Under the Proposed Build Alternative, the residential NAC would be approached or exceeded at one receptor location (NE-18) representing approximately 4 residences. There would be no exceedances of the commercial NAC in this segment.

6.3 Segment 3: I-205 Area

Modeled sound levels and project-related effects for the I-205 area are shown below in Table 6 (see Exhibit 7 for receptor locations).

Receptor	No. of Dwelling Units	Existing Conditions		No Build Alternative (2030)			Proposed Build Alternative (2030)		
		Existing Sound Level (L _{eq})	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?
ML-10 (commercial)	1	64	No	67	3	No	67	3	No
ML-11	2	73	Yes	76	3	Yes	77	4	Yes
ML-12	1	71	Yes	73	2	Yes	75	4	Yes
SO-1	2	66	Yes	69	3	Yes	69	3	Yes
SO-2	1	65	No	68	3	Yes	68	3	Yes
SO-3	1	63	No	66	3	Yes	66	3	Yes
SO-4	2	67	Yes	70	3	Yes	70	3	Yes
SO-5	2	63	No	67	4	Yes	67	4	Yes
SO-6	1	65	No	68	3	Yes	67	2	Yes
SO-7	2	61	No	64	3	No	63	2	No
SO-8	1	68	Yes	71	3	Yes	74	6	Yes
SO-9	2	61	No	64	3	No	63	2	No

ML = Monitoring location

TR, NE, SO, NO = Noise model receptor location, see Exhibit 7 for receptor locations

6.3.1 Existing Conditions

Under existing conditions, noise levels range from 61 to 73 dBA at residential locations along the west side of I-205, and south of NE 134th Street. Under existing conditions, the residential NAC is exceeded at three receptor locations (ML-11, ML-12, and SO-8) representing four residences near I-205. In addition, the residential NAC is exceeded at one receptor location on NE 134th Street (SO-4), representing two residences. Finally, the residential NAC is exceeded at one receptor location on NE 20th Avenue near NE 139th Street (SO-1), representing two residences.

6.3.2 No Build Alternative

Under the No Build Alternative, noise levels in Segment 3 would increase by 2 to 4 dBA over existing conditions due to increased traffic volumes in the future. Under the No Build Alternative, the residential NAC is exceeded at nine receptor locations (ML-11, ML-12, SO-1, SO-2, SO-3, SO-4, SO-5, SO-6, and SO-8), representing thirteen residences near I-205.

6.3.3 Proposed Build Alternative (2030)

Under the Proposed Build Alternative, project improvements in this area include an exit-only lane to NE 134th Street from northbound I-205, resulting in a two-lane off-ramp at this interchange. In Phase 2 of the project, a southbound on-ramp from NE 134th Street to I-205 would be constructed.

Under the Proposed Build Alternative, sound levels would increase by 2 to 6 dBA over existing conditions due to increased traffic volumes and the addition of the southbound on-ramp from NE 134th Street that would be constructed during Phase 2 of the project. The new on-ramp would be an elevated structure that crosses over I-205, bringing travel lanes closer to existing residences. With the proposed project, the residential NAC would be exceeded at nine receptor locations (ML-11, ML-12, SO-1, SO-2, SO-3, SO-4, SO-5, SO-6, and SO-8) representing thirteen widely-scattered residences in Segment 3.

6.4 Segment 4: I-5 (Southern) Area

Modeled sound levels and project-related effects for the I-205 (southern) area are shown in Table 7 (see Exhibit 8 for receptor locations).

Receptor	No. of Dwelling Units	Existing Conditions		No Build Alternative (2030)			Proposed Build Alternative (2030)		
		Existing Sound Level (L _{eq})	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?
ML-7	3	70	Yes	73	3	Yes	73	3	Yes
NO-24	3	63	No	67	4	Yes	66	3	Yes
NO-25	3	67	Yes	70	3	Yes	68	1	Yes
NO-26	3	63	No	66	3	Yes	66	3	Yes
NO-27	3	66	Yes	69	3	Yes	68	2	Yes

ML = Monitoring location

TR, NE, SO, NO = Noise model receptor location, see Exhibit 8 for receptor locations

6.4.1 Existing Conditions

Under existing conditions, noise levels range from 63 to 70 dBA at residential locations near the southbound I-5 off-ramp to I-205. Under existing conditions, the residential NAC is exceeded at three receptor locations (ML-7, NO-25, and NO-27), representing the nine residences nearest the off-ramp.

6.4.2 No Build Alternative

Under the No Build Alternative, noise levels in Segment 4 would increase by 3 to 4 dBA over existing conditions due to increased traffic volumes in the future. Under the No Build Alternative the residential NAC is exceeded at 5 receptor locations (ML-7, NO-24, NO-25, NO-26, and NO-27), representing 15 residences near the off-ramp.

6.4.3 Proposed Build Alternative (2030)

Under the Proposed Build Alternative, project improvements in this area include an additional lane in the I-5 northbound direction to accommodate a new on-ramp from NE 139th Street. In addition, the NE 139th Street extension across I-5 and I-205 is approximately 700 feet south of the existing residential development (see Exhibit 8).

Under the Proposed Build Alternative, sound levels at receptor locations in the residential development would increase by 1 to 3 dBA over existing conditions due to increased traffic volumes on I-5 and on the southbound off-ramp to I-205. With the proposed project improvements, the residential NAC would be exceeded at five receptor locations in the residential development (ML-7, NO-24, NO-25, NO-26, and NO-27), representing 15 residences.

6.5 Segment 5: I-5 (Northern) Area

Modeled sound levels and project-related effects for the I-5 (northern) area are shown below in Table 8 (see Exhibit 9 for receptor locations).

6.5.1 Existing Conditions

Under existing conditions, noise levels range from 62 to 77 dBA at residential locations in the developments east of I-5. Under existing conditions, the residential NAC is exceeded at 35 receptor locations, representing 95 residences near I-5.

6.5.2 No Build Alternative

Under the No Build Alternative, noise levels in Segment 5 would range from 65 to 80 dBA and increase by 2 to 3 dBA over existing conditions due to increased traffic volumes in the future. Under the No Build Alternative, the residential NAC is exceeded at 44 receptor locations, representing approximately 123 residences near I-5.

6.5.3 Proposed Build Alternative (2030)

Under the Proposed Build Alternative, project improvements in this area would include an additional lane in the northbound direction of I-5 to accommodate a new on-ramp from NE 139th Street.

Under the Proposed Build Alternative, sound levels at receptor locations in this area would range from 66 to 80 dBA, increasing by 0 to 5 dBA over existing conditions due to increased traffic volumes and the addition of the northbound travel lane on I-5. With the Proposed Build Alternative, the residential NAC would be exceeded at 46 receptor locations, representing approximately 130 residences adjacent to I-5.

Table 8. Modeled Noise Levels (dBA): Segment 5 – I-5 (Northern) Area

Receptor	No. of Dwelling Units	Existing Conditions		No Build Alternative (2030)			Proposed Build Alternative (2030)		
		Existing Sound Level (L _{eq})	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?	Modeled Sound Level (2030 L _{eq})	Change from Existing	Exceed Standard?
ML-1	4	75	Yes	78	3	Yes	79	4	Yes
ML-2	3	76	Yes	79	3	Yes	79	3	Yes
ML-3	1	73	Yes	76	3	Yes	76	3	Yes
NO-1	4	69	Yes	72	3	Yes	72	3	Yes
NO-2	4	66	Yes	69	3	Yes	69	3	Yes
NO-3	3	64	No	67	3	Yes	67	3	Yes
NO-4	3	69	Yes	72	3	Yes	74	5	Yes
NO-5	2	65	No	68	3	Yes	68	3	Yes
NO-6	2	63	No	66	3	Yes	67	4	Yes
NO-7	4	67	Yes	70	3	Yes	71	4	Yes
NO-8	3	64	No	67	3	Yes	68	4	Yes
NO-9	4	62	No	65	3	No	66	4	Yes
NO-10	Undeveloped	77	Yes	80	3	Yes	80	3	Yes
NO-11	Undeveloped	76	Yes	79	3	Yes	79	3	Yes
NO-12	3	64	No	67	3	Yes	68	4	Yes
NO-13	2	65	No	68	3	Yes	69	4	Yes
NO-14	4	63	No	66	3	Yes	67	4	Yes
NO-15	1	76	Yes	79	3	Yes	79	3	Yes
NO-16	4	72	Yes	75	3	Yes	77	5	Yes
NO-17	4	66	Yes	69	3	Yes	70	4	Yes
NO-18	4	63	No	66	3	Yes	67	4	Yes
NO-19	3	76	Yes	79	3	Yes	79	3	Yes
NO-20	4	63	No	66	3	Yes	67	4	Yes
NO-21	3	77	Yes	80	3	Yes	80	3	Yes
NO-22	4	69	Yes	72	3	Yes	73	4	Yes
NO-23	4	65	No	68	3	Yes	69	4	Yes
ML-1a	1	69	Yes	72	3	Yes	71	2	Yes
ML-1b	1	76	Yes	79	3	Yes	79	3	Yes
NA-1	3	71	Yes	73	2	Yes	71	0	Yes
NA-2	3	71	Yes	74	3	Yes	71	0	Yes
NA-3	3	71	Yes	74	3	Yes	71	0	Yes
NA-4	3	71	Yes	74	3	Yes	71	0	Yes
NA-5	3	73	Yes	76	3	Yes	76	3	Yes
NA-6	3	75	Yes	78	3	Yes	79	4	Yes
NA-7	3	75	Yes	78	3	Yes	79	4	Yes
NA-8	3	75	Yes	78	3	Yes	79	4	Yes
NA-9	3	75	Yes	78	3	Yes	79	4	Yes
NA-1a	2	69	Yes	72	3	Yes	70	1	Yes
NA-2a	2	69	Yes	72	3	Yes	70	1	Yes
NA-3a	2	69	Yes	72	3	Yes	70	1	Yes
NA-4a	2	69	Yes	72	3	Yes	70	1	Yes
NA-5a	4	69	Yes	72	3	Yes	73	4	Yes
NA-6a	3	70	Yes	73	3	Yes	74	4	Yes
NA-7a	3	70	Yes	73	3	Yes	74	4	Yes
NA-8a	3	70	Yes	73	3	Yes	75	5	Yes
NA-9a	3	70	Yes	73	3	Yes	75	5	Yes

ML = Monitoring location

TR, NE, SO, NO = Noise model receptor location, see Exhibit 9 for receptor locations

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7.0 NOISE MITIGATION MEASURES

7.1 Noise Mitigation Criteria

This section discusses methods for reducing the operational traffic noise effects identified in the previous section. According to the WSDOT noise policy, noise mitigation measures would be considered for Type I projects (i.e., new highway construction) at locations where noise effects are identified.

Mitigation measures to reduce traffic noise effects include the following:

- Traffic management measures, such as restricting vehicle speeds and prohibiting compression braking.
- Altering horizontal and vertical alignments (e.g., depressing roadway alignments to create shielding effects).
- Constructing noise barriers when reasonable and feasible.
- Installing noise insulation in public use or nonprofit institutional buildings.

This section focuses on considering noise barriers as the primary means of mitigating project-related noise effects. Because the proposed project would improve mobility on existing interstate highways (I-205 and I-5) as well as on existing principal arterials (including NE 134th Street, NE 139th Street, and NE 20th Avenue), substantial speed restrictions as a means of reducing traffic-related noise would be inconsistent with the aims of the project. Altering the horizontal and vertical alignments of existing roadways would not be feasible because the costs associated with excavating roadways and maintaining existing accesses would make such measures prohibitively expensive.

The WSDOT noise policy uses a number of factors to determine whether noise mitigation measures are reasonable and feasible for reducing noise effects:

- The mitigation measure must be feasible according to the following WSDOT criteria:
 - The measure must be physically constructible.
 - A majority of the first-row receivers closest to the alignment must receive a minimum 5 dBA noise benefit (that is, lowering of noise levels) as a result of the mitigation measure.
 - At least one of the first-row receivers must receive at least a 7 dBA noise benefit.
- Once the noise mitigation measure has been determined feasible (according to the above criteria), then a reasonableness determination would be made by considering:
 - The total cost of the mitigation measure compared to the allowed cost (the cost WSDOT would contribute for construction based on the level of effect) for benefiting receivers (those receiving 3 dBA or more of noise benefit from the mitigation measure).
 - The total cost of the mitigation measure per qualified residence or residential equivalent. The WSDOT noise analysis and abatement policy provides allowable costs per residence based on predicted horizon year absolute noise levels that are above the NAC, as well as relative substantial increases above existing levels that range between approximately \$37,400 and \$73,700.
 - The views and opinions of the majority of affected residents in any decision by WSDOT to implement noise abatement measures.

It is WSDOT's policy to make final determinations on the construction of noise barriers after final horizontal and vertical alignments have been determined and a detailed engineering analysis of the feasibility and reasonability of noise abatement can be made.

7.1.1 Segment 1: NE Tenney Road/NE 134th Street Area

Project improvements on NE 139th Street would result in noise effects at those residences closest to the new NE 139th Street alignment (four residences represented by receptor ML-8 and two residences represented by receptor TR-11 in Exhibit 5). The speed limit on NE 139th Street would be maintained at 35 miles per hour (mph); further speed limit restrictions would not be consistent with the transportation objectives of the project and would have a minor effect on lowering noise levels (a 5 mph speed limit reduction would lower noise levels by approximately 0.5 dBA and would not be perceptible). Altering the vertical alignment would not be feasible because of the need to maintain existing access to individual residences and businesses along the roadway.

A sound wall was modeled along the north side of NE 139th Street in the vicinity of NE 7th Court. The proposed project would eliminate three residences immediately adjacent to NE 139th Street. Because of the distance to the next row of homes a noise wall at this location would not provide the 5 dBA to 7 dBA noise benefit required by WSDOT's noise policy. A noise barrier would not be a feasible noise mitigation measure at this location. In addition, noise-affected residences represented by TR-11 and TR-16 are isolated residences for which the construction of sound walls would not be feasible.

7.1.2 Segment 2: NE 10th Avenue Area

In Segment 2, noise effects were identified at three residential locations along the NE 10th Avenue corridor (ML-6, NE-10, and NE-18 in Exhibit 6). NE 10th Avenue has a speed limit of 35 mph and a large number of residential driveways, business entrances, and intersections throughout its length. Noise mitigation measures would not be feasible on NE 10th Avenue because of the need to maintain access to individual residences and businesses. The short spacing between access points on NE 10th Avenue would make sound walls and other mitigation measures ineffective for reducing traffic-related noise levels.

7.1.3 Segment 3: I-205 Area

Noise effects were identified at four residential receptor locations near I-205 (ML-11, ML-12, SO-6, and SO-8 in Exhibit 7) representing five residences on the west side of I-205, south of NE 134th Street. Because of the small number of noise-affected residences in the vicinity of NE 129th Street, a sound wall would not meet the cost-effectiveness requirements of WSDOT's noise policy. Therefore, a sound wall was not considered feasible at this location.

The two residences represented by ML-12 and SO-8 are located on a forested bluff overlooking I-205. At this location, there is about a 50-foot elevation difference between the residential property line nearest the interstate and the edge of the roadway itself. A sound wall located along the edge of the roadway would not reduce noise levels at residences 50 feet higher and approximately 150 feet away. A sound wall constructed at the top of the bluff to benefit two residences would not meet WSDOT's cost-effectiveness criteria. Therefore, a sound wall was not considered at this location.

Residences represented by SO-1, SO-2, and SO-3 are located adjacent to NE 20th Avenue. Because of access requirements to these residences, a sound wall would not

be feasible in this location. Residences represented by SO-4 and SO-5 are located near the I-205/NE 134th Street intersection where access requirements (in addition to the small number of affected residences) would preclude construction of a feasible sound wall.

7.1.4 Segment 4: I-5 (Southern Area)

Noise effects were identified at five receptor locations (ML-7, NO-24, NO-25, NO-26, and NO-27 in Exhibit 8) in the residential development just south of NE 143rd Street representing 15 residences (see Exhibit 8). Noise effects in the development are primarily due to traffic noise from the southbound I-5 off-ramp to I-205. A barrier analysis was conducted at this location to determine if a sound wall would meet WSDOT's feasibility and cost-effectiveness criteria.

A sound wall 540 feet long was modeled at the east edge of the residential development (Barrier 1 in Exhibit 8). The mitigation analysis shown in Table 9 shows that a 10-foot-high sound wall would meet WSDOT's reasonableness, feasibility, and cost-effectiveness criteria and should be considered during final design of the proposed project.

7.1.5 Segment 5: I-5 (Northern Area)

Noise effects were identified at 46 receptor locations in the residential developments adjacent to I-5, representing approximately 130 individual residences (see Exhibit 9). Due to the large number of affected residences and lack of direct access to I-5 from this location, a detailed barrier analysis was conducted for this segment.

As shown in Exhibit 9, three sound walls were modeled in this segment. Barriers 2 and 3 were approximately 1,100 feet and 1,200 feet long, respectively, and Barrier 4 was about, 2,000 feet long. Mitigation analyses for these three barriers are shown in Table 10, Table 11, and Table 12, respectively.

As shown in Table 10 for Barrier 2, a 1,100-foot long sound wall between 12 and 16-feet high would meet WSDOT's reasonableness, feasibility, and cost-effectiveness requirements and would benefit approximately 16 residences in the development behind the barrier. A sound wall at this location should be considered during final design of the proposed project.

Table 11 for Barrier 3 shows that a sound wall approximately 1,200 feet long and 12- to 16-feet-high would meet WSDOT's reasonableness, feasibility, and cost-effectiveness requirements. A 14-foot-high sound wall would provide the least cost per benefiting residence. Barrier 3 would cross over the alignment of a culvert containing the north fork of an unnamed tributary to Whipple Creek. The location of the culvert, however, is approximately 40 feet below the level of the roadway (HDR, 2006), and constructability issues are not anticipated. A sound wall at this location should be considered during final design of the proposed project.

Table 12 for Barrier 4 shows that a sound wall approximately 2,000 feet long and 10- to 16-feet-high would meet WSDOT's reasonableness, feasibility, and cost-effectiveness requirements. A 10-foot-high sound wall would provide the least cost per benefiting residence. A sound wall at this location should also be considered during final design of the proposed project.

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Table 9. Mitigation Analysis: Barrier 1													
Location	Receptor #	# du	No Barrier	8 foot		10 foot		12 foot		14 foot		16 foot	
				Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease
1st Row	ML-7	3	73	67	6	66	7	65	8	65	8	64	9
2nd Row	NO-25	2	68	65	3	65	3	65	3	64	4	64	4
	NO-27	2	68	66	2	65	3	65	3	65	3	64	4
	NO-24	2	66	64	2	64	2	64	2	63	3	63	3
	NO-26	2	66	64	2	64	2	64	2	63	3	63	3
# benefiting receivers (at least 3 dBA):				5		7		7		9		11	
Maximum Reduction:				6		7		8		8		9	
WSDOT Feasibility Requirements				8 foot		10 foot		12 foot		14 foot		16 foot	
(Barrier must achieve both requirements to satisfy feasibility requirements)													
1 rec > 7dBA reduction from a barrier?				No		Yes		Yes		Yes		Yes	
60% or more 1st row > 5 dBA reduction?				Yes		Yes		Yes		Yes		Yes	
Is Barrier Feasible?				No		Yes		Yes		Yes		Yes	
WSDOT Cost Effectiveness Requirements				8 foot		10 foot		12 foot		14 foot		16 foot	
Length of Modeled Barrier				540									
Barrier Area (540 feet) x wall height, sq. ft.						5,400		6,480		7,560		8,640	
Barrier Cost (\$53.40 x Area)						\$288,360		\$346,032		\$403,704		\$461,376	
Allowed Cost, based on number of benefiting receivers and Allowed cost from Table B of WSDOT Policy						\$366,930		\$366,930		\$441,690		\$516,450	
(Allowed Cost) - (Wall Cost)						\$78,570		\$20,898		\$37,986		\$55,074	
Cost per benefiting receiver						\$32,040		\$49,433		\$44,856		\$41,943	
Is Barrier Cost Effective?						Yes		Yes		Yes		Yes	
Is Barrier Feasible and Cost Effective?				8 foot		10 foot		12 foot		14 foot		16 foot	
						Yes		Yes		Yes		Yes	

Location	Receptor #	# du	No Barrier	8 foot		10 foot		12 foot		14 foot		16 foot	
				Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease
1st Row	ML-1	4	79	74	5	74	5	72	7	70	9	69	10
	NO-10	1	80	76	4	76	4	75	5	74	6	74	6
2nd Row	NO-1	4	72	70	2	69	3	68	4	67	5	67	5
	NO-4	3	74	71	3	71	3	70	4	68	6	67	7
	NO-7	4	71	69	2	69	2	67	4	66	5	66	5
# benefiting receivers (at least 3 dBA):				8		12		16		16		16	

Maximum Reduction:	5	5	7	9	10
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WSDOT Feasibility Requirements	8 foot	10 foot	12 foot	14 foot	16 foot
(Barrier must achieve both requirements to satisfy feasibility requirements)					
1 rec > 7dBA reduction from a barrier?	No	No	Yes	Yes	Yes
60% or more 1st row > 5 dBA reduction?	No	No	Yes	Yes	Yes
Is Barrier Feasible?	No	No	Yes	Yes	Yes

WSDOT Cost Effectiveness Requirements	8 foot	10 foot	12 foot	14 foot	16 foot
Length of Modeled Barrier	1,100 feet				
Barrier Area (1,100 feet) x wall height, sq. ft.			13,200	15,400	17,600
Barrier Cost (\$53.40 x Area)			\$704,880	\$822,360	\$939,840
Allowed Cost, based on number of benefiting receivers and Allowed cost from Table B of WSDOT Policy			\$1,026,470	\$1,026,470	\$1,026,470
(Allowed Cost) - (Wall Cost)			\$321,590	\$204,110	\$86,630
Cost per benefiting receiver			\$44,055	\$51,398	\$58,740
Is Barrier Cost Effective?			Yes	Yes	Yes
Is Barrier Feasible and Cost Effective?	8 foot	10 foot	12 foot	14 foot	16 foot
			Yes	Yes	Yes

Table 11. Mitigation Analysis: Barrier 3

Location	Receptor #	# du	No Barrier	8 foot		10 foot		12 foot		14 foot		16 foot	
				Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease
1st Row	ML-2	3	79	74	5	73	6	70	9	68	11	68	11
	NO-15	1	79	73	6	73	6	70	9	69	10	69	10
	NO-19	3	79	74	5	73	6	69	10	68	11	67	12
	NO-21	3	80	75	5	74	6	71	9	69	11	68	12
2nd Row	NO-16	4	77	72	5	72	5	71	6	68	9	68	9
	NO-22	4	73	70	3	70	3	69	4	67	6	67	6
# benefiting receivers (at least 3 dBA):				18		18		18		36		36	
Maximum Reduction:				5		6		10		11		12	

WSDOT Feasibility Requirements

	8 foot	10 foot	12 foot	14 foot	16 foot
(Barrier must achieve both requirements to satisfy feasibility requirements)					
1 rec > 7dBA reduction from a barrier?	No	No	Yes	Yes	Yes
60% or more 1st row > 5 dBA reduction?	Yes	Yes	Yes	Yes	Yes
Is Barrier Feasible?	No	No	Yes	Yes	Yes

WSDOT Cost Effectiveness Requirements

	8 foot	10 foot	12 foot	14 foot	16 foot
Length of Modeled Barrier	1,200 feet				
Barrier Area (1,200 feet) x wall height, sq. ft.			14,400	16,800	19,200
Barrier Cost (\$53.40 x Area)			\$768,960	\$897,120	\$1,025,280
Allowed Cost, based on number of benefiting receivers and Allowed cost from Table B of WSDOT Policy			\$810,812	\$1,061,972	\$1,061,972
(Allowed Cost) - (Wall Cost)			41,852	164,852	36,692
Cost per benefiting receiver			\$42,720	24,920	\$28,480
Is Barrier Cost Effective?			Yes	Yes	Yes
Is Barrier Feasible and Cost Effective?			Yes	Yes	Yes

Table 12. Mitigation Analysis: Barrier 4													
Location	Receptor #	# du	No Barrier	8 foot		10 foot		12 foot		14 foot		16 foot	
				Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease	Level	Decrease
1st Row	NA-1	3	71	68	3	67	4	67	4	67	4	67	4
	NA-2	3	71	67	4	66	5	66	5	65	6	65	6
	NA-3	3	71	67	4	66	5	65	6	65	6	64	7
	NA-4	3	71	67	4	66	5	66	5	65	6	64	7
	NA-5	3	76	71	5	68	8	67	9	66	10	65	11
	NA-6	3	79	74	5	73	6	70	9	69	10	68	11
	NA-7	3	79	75	4	74	5	73	6	70	9	69	10
	NA-8	3	79	77	2	76	3	74	5	73	6	70	9
	NA-9	3	79	79	0	77	2	77	2	75	4	73	6
2nd Row	NA-1a	2	70	67	3	67	3	67	3	66	4	66	4
	NA-2a	2	70	66	4	66	4	65	5	65	5	65	5
	NA-3a	2	70	66	4	65	5	65	5	64	6	64	6
	NA-4a	2	70	67	3	66	4	65	5	64	6	64	6
	NA-5a	4	73	69	4	68	5	66	7	65	8	64	9
	NA-6a	3	74	71	3	70	4	69	5	67	7	66	8
	NA-7a	3	74	72	2	71	3	70	4	68	6	67	7
	NA-8a	3	75	73	2	72	3	71	4	70	5	68	7
	NA-9a	3	75	74	1	73	2	72	3	72	3	70	5

# benefiting receivers (at least 3 dBA):	36	45	48	51	51
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Maximum Reduction:	5	8	9	10	11
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WSDOT Feasibility Requirements	8 foot	10 foot	12 foot	14 foot	16 foot
(Barrier must achieve both requirements to satisfy feasibility requirements)					
1 rec > 7dBA reduction from a barrier?	No	Yes	Yes	Yes	Yes
60% or more 1st row > 5 dBA reduction?	No	Yes	Yes	Yes	Yes
Is Barrier Feasible?	No	Yes	Yes	Yes	Yes

WSDOT Cost Effectiveness Requirements	8 foot	10 foot	12 foot	14 foot	16 foot
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Length of Modeled Barrier	2,038				
Barrier Area (1,200 feet) x wall height, sq. ft.		20,380	24,456	28,532	32,608
Barrier Cost (\$53.40 x Area)		\$1,088,292	\$1,305,950	\$1,523,608	\$1,741,267
Allowed Cost, based on number of benefiting receivers and Allowed cost from Table B of WSDOT Policy		\$3,216,960	\$3,648,210	\$3,648,210	\$3,648,210
(Allowed Cost) - (Wall Cost)		\$2,128,668	\$2,342,260	\$2,124,602	\$1,906,943
Cost per benefiting receiver		\$24,184	\$27,207	\$29,875	\$34,142
Is Barrier Cost Effective?		Yes	Yes	Yes	Yes

	8 foot	10 foot	12 foot	14 foot	16 foot
Is Barrier Feasible and Cost Effective?		Yes	Yes	Yes	Yes

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8.0 CONSTRUCTION NOISE

8.1 Construction Noise Activities

Table 13 shows noise levels produced by various types of construction equipment. Properly maintained equipment would produce noise levels near the middle of the indicated ranges. The types of construction equipment used for this project would typically generate noise levels of 80 to 90 dBA at a distance of 50 feet while the equipment is operating (EPA 1971; Toth 1979; Gharabegian et al., 1985).

Construction equipment operations can vary from intermittent to fairly continuous with multiple pieces of equipment operating concurrently. Assuming a bulldozer (80 dBA), backhoe (90 dBA), grader (90 dBA), and front-end loader (82 dBA) are operating concurrently in the same area, peak construction period noise would be approximately 94 dBA at 50 feet from the construction site.

Type of Equipment	Noise Level in dBA at 50 Feet
Bulldozer	80
Front loader	72 – 84
Jack hammer or rock drill	81 – 98
Crane with headache ball	75 – 87
Backhoe	72 – 93
Scraper and grader	80 – 93
Electrical generator	71 – 82
Concrete pump	81 – 83
Concrete vibrator	76
Concrete and dump trucks	83 – 90
Air compressor	74 – 87
Pile drivers (peaks)	95 – 106
Pneumatic tools	81 – 98
Roller (compactor)	73 – 75
Saws	73 – 82

Source: U.S. Environmental Protection Agency 1971

Locations within 1,900 feet of a construction site would experience occasional episodes of noise levels greater than 60 dBA. Areas within 750 feet of a construction site would experience episodes of noise levels greater than 70 dBA. Such episodes of high noise levels would be restricted to daylight hours where practical. However, some construction activities, such as paving and bridge demolition and construction, are anticipated to occur during nighttime hours to minimize effects to the traveling public and to increase safety. Nighttime construction activities may exceed the maximum permissible noise levels as defined in WAC 173-60-040. To address this, the project may require the use of a noise variance from WAC 173-60-040 maximum permissible environmental noise levels. The variance would be needed for more than a 30 day period. Incidents of noise conflicts could occur when construction occurs directly adjacent to residential, park, or

recreation areas is necessary; however, there are no active public parks, recreation areas, or wildlife or waterfowl refuges within the footprint of the Proposed Build Alternative nor within 500 feet of the proposed roadway improvements that would be affected by project-related noise effects.

8.2 Construction Noise Mitigation

Construction activities must comply with all state and local noise regulations. The Washington Administrative Code (WAC 173-060, *Maximum Environmental Noise Levels*) limits maximum allowable sound levels based on land use categories of the source and receiving properties. The most stringent limits apply to sounds received in residential areas and the daytime limits in residential areas are reduced by 10 dBA during nighttime hours. WAC 173-060-050 (*Exemptions*) exempts certain activities from the maximum permissible noise limits. Sounds originating from temporary construction sites as a result of construction activity during daytime hours (between 7:00 a.m. and 10:00 p.m.) are exempt from the limits (WAC 170-60-050(3)(a)). Construction occurring outside of these hours would likely require a variance, as previously discussed.

Clark County does not have specific environmental noise regulations other than neighborhood nuisance provisions, and would default to the provisions set forth by the WAC.

To reduce temporary noise effects associated with construction, contractors would comply with all state and local regulations relating to construction noise. The following measures could be incorporated into contract specifications to help reduce the effects of construction noise:

- All equipment would have sound control devices that are at least as effective as those on the original equipment. No equipment would have unmuffled exhaust.
- The noise from any rock-crushing or screening operations performed within 3,000 feet of any occupied residence would possibly be mitigated by placing material stockpiles between the operation and the affected residence or by other means approved by the construction manager.

9.0 REFERENCES

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