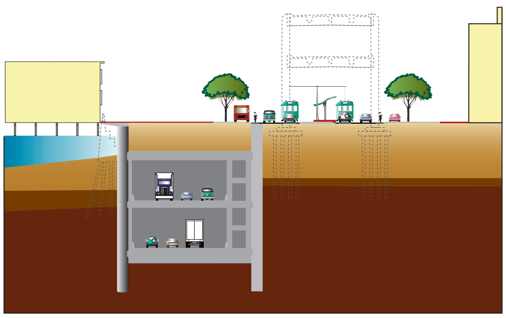
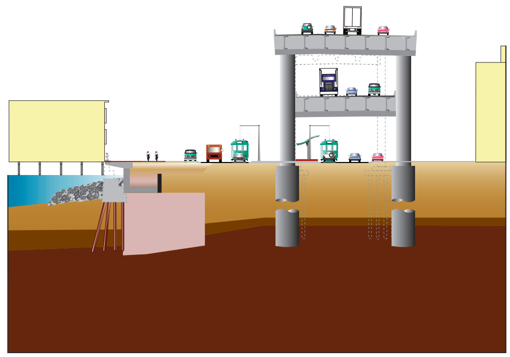
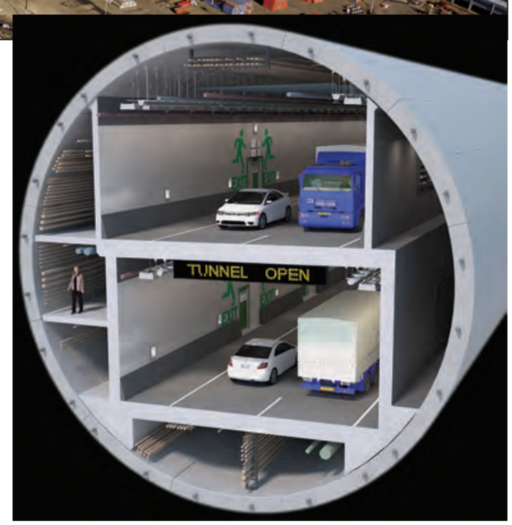
ALASKAN WAY VIADUCT REPLACEMENT PROJECT
Final Environmental Impact Statement

APPENDIX M Air Discipline Report







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U.S. Department of Transportation
Federal Highway Administration

Washington State Department of Transportation

City of Seattle

JULY 2011

Alaskan Way Viaduct Replacement Project

Final EIS
Air Discipline Report

The Alaskan Way Viaduct Replacement Project is a joint effort between the Federal Highway Administration (FHWA), the Washington State Department of Transportation (WSDOT), and the City of Seattle. To conduct this project, WSDOT contracted with:

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In association with:
Coughlin Porter Lundeen, Inc.
EnviroIssues, Inc.
GHD, Inc.
HDR Engineering, Inc.
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ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	micrograms per cubic meter
AM	morning
CFR	Code of Federal Regulations
City	City of Seattle
CO	carbon monoxide
DPM	diesel particulate matter
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EMIT	Easy Mobile Inventory Tool
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
LRTP	long-range transportation plan
MSAT	mobile source air toxic
NAAQS	National Ambient Air Quality Standards
NATA	National Air Toxics Assessment
NEPA	National Environmental Policy Act
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PM	afternoon
PM_{10}	particulate matter with diameter of 10 micrometers or less
$PM_{2.5}$	particulate matter with diameter of 2.5 micrometers or less
POM	polycyclic organic matter
ppm	parts per million
Program	Alaskan Way Viaduct and Seawall Replacement Program
project	Alaskan Way Viaduct Replacement Project
PSCAA	Puget Sound Clean Air Agency
PSRC	Puget Sound Regional Council
SODO	South of Downtown
SR	State Route
VMT	vehicle miles of travel
WAC	Washington Administrative Code
WASIST	Washington State Intersection Screening Tool
WSDOT	Washington State Department of Transportation

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Chapter 1 SUMMARY

1.1 Alternatives Considered

This discipline report was prepared in support of the Final Environmental Impact Statement (EIS) for the Alaskan Way Viaduct Replacement Project (project). The Final EIS and all of the supporting discipline reports evaluate the Viaduct Closed (No Build Alternative) in addition to the three build alternatives: Bored Tunnel Alternative (preferred), Cut-and-Cover Tunnel Alternative, and Elevated Structure Alternative. The designs for both the Cut-and-Cover Tunnel and the Elevated Structure Alternatives have been updated since the 2006 Supplemental Draft EIS (WSDOT et al. 2006) to reflect that the section of the viaduct between S. Holgate Street and S. King Street is being replaced by a separate project, and the alignment at Washington Street is no longer in Elliott Bay. All three build alternatives are evaluated with tolls and without tolls.

The Federal Highway Administration (FHWA) is the lead federal agency for this project, primarily responsible for compliance with the National Environmental Policy Act (NEPA) and other federal regulations, as well as distributing federal funding. Per the NEPA process, FHWA was responsible for selecting the preferred alternative. FHWA has based its decision on the information evaluated during the environmental review process, including information contained in the 2010 Supplemental Draft EIS (WSDOT et al. 2010) and previous evaluations in 2004 and 2006. After issuance of the Final EIS, FHWA will issue its NEPA decision, called the Record of Decision (ROD).

The 2004 Draft EIS (WSDOT et al. 2004) evaluated five Build Alternatives and a No Build Alternative. In December 2004, the project proponents identified the Cut-and-Cover Tunnel Alternative as the preferred alternative and carried the Rebuild Alternative forward for analysis as well. The 2006 Supplemental Draft EIS (WSDOT et al. 2006) analyzed two alternatives—a refined Cut-and-Cover Tunnel Alternative and a modified rebuild alternative called the Elevated Structure Alternative. After continued public and agency debate, Governor Gregoire called for an advisory vote to be held in Seattle. The March 2007 ballot included an elevated structure alternative (differing in design from the current Elevated Structure Alternative) and a surface tunnel hybrid alternative. The citizens voted down both alternatives.

After the 2007 election, the lead agencies committed to a collaborative process (referred to as the Partnership Process) to find a solution to replace the viaduct along Seattle's central waterfront. In January 2009, Governor Gregoire, King County Executive Sims, and Seattle Mayor Nickels announced that the agencies had reached a consensus and recommended replacing the aging viaduct with a bored tunnel, which is being evaluated in this Final EIS as the preferred alternative.

1.2 Build Alternatives Overview

The Alaskan Way Viaduct Replacement Project is one of several independent projects developed to improve safety and mobility along State Route (SR) 99 and the Seattle waterfront from the South of Downtown (SODO) area to Seattle Center. Collectively, these individual projects are often referred to as the Alaskan Way Viaduct and Seawall Replacement Program (the Program). See Exhibit 1-1.

Exhibit 1-1. Other Projects Included in the Alaskan Way Viaduct and Seawall Replacement Program

Project	Bored Tunnel Alternative	Cut-and-Cover Tunnel Alternative	Elevated Structure Alternative
Independent Projects That Complement the Bored Tunnel Alternative			
Elliott Bay Seawall Project	X	Included in alternative	Included in alternative
Alaskan Way Surface Street Improvements	X	Included in alternative	Included in alternative
Alaskan Way Promenade/Public Space	X	Included in alternative	Included in alternative
First Avenue Streetcar Evaluation	X	Included in alternative	Included in alternative
Elliott/Western Connector	X	Function provided[1]	Function provided[1]
Transit enhancements	X	Not proposed[2]	Not proposed[2]
Projects That Complement All Build Alternatives			
S. Holgate Street to S. King Street Viaduct Replacement Project	X	X	X
Mercer West Project	X	X	X
Transportation Improvements to Minimize Traffic Effects During Construction	X	X	X
SR 99 Yesler Way Vicinity Foundation Stabilization	X	X	X
S. Massachusetts Street to Railroad Way S. Electrical Line Relocation Project	X	X	X

Notes: X denotes that it is not included in the alternative.

1. These specific improvements are not proposed with the Cut-and-Cover Tunnel and Elevated Structure Alternatives; however, these alternatives provide a functionally similar connection with ramps to and from SR 99 at Elliott and Western Avenues.
2. Similar improvements included with the Bored Tunnel Alternative could be proposed with this alternative.

This Final EIS (Chapter 7) evaluates the cumulative effects of all the build alternatives; however, direct and indirect environmental effects of these independent projects within the Program will be considered separately in independent environmental documents.

The S. Holgate Street to S. King Street Viaduct Replacement Project, currently under construction as a separate project, was designed to be compatible with any of the three viaduct replacement alternatives analyzed in this Final EIS.

1.2.1 Bored Tunnel Overview

The Bored Tunnel Alternative (preferred alternative) includes replacing SR 99 with a bored tunnel and associated improvements, such as relocating utilities located on or under the viaduct, removing the viaduct, decommissioning the Battery Street Tunnel, and making improvements to the surface streets in the tunnel's south and north portal areas.

The Bored Tunnel Alternative would replace SR 99 between S. Royal Brougham Way and Roy Street with two lanes in each direction.

Beginning at S. Royal Brougham Way, SR 99 would be a side-by-side surface roadway that would descend to a cut-and-cover tunnel. At approximately S. King Street, SR 99 would then become a stacked bored tunnel, with two southbound travel lanes on the top and two northbound travel lanes on the bottom.

The bored tunnel would continue under Alaskan Way S. to approximately S. Washington Street, where it would curve slightly away from the waterfront and then travel under First Avenue beginning at approximately University Street. At Stewart Street, it would extend north under Belltown. At Denny Way, the bored tunnel would travel under Sixth Avenue N., where it would transition to a side-by-side surface roadway at about Harrison Street.

Access and exit ramps in the south would include a southbound on-ramp to and northbound off-ramp from SR 99 that would be built in retained cuts and feed directly into a reconfigured Alaskan Way S. with three lanes in each direction. Alaskan Way S. would have one new intersection, with the new east-west cross street at S. Dearborn Street.

The Bored Tunnel Alternative also includes reconstructing a portion of the east-west S. King Street and widening of the East Frontage Road from S. Atlantic Street to S. Royal Brougham Way to accommodate truck turning movements. Railroad Way S. would be replaced by a new one-lane roadway on which northbound traffic could travel between S. Dearborn Street and Alaskan Way S.

Access from northbound SR 99 and access to southbound SR 99 would be provided via new ramps at Republican Street. The northbound off-ramp to Republican Street would be provided on the east side of SR 99 and routed to an intersection at

Dexter Avenue N. Drivers would access the southbound on-ramp via a new connection with Sixth Avenue N. on the west side of SR 99.

Surface streets in the north portal area would be reconfigured and improved. The street grid between Denny Way and Harrison Street would be connected by restoring a section of Aurora Avenue just north of the existing Battery Street Tunnel portal. John, Thomas, and Harrison Streets would be connected as cross streets.

1.2.2 Cut-and-Cover Tunnel Alternative Overview

Under the Cut-and-Cover Tunnel Alternative, a six-lane stacked tunnel would replace the existing viaduct between S. Dearborn Street and Pine Street. At Pine Street, SR 99 would transition out of the tunnel near the Pike Street Hillclimb and cross over the BNSF Railway tracks on a side-by-side aerial roadway. Near Lenora Street, SR 99 would transition to a retained cut extending up to the Battery Street Tunnel portal. SR 99 would travel under Elliott and Western Avenues. The southbound on-ramp from Elliott Avenue and the northbound on-ramp at Western Avenue would be rebuilt. The northbound on-ramp from Bell Street and the southbound off-ramp at Battery Street and Western Avenue would be closed and used for maintenance and emergency access only.

The Battery Street Tunnel would be retrofitted for improved seismic safety. The existing tunnel safety systems would be updated. Improvements would include widening of the south portal, a new fire suppression system, ventilation, and new emergency egress structures near Second, Fourth, and Sixth Avenues.

From the north portal of the Battery Street Tunnel, SR 99 would be lowered in a retained cut to about Mercer Street, with improvements and widening north to Aloha Street. Broad Street would be closed between Fifth and Ninth Avenues N., allowing the street grid to be connected. Mercer Street would continue to cross under SR 99 as it does today. However, it would be widened and converted from a one-way to a two-way street, with three lanes in each direction and a center turn lane.

Access to and from SR 99 would be provided at Denny Way and Roy Street. In the northbound direction, drivers could exit at Republican Street.

The Cut-and-Cover Tunnel Alternative would replace the existing seawall with the west wall of the tunnel. Alaskan Way would be rebuilt with this alternative.

1.2.3 Elevated Structure Alternative Overview

The Elevated Structure Alternative would replace the existing viaduct mostly within the existing right-of-way. The Elevated Structure Alternative would replace the seawall between S. Jackson and Broad Streets.

In the central section of Seattle's downtown, the Elevated Structure Alternative would replace the existing viaduct with a stacked aerial structure along the central waterfront. The SR 99 roadway would have three lanes in each direction, with wider lanes and shoulders than the existing viaduct.

The existing ramps at Columbia and Seneca Streets would be rebuilt and connected to a new drop lane. This extra lane would improve safety for drivers accessing downtown Seattle on the midtown ramps.

The existing SR 99 roadway would be retrofitted, starting between Virginia and Lenora Streets up to the Battery Street Tunnel's south portal. SR 99 would travel over Elliott and Western Avenues to connect to the Battery Street Tunnel. This aerial structure would transition to four lanes as it enters the Battery Street Tunnel by dropping a northbound lane to Western Avenue. The Battery Street Tunnel would be upgraded with new safety improvements, which include a fire suppression system, seismic retrofitting, and access and egress structures. The vertical clearance would be increased to about 16.5 feet throughout the length of the tunnel.

Unlike the Battery Street Tunnel improvements with the Cut-and-Cover Tunnel Alternative, the roadway at the south portal would not be widened.

The Elliott and Western Avenue ramps would be rebuilt, and the existing southbound off-ramp at Battery Street and Western Avenue and the northbound on-ramp from Bell Street would be closed and used for maintenance and emergency access only. The southbound on-ramp from Elliott Avenue and the northbound on-ramp at Western Avenue would be rebuilt.

The Alaskan Way surface street would be rebuilt as part of the Elevated Structure Alternative. The southbound lanes would be built in a similar location as the existing roadway, and the northbound lanes would be constructed underneath the new elevated structure.

Starting at the north portal of the Battery Street Tunnel, Aurora Avenue would be modified from Denny Way to Aloha Street. Aurora Avenue would be lowered in a side-by-side retained cut roadway from the north portal of the Battery Street Tunnel to about Mercer Street, and it would be at-grade between Mercer and Aloha Streets. Ramps to and from Denny Way would provide access to and from SR 99 similar to today. The street grid would be connected over Aurora Avenue at Thomas and Harrison Streets. Mercer Street would be widened and converted to a two-way street with three lanes in each direction and a center turn lane. It would continue to cross under Aurora Avenue as it does today.

1.3 Analyses and Summary of Results

The purpose of this report is to identify potential effects on air quality associated with the project. The Alaskan Way Viaduct is part of SR 99, a regionally important north-south highway on the western edge of downtown Seattle.

Traffic in the project area would be affected by changes in the number of vehicles, the travel speeds, and the levels of congestion experienced on local roadways. Air quality, which is a general term used to describe pollutant concentrations in the atmosphere, can be affected by these changes.

The study area evaluated for effects on air quality includes areas likely to be affected by changes in pollutant concentrations due to changes in traffic conditions resulting from the build alternatives. The study area also includes areas likely to be affected by emissions from the tunnel ventilation system that could result from the Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative. Both the Cut-and-Cover Tunnel Alternative and the Elevated Structure Alternative would include a new ventilation system for the Battery Street Tunnel.

The air quality analyses for this project followed current guidelines developed by the U.S. Environmental Protection Agency (EPA), FHWA, the Washington State Department of Transportation (WSDOT), the Washington State Department of Ecology (Ecology), and the Puget Sound Regional Council (PSRC).

EPA has identified several air pollutants that are a concern nationwide. These pollutants are known as *criteria pollutants*. The sources of these pollutants, their effects on human health and the nation's welfare, and their concentrations in the atmosphere vary considerably. Under the Clean Air Act, EPA has established National Ambient Air Quality Standards (NAAQS), which specify maximum allowable concentrations for these criteria pollutants (EPA 2010). Areas in compliance with the NAAQS are deemed *attainment areas;* areas not in compliance with the NAAQS are deemed *nonattainment areas;* and areas that were once classified as nonattainment areas but have since demonstrated attainment of the NAAQS are classified as *maintenance areas*. The study area is located within a maintenance area for carbon monoxide (CO) and an attainment area for all of the other criteria pollutants.

In addition to the criteria pollutants for which there are NAAQS, EPA also regulates *air toxics*, which are pollutants known or suspected to cause cancer or other serious health effects. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes, construction equipment, marine vessels, and locomotives), area sources (e.g., dry cleaners), and stationary sources (e.g., factories and refineries). *Mobile source air toxics* (MSATs) are compounds emitted from highway vehicles and non-road equipment. EPA has assessed the extensive list of air toxics and identified the following compounds with significant contributions from mobile sources: benzene, acrolein, formaldehyde, 1,3-butadiene, diesel exhaust, naphthalene, and polycyclic organic matter (POM). FHWA, which has issued guidance for consideration of MSATs for transportation projects, considers these the priority

MSATs. The list is subject to change and may be adjusted in consideration of future EPA rules.

Because the project area is located within a CO maintenance area, the preferred alternative (the Bored Tunnel Alternative), must comply with the project-level and regional conformity criteria described in EPA's Transportation Conformity Rule (Code of Federal Regulations, Title 40, Part 93 [40 CFR 93]) and with Washington Administrative Code, Chapter 173-420 (WAC 173-420). Because the Bored Tunnel Alternative would not cause or exacerbate an exceedance of the NAAQS or increase regional emissions, it would meet the project-level conformity requirements (40 CFR 93.123).

The project is included in PSRC's long-range transportation plan (LRTP), approved May 20, 2010, and referred to as *Transportation 2040* (PSRC 2010a), and the Statewide Transportation Improvement Program (WSDOT 2010a). The inclusion of this project is required to show that the project conforms with the Puget Sound region's Air Quality Maintenance Plans and would not cause or contribute to exceedances of the NAAQS at the regional level. The project meets all the requirements of 40 CFR 93 and WAC 173-420 and demonstrates regional conformity.

The Washington State Intersection Screening Tool (WASIST) was used to estimate CO concentrations at sensitive receptor sites near heavily congested intersections that are expected to be affected by the Viaduct Closed (No Build Alternative) and the three build alternatives. The analysis showed that the non-tolled and tolled Bored Tunnel Alternative, the non-tolled and tolled Cut-and-Cover Tunnel Alternative, and the non-tolled and tolled Elevated Structure Alternative would not cause or contribute to any new localized violations of the NAAQS for CO, increase the frequency or severity of any existing violations of the NAAQS, or delay the timely attainment of the NAAQS in the 2030 design year.

In accordance with FHWA guidelines, the Easy Mobile Inventory Tool (EMIT) was used to calculate annual MSAT pollutant burdens (in tons per year) for the seven priority MSATs. To assess potential project-related effects, existing MSAT pollutant emission burdens were compared to future burdens under each build alternative. The future MSAT concentrations are predicted to be lower than the existing concentrations, even with the increase in vehicle miles of travel (VMT).

Because regional MSAT emissions are not expected to increase and no exceedances of the NAAQS are expected, no significant adverse effects on air quality are expected to result from the three build alternatives. Therefore, no mitigation measures for operational effects would be required.

Construction effects on air quality would occur primarily as a result of emissions from heavy-duty construction equipment (such as bulldozers, backhoes, and cranes), diesel-fueled mobile sources (such as trucks, brooms, and sweepers), diesel- and gasoline-fueled generators, and on- and off-site project-related vehicles (such as service trucks and pickup trucks). Fugitive dust (particulate matter) emissions are associated with demolition, land clearing, ground excavation, grading, cut-and-fill operations, and structure erection.

If construction traffic and lane closures increase congestion and reduce the speed of other vehicles in the area, emissions from traffic would increase temporarily while those vehicles are delayed. These emissions would be temporary, and the effects of these emissions would generally be limited to the immediate area in which the congestion occurs. Some construction stages (particularly those involving paving operations using asphalt) would result in short-term odors, which might be detectable by some people near the site, and they would be diluted as the distance from the site increases.

A fugitive dust control plan implemented as part of project would require dust control measures during construction. The plan could include measures such as spraying exposed soil with water, covering truck loads and materials as needed, washing truck wheels before the trucks leave the site, removing particulate matter from roads, routing and scheduling construction trucks to reduce delays, ensuring well-maintained equipment, and implementing other temporary mitigation measures as needed and considered appropriate.

Chapter 2 BACKGROUND, STUDIES, AND COORDINATION

2.1 Air Quality Standards

EPA has identified several air pollutants as pollutants of concern nationwide. These pollutants, known as *criteria pollutants*, are CO, particulate matter with a diameter of 10 micrometers or less (PM_{10}), particulate matter with a diameter of 2.5 micrometers or less ($PM_{2.5}$), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), and nitrogen dioxide (NO_2). The sources of these pollutants, their effects on human health and the nation's welfare, and their concentrations in the atmosphere vary considerably. Under the Clean Air Act, EPA has established NAAQS, which specify maximum allowable concentrations for these criteria pollutants (EPA 2010). Washington State and the Puget Sound Clean Air Agency (PSCAA) have also adopted these standards. In addition, Washington State and PSCAA have a standard for total suspended particulates. The standards applicable to transportation projects are summarized in Exhibit 2-1.

A violation of the NAAQS may threaten federal funding of a transportation project, and proposed roadway projects requiring federal funding or approval must demonstrate compliance with EPA's Transportation Conformity Rule (40 CFR 93). Conformity is demonstrated by showing that a project would not cause or contribute to any new violation of any NAAQS, increase the frequency or severity of any existing NAAQS violations, or delay timely attainment of the NAAQS.

2.2 Air Pollutants for Analysis

Ambient concentrations of CO and ozone in and beyond the project area are predominantly influenced by emissions from motor vehicle activity. Nitrogen dioxide is emitted from motor vehicle activity and stationary sources (e.g., fossil fuel-fired power plants). Sulfur dioxide emissions are associated mainly with stationary sources. Emissions of particulate matter (PM_{10} and $PM_{2.5}$) are associated with stationary sources and diesel-fueled mobile sources (heavy trucks and buses). Lead emissions, which historically were principally influenced by motor vehicle activity, have been substantially reduced by the elimination of lead from gasoline. The pollutants that are associated with motor vehicle activity are discussed in further detail in the following subsections.

Exhibit 2-1. Summary of Ambient Air Quality Standards

Pollutant	National Primary Standard	Washington State Standard	PSCAA Regional Standard
Carbon Monoxide (CO)			
1-hour average (not to be exceeded more than once per year)	35 ppm	35 ppm	35 ppm
8-hour average (not to be exceeded more than once per year)	9 ppm	9 ppm	9 ppm
PM_{10}			
Annual arithmetic mean	NA	50 µg/m^3	50 µg/m^3
24-hour average concentration	150 µg/m^3	150 µg/m^3	150 µg/m^3
$PM_{2.5}$			
Annual arithmetic mean	15 µg/m^3	NA	NA
24-hour average concentration (98th percentile)	35 µg/m^3	NA	NA
Total Suspended Particulates			
Annual arithmetic mean	NA	60 µg/m^3	60 µg/m^3
24-hour average concentration (not to be exceeded more than once per year)	NA	150 µg/m^3	150 µg/m^3
Ozone (O_3)			
8-hour average (3-year average of fourth highest daily maximum)	0.075 ppm	NA	NA
Sulfur Dioxide (SO_2)			
1-hour average (not to be exceeded more than twice in 7 days)	NA	0.25 ppm	0.25 ppm
24-hour average concentration (never to be exceeded)	0.14 ppm	0.1 ppm	0.1 ppm
Annual arithmetic mean	0.03 ppm	0.02 ppm	0.02 ppm
Nitrogen Dioxide (NO_2)			
1-hour average	0.1 ppm		
Annual arithmetic mean	0.053 ppm	0.053 ppm	0.053 ppm
Lead (Pb)			
Rolling 3-month average	0.15 µg/m^3		
Quarterly average	1.5 µg/m^3	1.5 µg/m^3	1.5 µg/m^3

Sources: EPA 2010; PSCAA 1994; 40 CFR 50 (1997); WAC 173-470, 173-474, and 173-175 (1987).

Notes: The 8-hour ozone standard of 0.075 ppm (effective in 2008) replaces (for the most part) the previous 1-hour standard of 0.08 ppm.

µg/m^3 = micrograms per cubic meter

NA = not applicable

$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers

PM_{10} = particulate matter with diameter less than or equal to 10 micrometers

ppm = parts per million

PSCCA = Puget Sound Clean Air Agency

2.2.1 Carbon Monoxide

CO is a colorless gas that interferes with the transfer of oxygen to the brain. CO is emitted almost exclusively from the incomplete combustion of fossil fuels. Prolonged exposure to high levels of CO can cause headaches, drowsiness, loss of equilibrium, and heart disease. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations of CO are typically found near congested intersections, along heavily used roadways conveying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban "street canyon" conditions. Consequently, CO concentrations are predicted on a localized, or microscale, basis.

2.2.2 Particulate Matter

Particulate pollution is composed of solid particles or liquid droplets that are small enough to remain suspended in the air. Of particular concern are those particles that have a diameter less than, or equal to, 10 micrometers (PM_{10}) and 2.5 micrometers ($PM_{2.5}$).

PM_{10} consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. It also forms when gases emitted from motor vehicles or industrial sources undergo chemical reactions in the atmosphere. Major sources of PM_{10} include motor vehicles; wood-burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. Suspended particulates produce a haze and reduce visibility. PM_{10} poses a greater health risk than larger particles. When inhaled, these small particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract. PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections.

$PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces, and wood stoves. $PM_{2.5}$ can also be formed in the atmosphere from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds (VOCs). The main health effects of airborne $PM_{2.5}$ are on the respiratory system. Like PM_{10}, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Whereas particles larger than 2.5 and up to 10 micrometers in diameter tend to collect in the upper portion of the respiratory system, particles with a diameter of 2.5 micrometers or less are so tiny that they can penetrate deeper into the lungs and damage lung tissues. Because of the diesel truck emissions that would be generated from fuel combustion within the tunnel alternatives, $PM_{2.5}$ emissions released from the tunnel portals and tunnel operations/maintenance buildings were considered on a localized level.

2.2.3 Ozone

Ozone (O_3) is a colorless toxic gas that enters the bloodstream and interferes with the transfer of oxygen, depriving sensitive tissues in the heart and brain of oxygen. Ozone also damages plants by inhibiting their growth. Although ozone is not directly emitted, it forms in the atmosphere through a chemical reaction between reactive organic gases and nitrogen oxides, which are emitted from industrial sources and automobiles. Substantial ozone formations generally require a stable atmosphere with strong sunlight.

The effects of ozone are usually examined on an areawide, or mesoscale, basis. However, the effects of the project on regional traffic conditions would be minimal; therefore, a regional ozone analysis is not warranted.

2.2.4 Nitrogen Oxides

Nitrogen dioxide (NO_2) is a brownish gas that irritates the lungs. It can cause breathing difficulties at high concentrations. Like ozone, nitrogen dioxide is not directly emitted but is formed through a reaction between nitrous oxide (N_2O) and atmospheric oxygen. Nitrous oxide and nitrogen dioxide, which are collectively referred to as nitrogen oxides (NO_x), are major contributors to ozone formation. Nitrogen dioxide also contributes to the formation of particulate matter. At atmospheric concentrations, nitrogen dioxide is only potentially irritating. High concentrations of nitrogen dioxide result in a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between nitrogen dioxide and chronic pulmonary fibrosis. Some increase in bronchitis in children (2 and 3 years old) has also been observed at concentrations less than 0.3 parts per million (ppm).

Nitrogen oxide emissions for a transportation project are usually examined on a regional basis as a precursor of ozone. However, because of the minimal project-related effects on regional traffic conditions, a regional analysis of nitrogen oxide emissions is not warranted.

2.2.5 Lead

Lead (Pb) is a stable element that persists and accumulates in the environment and in animals, including humans. Its principal effects in humans are on the blood-forming, nervous, and renal systems. Lead levels in the urban environment from mobile sources, such as automobiles, have substantially decreased since the federally mandated switch to unleaded gasoline and are expected to decrease further. Therefore, an analysis of lead from mobile sources is not warranted.

2.2.6 Mobile Source Air Toxics

In addition to the criteria pollutants for which there are NAAQS, EPA also regulates *air toxics*, which are pollutants known or suspected to cause cancer or other serious health effects. Most air toxics originate from human sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries).

Controlling emissions of air toxics became a national priority with the passage of the Clean Air Act Amendments of 1990, whereby Congress mandated that EPA regulate 188 air toxics, also known as *hazardous air pollutants*. The EPA has assessed this expansive list in its latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in the Integrated Risk Information System (IRIS) (http://www.epa.gov/ncea/iris/index.html). In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from the 1999 National Air Toxics Assessment (NATA) (http://www.epa.gov/ttn/atw/nata1999/). These are acrolein, benzene, 1,3-butadiene, diesel particulate matter plus diesel exhaust organic gases (diesel particulate matter [DPM]), formaldehyde, naphthalene, and POM.

EPA's February 2007 rule mentioned above requires engine controls that will dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. According to an FHWA analysis using EPA's MOBILE6.2 model, even if national average vehicle activity (VMT) increases by 145 percent as assumed, a combined reduction of 72 percent in the total annual emission rate for the priority MSAT is projected from 1999 to 2050.

Brief descriptions of the seven priority MSATs are provided below.

- 1,3-Butadiene – characterized as carcinogenic to humans if inhaled.
- Acrolein – very little available information about the effects on human health due to long-term exposure to acrolein. Its potential carcinogenicity cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation exposure route. However, acrolein is extremely acrid and irritating to mucous membranes.
- Benzene – characterized as a known human carcinogen.
- Diesel exhaust – likely to be carcinogenic to humans by inhalation from environmental exposures. Diesel exhaust, as reviewed in the 1999 NATA, is the combination of DPM and diesel exhaust organic gases. Diesel exhaust also produces chronic respiratory effects, possibly the primary noncancer hazard from MSATs. Prolonged exposures may impair

pulmonary function and could produce symptoms, such as cough, phlegm, and chronic bronchitis. Exposure relationships have not been developed from these studies.

- Formaldehyde – a probable human carcinogen, based on limited evidence in humans and sufficient evidence in animals.
- Naphthalene – EPA has classified naphthalene as a Group C, possible human carcinogen. Acute exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia, damage to the liver, and neurological damage. Cataracts have also been reported in workers with acute exposures to naphthalene by inhalation and ingestion.
- Polycyclic organic matter – a broad class of compounds that includes the polycyclic aromatic hydrocarbons (PAHs), of which benzo(a)pyrene is a member. Cancer is the major concern from exposure to POM. EPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.

While FHWA considers these the priority MSATs, the list is subject to change and may be adjusted on the basis of future EPA rules.

2.3 Climate and Air Quality

In accordance with WSDOT guidelines, greenhouse gas effects associated with the project are presented in Appendix R, Energy Discipline Report.

2.4 Project Coordination

Methods for air quality analysis were developed for the Program in coordination with WSDOT, the City of Seattle (City), King County, and FHWA. In April 2002, an approach for the air quality analysis was distributed to these agencies for review and comment. Their input was incorporated into the approach, and on March 5, 2009, an updated methodology was presented to WSDOT and City staff. Input from WSDOT and the City was incorporated into the approach used in the air quality analysis. The methodology was further updated for the Final EIS based on revised guidance and procedures from these agencies.

Chapter 3 METHODOLOGY

3.1 Study Area

Effects on air quality were evaluated in areas likely to be affected by changes in pollutant concentrations due to changes in traffic conditions resulting from the build alternatives. The study area also includes areas likely to be affected by potential emissions from the tunnel ventilation systems associated with the Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative or the new ventilation systems for the Battery Street Tunnel associated with the Elevated Structure Alternative. It also includes areas that are likely to be affected by increased emissions during construction. The ventilation system for the bored tunnel and the cut-and-cover tunnel would be housed in the two tunnel operations buildings. The ventilation system for the Battery Street Tunnel would be housed in several tunnel maintenance buildings located along the tunnel alignment for the Cut-and-Cover Tunnel and Elevated Structure Alternatives.

Localized effects on air quality were evaluated for one main study area within the Center City area of Seattle (Exhibit 3-1). The MSAT effects were also evaluated on a regional scale, including all the vehicle movements occurring in King, Pierce, Snohomish, and Kitsap Counties.

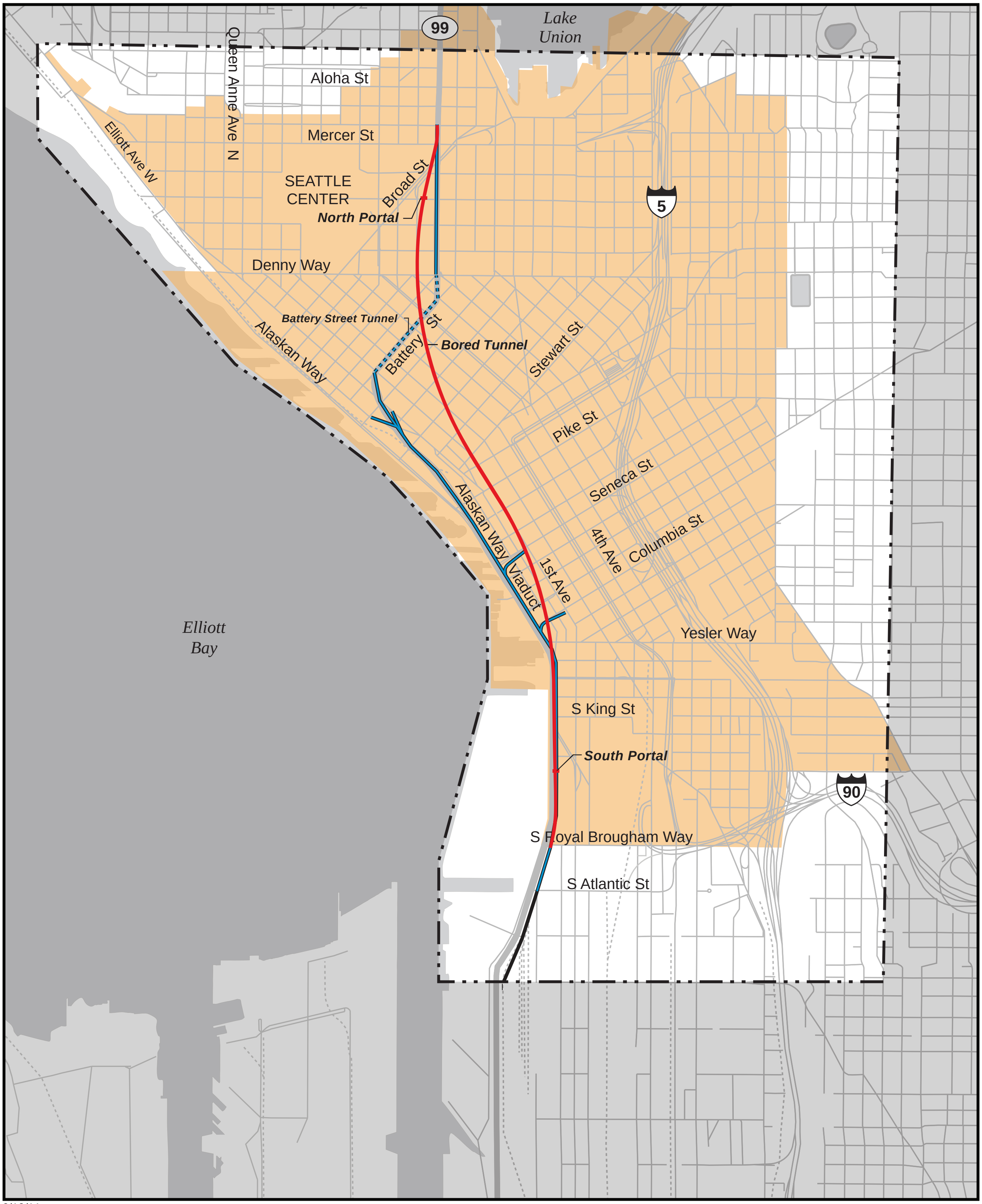
3.2 Applicable Regulations and Guidelines

Air quality in the project area is regulated by EPA, Ecology, and PSCAA. The air quality analysis and preparation of this report followed guidance provided in Chapter 425 of WSDOT's *Environmental Procedures Manual* (WSDOT 2010b), as well as guidelines developed by EPA, FHWA, WSDOT, Ecology, and PSRC.

3.3 Data Needs and Sources

3.3.1 Traffic Data

The evaluation of effects on air quality was based on the data and findings of the transportation analysis (provided in Appendix C, Transportation Discipline Report). The study area for the transportation analysis includes the portion of Seattle in which traffic patterns would most likely be affected by the build alternatives. Detailed traffic analyses were completed for existing conditions (2015) and the project design year (2030) for the Viaduct Closed (No Build Alternative) and all three build alternatives. The results of these analyses are provided in Appendix C, Transportation Discipline Report. Detailed traffic analyses were completed for the Bored Tunnel Alternative (preferred) only for the year of opening (2015) and the LRTP analysis year (2040) as



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Study Area
Center City
Battery Street Tunnel
Elevated Structure and Cut-and-Cover Tunnel Alternatives
Bored Tunnel Alternative

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Note: The Cut-and-Cover Tunnel Alternative does not include the four ramps (Elliott, Western, Seneca, and Columbia) shown in blue.

Exhibit 3-1
Center City

part of the conformity compliance determination. The 2015 and 2040 traffic analyses for the Bored Tunnel Alternative are described in Attachment D of this report.

3.3.2 Background Concentrations

Microscale modeling provides estimated concentrations of pollutants from motor vehicle emissions on the roadways adjacent to the receptor locations. To estimate total pollutant concentrations at a prediction site, background concentrations are added to the estimates to account for pollution entering the area from other sources upwind.

WASIST, a screening model developed by WSDOT, was used in all the mobile source analyses. It uses a conservative background concentration of 3 ppm for determining reasonable worst-case 1-hour and 8-hour CO concentrations at signalized intersections throughout Washington (WSDOT 2005).

The CO and $PM_{2.5}$ background concentrations that were used in the more detailed analyses for the tunnel portals and tunnel operations (or maintenance) buildings were estimated using monitoring data for the latest 3 years (2006–2008) at the Beacon Hill Reservoir station, located about three miles south of the study area. Out of the second-highest concentrations recorded in these 3 years, the highest of the three concentrations was used to determine the following background values:

- CO — 2.3 ppm for 1-hour values and 1.5 ppm for 8-hour values
- $PM_{2.5}$ — 20.2 micrograms per cubic meter ($\mu g/m^3$) for 24-hour values and 7.5 $\mu g/m^3$ for annual values

These values were added to the results of the modeling analyses to estimate total pollutant concentrations, which were then compared to the NAAQS.

3.3.3 Vehicle Emissions

Pollutant emissions from motor vehicles are affected by many factors, including travel speed; temperature; operating mode; and the age, type, and condition of the vehicle. Emission models calculate emission factors for average vehicles operating under specific parameters, such as speed, vehicle (which is a composite of automobiles, light trucks, heavy trucks, sport utility vehicles), age, and local emission control requirements.

Emission factors for CO and $PM_{2.5}$ for vehicles in Seattle traveling on an arterial or highway were estimated using the latest version of EPA's emission factor algorithm (MOBILE6.2.03). The data inputs provided by PSRC are based on implementation of Washington State's basic inspection and maintenance and antitampering programs, which require biannual inspections of automobiles and light trucks to determine whether emissions from the vehicles' exhaust systems are less than the strict emission standards. Vehicles failing the emissions test must undergo maintenance and pass a retest or receive a waiver to be registered in Washington State.

MOBILE6.2.03 emission factors were developed for the existing conditions (2015), the project's design year (2030), and the area's transportation planning year (2040) to determine compliance with the EPA's Transportation Conformity Rule (40 CFR 93). Emission factors were developed for winter conditions, which provide reasonable worst-case CO estimates. Emission factors generally decrease over time as a result of the gradual replacement of older vehicles with newer, less-polluting vehicles. All vehicles traveling on SR 99 (including those within tunnels) were assumed to be operating in the hot stabilized mode (i.e., after the engine has warmed up).

3.4 Analysis of Environmental Effects

3.4.1 Analysis Years

The following years were considered in the operational analysis: the existing conditions (2015) and the project's design year (2030). The Transportation Discipline Report (Appendix C) of the Supplemental Draft EIS (WSDOT et al. 2010) used conditions in the year 2005 for the affected environment. The affected environment describes the context, or setting, of the project. For the Final EIS, the year 2015 was chosen to represent the affected environment to account for projects recently completed or currently underway. The S. Holgate Street to S. King Street Viaduct Replacement Project affects access to the Alaskan Way Viaduct. The project is funded, under construction, and will be completed by 2015. Recent modifications to SR 519 have also resulted in new traffic patterns in the south area, which need to be captured as part of the affected environment. Based primarily on these two projects, it was determined that 2015 would serve as a better description of the project setting in the Final EIS than 2005 conditions. Appendix C, Transportation Discipline Report, provides more information on the determination of traffic conditions under 2015 existing conditions.

A conformity compliance determination was performed for the preferred alternative (the Bored Tunnel Alternative), as both a non-tolled and a tolled facility). The project's reasonable worst-case construction year (2012), the year of opening (2015), and the LRTP analysis year (2040)[1] were considered as part of the conformity compliance determination. The 2015 and 2040 traffic analyses are documented in Attachment D of this report.

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[1] Includes this project's study area.

3.4.2 Analysis Periods

For the local (microscale) analysis, traffic data for the afternoon (PM) peak period and morning (AM) peak period were used to estimate maximum 1-hour and 8-hour CO concentrations. The PM peak period is the period of the day with the highest traffic volume in downtown Seattle.

For the analysis of tunnel portals and tunnel operation/maintenance buildings, hourly emission rates were developed based on hour-by-hour traffic conditions over a 24-hour period. These emission rates were then used to estimate 1-hour and 8-hour CO concentrations and 24-hour and annual $PM_{2.5}$ concentrations associated with emissions generated within the tunnel and released through the exit portals.

3.4.3 Mobile Source CO Analysis Sites and Receptor Locations for Operational Analysis

Analysis sites typically include critical roadway links and heavily congested intersections, connecting bus routes, locations adjacent to sensitive land uses, and representative locations throughout the study area that may be affected by the project. To select sites for analysis, major signalized intersections that may be affected by the project were identified. These intersections were then evaluated for traffic volumes and levels of service under the build alternatives for the design year 2030 and ranked according to the results. Sites at which air quality was most likely to be substantially affected by the build alternatives were selected for analysis in accordance with accepted WSDOT procedure.

The WASIST simulates physical conditions and predicts pollutant concentrations at specific receptor locations on sidewalks near intersections affected by roadway traffic. For this project, receptors were located at the four sidewalks of each intersection, at a distance of 10 feet from the edge of each travel lane.

The intersections were ranked and prioritized based on the total approach volume and intersection delay for the build alternatives in 2030. The highest ranked intersections for each condition were selected for analysis. Seven intersections were analyzed:

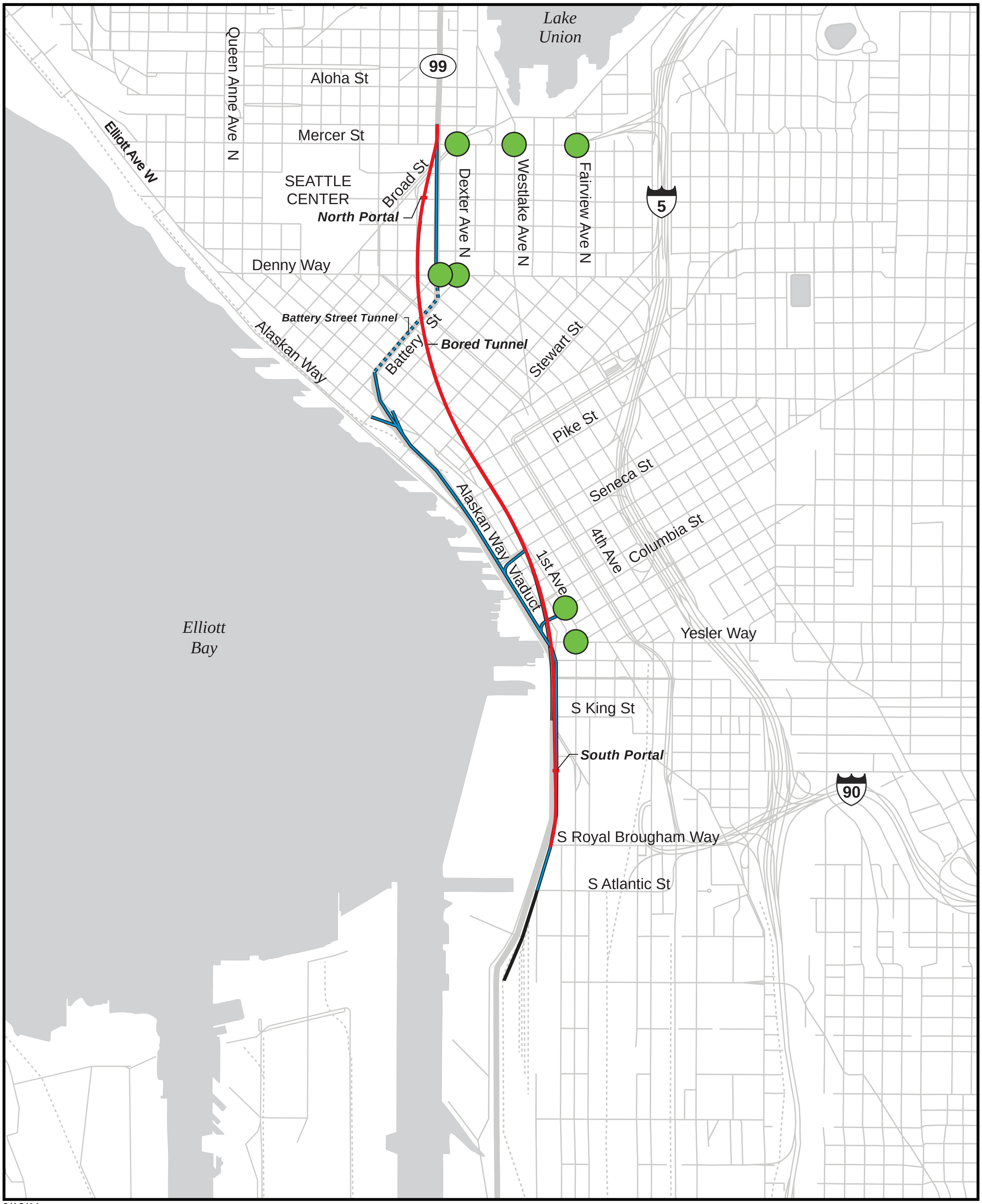
- Yesler Way and First Avenue
- Columbia Street and First Avenue
- Denny Way and Dexter Avenue
- Denny Way and Aurora Avenue northbound
- Mercer Street and Fairview Avenue N.
- Mercer Street and Westlake Avenue N.
- Mercer Street and Dexter Avenue N.

The reasons for selecting these sites are summarized in Exhibit 3-2, and the site locations are shown in Exhibit 3-3.

Exhibit 3-2. Mobile Source CO Analysis Sites

Intersection	Peak Period (AM or PM)	Reasons for Selection
Columbia Street and First Avenue	PM	Delay: Tolled Elevated Structure Alternative
Yesler Way and First Avenue	PM	Delay: Tolled Elevated Structure Alternative
Denny Way and Dexter Avenue	PM	Delay: Tolled Bored Tunnel Alternative Tolled Cut-and-Cover Tunnel Alternative Non-tolled Elevated Structure Alternative
Denny Way and Dexter Avenue	AM	Delay: Non-tolled Bored Tunnel Alternative
Denny Way and Aurora Avenue NB	PM	Delay: Non-tolled and tolled Cut-and-Cover Tunnel Alternative Tolled Elevated Structure Alternative
Mercer Street and Fairview Avenue N.	PM	Delay and volume: Non-tolled and tolled Bored Tunnel Alternative Non-tolled and tolled Cut-and-Cover Tunnel Alternative Non-tolled Elevated Structure Alternative Volume: Tolled Elevated Structure Alternative
Mercer Street and Westlake Avenue N.	PM	Delay and volume: Non-tolled and tolled Bored Tunnel Alternative Non-tolled Cut-and-Cover Tunnel Alternative Non-tolled Elevated Structure Alternative Volume: Tolled Elevated Structure Alternative Tolled Cut-and-Cover Tunnel Alternative
Mercer Street and Dexter Avenue N.	PM	Volume: Non-tolled and tolled Bored Tunnel Alternative Non-tolled and tolled Cut-and-Cover Tunnel Alternative Non-tolled and tolled Elevated Structure Alternative

Notes: AM = morning
NB = northbound
PM = afternoon



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Intersections Modeled for 2030

Battery Street Tunnel

Elevated Structure and Cut-and-Cover Tunnel Alternatives

Bored Tunnel Alternative

Exhibit 3-3
CO Analysis Locations

All of these intersections were considered for the analysis of existing (2015) conditions and future (2030) conditions under the Viaduct Closed (No Build Alternative) and the build alternatives. While intersections were evaluated under reasonable worst-case traffic conditions (PM peak period), one intersection (Denny Way and Dexter Avenue) was analyzed for both the AM and PM peak periods because of high traffic volumes at this location during the AM peak period with the build alternatives.

The reasonable worst-case CO concentrations estimated for the receptors at these locations were compared to the NAAQS to determine whether the build alternatives would potentially result in concentrations greater than these standards.

3.4.4 Analysis Sites Near Tunnel Portals and Tunnel Operations/Maintenance Buildings

Air quality levels were estimated at sensitive land uses located near the tunnel portals and the north tunnel operations/maintenance building. Receptors were placed along sidewalks at locations that are accessible to the public and buildings with windows or doors that open toward the roadway. The exact number of receptors considered near each analysis site was determined based on the configuration and complexity of the site. The following types of receptor sites were used:

- Locations near the tunnel portals that would be accessible to the public and at least 10 feet from either side of the travelway
- Both ground-level and elevated receptors (e.g., operable windows, air intake ducts) on nearby buildings

3.4.5 Mobile Source Model

WASIST, which was used for all the mobile source intersection analyses, is a screening model used for determining reasonable worst-case CO concentrations at signalized intersections throughout Washington. The results are based on the latest version of EPA's emission factor algorithm (MOBILE6.2.03) and EPA's CAL3QHC mobile source dispersions model. CO concentrations are estimated based on the intersection geometry, user inputs, and reasonable worst-case assumptions regarding meteorological and topographical factors. CO emission factors are determined for each approaching leg of traffic and for idling vehicles. All the parameters used in WASIST and the model's output are provided in Attachment A.

WASIST uses readily available data in a user-friendly application to make a conservative estimate of project-related CO concentrations. It uses a combination of reasonable worst-case conditions that, when occurring simultaneously, produce the highest concentrations of CO. The purpose of the model is to allow the user to conservatively estimate the highest CO concentrations that would be found at an intersection without having to perform a more time-consuming detailed analysis. If the results from WASIST do not violate the NAAQS for CO, the effect from any other combination of conditions would also be less than the standards, and no further modeling is required.

3.4.6 MSAT Emissions Modeling Methodology

On February 3, 2006, FHWA released *Interim Guidance on Air Toxic Analysis in NEPA Documents.* On September 30, 2009, this guidance was superseded by FHWA's *Interim Guidance Update on Air Toxic Analysis in NEPA Documents* (FHWA 2009). The purpose of FHWA's guidance is to advise on when and how to analyze MSATs in the NEPA process for highways. This guidance is considered interim guidance because MSAT science is still evolving. As the science progresses, FHWA will update the guidance.

FHWA's interim guidance groups projects into three categories:

- Tier 1 – No analysis for projects without potential for meaningful MSAT effects
- Tier 2 – Qualitative analysis for projects with a low potential for MSAT effects
- Tier 3 – Quantitative analysis to differentiate alternatives for projects with a higher potential for MSAT effects

FHWA has developed this approach because currently available technical tools do not allow a prediction of the project-specific health effects that would result from the potential emission changes associated with a project. These limitations include the following:

- Emissions – The EPA tools to estimate MSAT emissions from motor vehicles are not sensitive to key variables that determine emissions of MSATs in the context of a highway project.
- Dispersion – The tools to predict dispersion of MSATs into the environment are limited. The current dispersion models were developed for predicting episodic concentrations of CO to determine compliance with the NAAQS. The performance of dispersion models is more accurate for predicting maximum concentrations than for predicting exposure patterns.
- Exposure levels and health effects – Even if emission levels and concentrations of MSATs could be accurately predicted, shortcomings in current techniques for exposure assessment and risk analysis preclude any meaningful conclusion about project-specific health effects. Exposure assessments are difficult because it is difficult to accurately calculate

annual concentrations of MSATs near roadways and to determine the portion of a year that people are actually exposed to those concentrations at a specific location.

Based on FHWA's recommended tiered approach, the project belongs in Tier 3 (i.e., projects with a high potential for MSAT effects). This category is appropriate because the tunnel alternatives have the potential to add capacity to urban roadways, and the affected roadways are located near populated areas.

Following FHWA's recommendation, EMIT was used to calculate annual MSAT pollutant burdens in tons per year for the project. EMIT incorporates EPA's MOBILE6.2.03 emission factor algorithm along with components for forecasting vehicle speeds under congested conditions and VMT as a function of area type and roadway functional class. EMIT focuses on the following pollutants because they were previously (before EPA's February 2007 rule) classified as priority MSATs:

- 1,3-Butadiene
- Acetaldehyde
- Acrolein
- Benzene
- DPM/diesel exhaust organic gases
- Formaldehyde

Summer and winter parameters were used as input to the MOBILE6.2.03 portion of EMIT to obtain an accurate estimate of the annual pollutant burden. MOBILE6.2.03 input parameters recommended by PSRC, Ecology, and FHWA were used in EMIT, along with the traffic volumes, speeds, and travel characteristics forecasted for the project.

The current version of EMIT has not yet been updated to reflect all the MSATs of concern listed in EPA's February 2007 rule. For the air toxics not evaluated within EMIT (naphthalene and POM), MOBILE6.2 was run directly for each roadway functional class and associated speed. The calculated emission rates were then multiplied by the VMT, resulting in the emission burden. Because POM is a broad class of compounds rather than one single MSAT, the following air toxics emission rates were independently calculated with MOBILE6.2 and combined:

- Acenaphthene
- Anthracene
- Acenaphylene
- Benz[a]anthracene
- Benzo[b]fluoranthene

- Benzo[k]fluoranthene
- Benzo[a]pyrene
- Benzo[g,h,i] perylene
- Chrysene
- Debenz[a,h]anthracene
- Fluoranthene
- Fluorene
- Ideno[1,2,3-cd]pyrene
- Phenanthrene
- Pyrene

All the parameters used in EMIT and the model's output are provided in Attachment B.

3.4.7 Stationary Source Model

Stationary source models are the basic analytical tools used to estimate pollutant concentrations resulting from one or more localized emission sources. The EPA AERMOD model is a current recommended stationary model that was used to estimate pollutant concentrations near the tunnel portals and tunnel operations/maintenance buildings. The basis of the AERMOD model, which can be used to estimate the combined effects from multiple emission sources, is the straight-line, steady-state Gaussian plume equation. The model is used to estimate effects from simple point-source emissions from stacks; emissions from stacks that are subjected to aerodynamic downwash due to nearby buildings; and emissions from isolated vents, multiple vents, storage piles, conveyor belts, and the like.

Two types of stationary sources were considered for this analysis: point sources and area sources.

- A point source refers to a condition in which emissions are released through a limited opening such as a stack or vent. The emissions released through the exhaust stacks located on the roofs of the tunnel operations/maintenance buildings were considered as point sources.
- An area source refers to a two-dimensional area from which pollutants are emitted, usually from or near ground level. The emissions released through the tunnel portals and ramps (before they reach sensitive land uses) and downstream of the portal exits/entrances were considered as area sources.

AERMOD accepts hourly meteorological observations and is able to directly estimate concentrations over short-term (e.g., 1-hour, 3-hour, 8-hour, and 24-hour) and long-term (e.g., annual) periods. This analysis used 5 years of the atmospheric meteorological data (2005 to 2009) collected at Seattle-Tacoma International Airport. Surface characteristics and surface roughness factors were determined based on local land uses. Two sets of dispersion algorithms are included in AERMOD: one for urban areas and one for rural areas. The urban algorithms were used for all the project-related analyses.

3.5 Air Quality Modeling Methodology

3.5.1 Roadways and Intersections

A microscale modeling analysis was conducted using WASIST to estimate CO concentrations at sensitive receptor sites located near heavily congested intersections that are expected to be affected under the Viaduct Closed (No Build Alternative) and the build alternatives.

3.5.2 Tunnel Portals

The potential air quality effects of emissions released from the tunnel portals were estimated using normal (i.e., not emergency or breakdown) operating conditions. During a fire in the tunnel or other emergency condition, pollutant concentrations may exceed the NAAQS at nearby receptors, but they are not expected to exceed acutely harmful concentrations during the time it would take to evacuate the adjacent areas.

CO and $PM_{2.5}$ concentrations were estimated at sensitive land uses located near the tunnel portals using a method specifically developed for this type of emissions source. The method is based on wind tunnel test data developed for several similar projects and procedures that were accepted by regulatory agencies in the United States and elsewhere. This analysis was conducted using data for emissions released through the tunnel portals, as supplied by the project's mechanical ventilation engineers.

Total pollutant concentrations estimated at each receptor location considered were assumed to be affected by the following components:

- Emissions exhausted out of the tunnel portals
- Emissions from the vehicles traveling on roadways immediately downstream of the tunnel portals (including on- and off-ramps)
- Emissions (where applicable, depending on the portal and receptor locations and the critical wind angles) from traffic on adjacent surface roadways
- Background concentrations appropriate for the area

Total pollutant concentrations estimated at nearby receptors from all of these sources combined were compared with the appropriate air quality standards. The methods used to estimate the potential effects from each of the previously mentioned sources are discussed separately in the following subsections. Attachment C provides representative examples of emission and modeling data (including input and output tables) used in the tunnel and ventilation modeling analyses.

Releases From Tunnel Portals

The approach that was used to analyze releases from the tunnel portals is based on the assumption that the jet of air exiting a tunnel portal maintains its integrity (i.e., maintains a uniform set of conditions from which pollutants disperse) for a finite distance along the roadway after exiting the portal. This assumption is based on researchers' observations indicating that air emitted from a tunnel portal forms a plume that is both pushed out of the tunnel by vehicles before they exit the tunnel (and, if applicable, by mechanical ventilation systems) and dragged out of the portal by these same vehicles as they move downstream of the portal. In addition, the stream of moving cars exiting a tunnel portal creates a continuous source of momentum that maintains a jet of air with a finite length, width, and height, and the individual cars in the stream create a mechanical turbulence that mixes the air uniformly within this region.

Although no method is currently available for mathematically estimating the configuration of the jet or its concentration gradients, the following factors were used to estimate its size and shape:

- The speed of the vehicles passing through the tunnel
- The atmospheric wind speed and direction
- The topography of the area immediately surrounding the tunnel portal
- The type of portal (i.e., whether it is one-way or two-way)
- The geometry of the portal (i.e., its height and physical configuration, and whether there is a wall between the directional roadways)
- The type of ventilation used in the tunnel (i.e., natural or mechanical and, if mechanical, either longitudinal or transverse)

In general, the greater the tunnel exhaust velocity (from a naturally or mechanically ventilated tunnel) and the lower the atmospheric wind speed in the direction opposite the traffic flow, the greater the length of the jet. In addition, the faster the speed of the vehicles exiting the portals, the greater the tunnel exhaust velocity.

Based on wind tunnel studies conducted for similar tunnel portals, a scenario that divides the overall jet into separate finite regions, each with its own unique (and uniform) set of emission rates, was developed for each analysis. The portal jet properties that were assumed for estimating the effects of the project were based on the following factors:

- The number of lanes of traffic exiting each portal.
- Whether the entrance and exit roadways of the portal are physically separated.

- For jets located in depressed sections of roadway downstream of the tunnel portals, the emissions from these jets would disperse through the top portion of the exiting lanes of the depressed roadways. (Each of these jets was modeled as an area source that has the width of the exiting roadway. The relative height of receptor sites located at sidewalks immediately over a portal was raised above the area source to account for the vertical distances between these receptors and the height of the emission sources. The length of each jet was estimated based on vehicle speeds, portal release exit flow rates, and the geometrical alignment of the portal area.)
- Based on a review of wind tunnel studies, it was assumed that the total emissions released through the tunnel portals would be dispersed into the atmosphere via three jet sections of equal length. The lengths of each jet section and the percentage of total portal emissions in each section were based on the configuration of the tunnel portal and the downstream roadway.

The effects were estimated using AERMOD, with each jet section was assumed to be an area source.

Roadway Emissions From Downstream Traffic

Emissions from the traffic immediately downstream of each portal on the mainline and on the ramps were also modeled (using AERMOD) as area sources with emissions that would be released into the atmosphere along the top of the depressed roadway sections or above the at-grade sections as appropriate. The width of the area source was the width of the roadway. The length of the area source was estimated based on the proposed configuration of the roadway. Hourly emission rates were developed based on hour-by-hour traffic conditions over a 24-hour period.

Total Concentrations Near Tunnel Portals

Total CO concentrations at each of the receptor locations were estimated by adding the effects of all of these sources to the appropriate background concentrations. Maximum CO concentrations estimated at each receptor location near each tunnel portal were compared to the NAAQS.

3.5.3 Tunnel Operations/Maintenance Buildings

Emissions captured by the tunnel ventilation systems would be released through the exhaust located on the roofs of the tunnel operations/maintenance buildings. The effects of these emissions were modeled using the AERMOD point-source option. Exhaust points were located at the tops of the ventilation stacks. Stack tip downwash and the downwash effect of the ventilation and other nearby buildings were taken into account. Background concentrations and emissions from the tunnel portals and nearby roadways (where applicable) were added together to estimate the total pollutant concentrations at nearby sensitive receptors.

3.6 Analysis of Construction Effects

Two analyses were conducted to evaluate the potential effects during project-related construction. One was a qualitative analysis of potential effects associated with emissions from dust-generating activities, operation of heavy-duty diesel equipment, and trucking activities within major construction areas. The other was a quantitative mobile source analysis to estimate potential effects associated with changes in traffic conditions during major construction (as a result of changes in traffic patterns during major phases of construction and construction-related trucking activities on the local roadway network). The quantitative analysis was conducted as part of the determination of the project's compliance with EPA's Transportation Conformity Rule (40 CFR 93).

3.7 Conformity Compliance Determination

Because the project is located within a CO maintenance area, conformity compliance analyses were conducted to determine whether the project, and specifically the preferred alternative (Bored Tunnel Alternative), would cause or exacerbate an exceedance of the NAAQS for CO. The analyses were conducted for both the operational and construction phases of the non-tolled and tolled Bored Tunnel Alternative.

3.7.1 Operational Phase

To select sites for analysis, major signalized intersections identified for the year 2030 for the Bored Tunnel Alternative were selected for analysis of the Bored Tunnel Alternative, under both non-tolled and tolled conditions, for the LRTP analysis year (2040). Traffic volumes for 2040 were determined by applying a growth factor to the 2030 traffic volumes (see Attachment D). The major signalized intersections were then evaluated in terms of traffic volumes and levels of service under the non-tolled and tolled Bored Tunnel Alternative during the year of opening (2015) and ranked according to the results. Sites at which air quality was most likely to be substantially affected by the alternative were selected for analysis in accordance with accepted WSDOT procedure.

Intersections were ranked and prioritized based on total approach volumes and intersection delays for the non-tolled and tolled Bored Tunnel Alternative. The highest ranked intersections for each condition were selected for analysis. Four intersections were analyzed:

- Mercer Street and Dexter Avenue N.
- Denny Way and Dexter Avenue

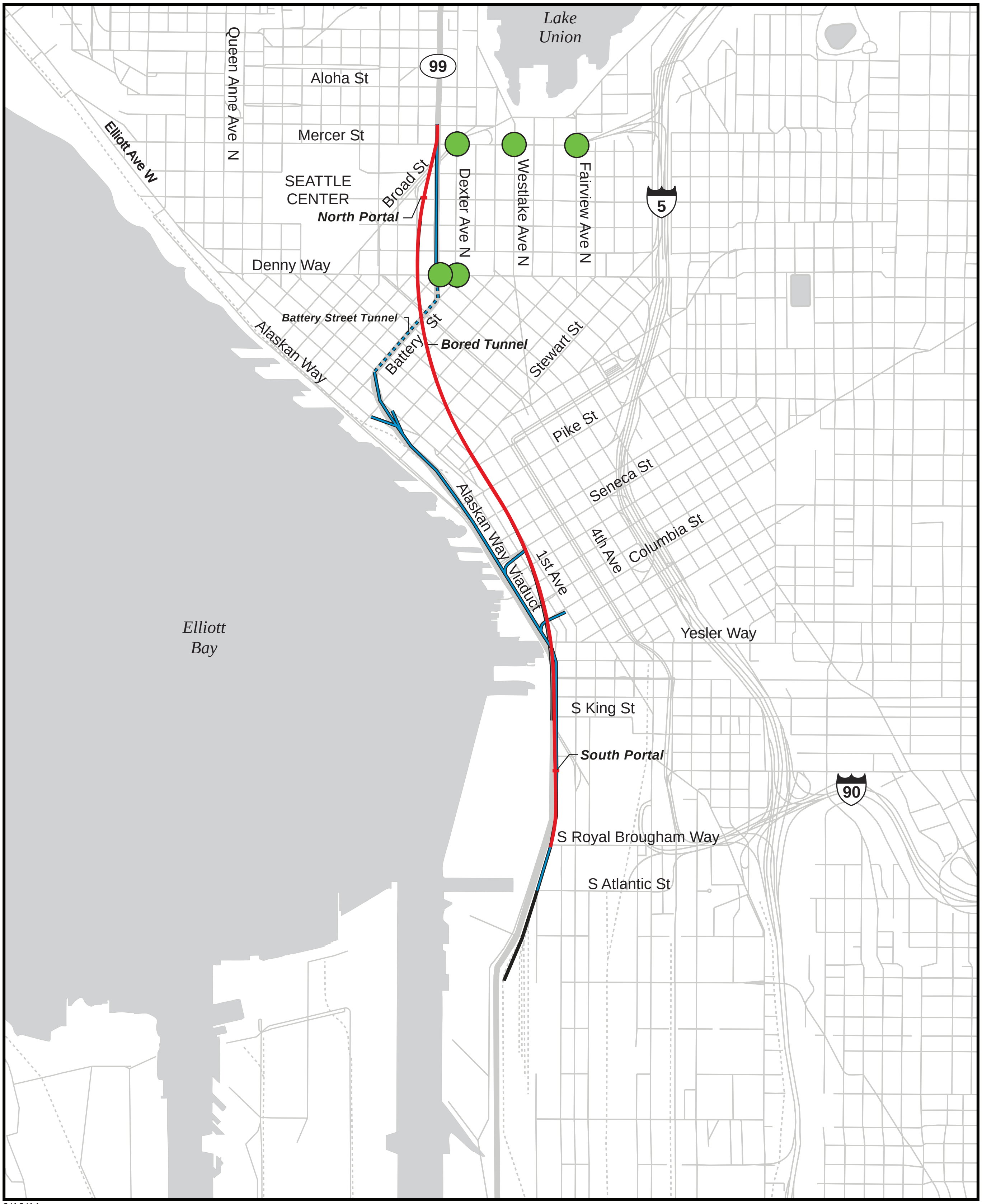
- Mercer Street and Westlake Avenue N.
- Mercer and Fairview Avenue N.

All of these intersections were analyzed for the project's opening year (2015), the project's design year (2030), and the area's LRTP analysis year (2040). Although all of these intersections were evaluated under reasonable worst-case traffic conditions, (the PM peak period), two intersections were analyzed for both the AM and PM peak periods because of high traffic volumes at these locations during the AM peak period (see Exhibits 3-4 and 3-5).

Exhibit 3-4. Conformity Mobile Source Analysis Sites for the Bored Tunnel Alternative

Intersection	Peak Period (AM or PM)	Reasons for Selection
Mercer Street and Fairview Avenue N.	PM	Delay and volume: 2015 tolled Bored Tunnel Alternative 2040 non-tolled and tolled Bored Tunnel Alternative Volume: 2015 non-tolled Bored Tunnel Alternative
Mercer Street and Fairview Avenue N.	AM	Volume: 2015 tolled Bored Tunnel Alternative
Mercer Street and Westlake Avenue N.	PM	Delay and volume: 2015 non-tolled Bored Tunnel Alternative 2040 non-tolled and tolled Bored Tunnel Alternative
Mercer Street and Dexter Avenue N.	PM	Delay and volume: 2015 non-tolled Bored Tunnel Alternative Volume: 2040 non-tolled and tolled Bored Tunnel Alternative
Denny Way and Dexter Avenue	PM	Delay: 2015 non-tolled and tolled Bored Tunnel Alternative 2040 tolled Bored Tunnel Alternative
Denny Way and Dexter Avenue	AM	Delay: 2040 non-tolled Bored Tunnel Alternative
Denny Way and Aurora Avenue NB	PM	Delay: 2015 tolled Bored Tunnel Alternative

Notes: AM = morning
NB = northbound
PM = afternoon



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Intersections Modeled for 2015 and 2040 Conformity Determination of the Bored Tunnel Alternative (Tolled and Non-Tolled)

Battery Street Tunnel

Elevated Structure and Cut-and-Cover Tunnel Alternatives

Bored Tunnel Alternative

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Exhibit 3-5
Intersections Modeled for Conformity Determination

Maximum CO concentrations estimated for the receptors at these locations were compared to the NAAQS to determine whether the Bored Tunnel Alternative would potentially result in concentrations greater than these standards.

3.7.2 Construction Phase

A quantitative mobile source analysis was conducted to estimate the potential effects associated with changes in traffic conditions during major construction (as a result of both changes in traffic patterns during major phases of construction and construction-related trucking activities on the local roadway network). The quantitative analysis was conducted as part of the conformity compliance determination.

Sites for mobile source analysis were chosen using the method described in Section 3.4.3. Major signalized intersections that may be affected by project-related construction were identified. These intersections were then evaluated in terms of traffic volumes and levels of service under the Bored Tunnel Alternative with reasonable worst-case traffic conditions. The intersections were ranked according to the results of the evaluation. Those sites at which air quality was most likely to be substantially affected by the project were selected for analysis in accordance with accepted PSCAA procedures.

The intersections were ranked and prioritized based on the total approach volume and intersection delay for the reasonable worst-case construction conditions during the earliest affected year (2012) (Exhibit 3-6). The potential for localized CO concentrations in excess of the NAAQS at these locations was estimated.

Exhibit 3-6. Mobile Source Analysis Sites for Construction

Intersection	Peak Period (AM or PM)	Reasons for Selection
Mercer Street and Fairview Avenue N.	PM	Volume and delay
Mercer Street and Westlake Avenue N.	PM	Volume
Mercer Street and Fairview Avenue N.	AM	Delay
Mercer Street and Ninth Avenue N.	PM	Delay
Mercer Street and Dexter Avenue N.	PM	Volume

Notes: Volume and delay are for the reasonable worst-case construction conditions (2012).
AM = morning
PM = afternoon

Chapter 4 AFFECTED ENVIRONMENT

4.1 Study Area Characteristics

The study area for the air quality analysis is located in downtown Seattle. This is a dense urban area, and land use in the area ranges from industrial and commercial to residential buildings.

4.2 Regulatory Status of Study Area

Air quality in the study area is regulated by EPA, Ecology, and PSCAA. Section 107 of the 1977 Clean Air Act Amendments requires EPA to publish a list of all geographic areas in compliance with the NAAQS, as well as those not attaining the NAAQS. Areas in compliance with the NAAQS are deemed *attainment* areas; areas not in compliance with the NAAQS are deemed *nonattainment* areas; and areas that were once classified as nonattainment but have since demonstrated attainment are classified as *maintenance* areas. The designation of an area is based on the data collected by the state monitoring network on a pollutant-by-pollutant basis.

The project area is located entirely within a CO maintenance area, as shown on Exhibit 4-1. This area was designated as a nonattainment area for CO and classified as *moderate* upon enactment of the Clean Air Act Amendments of 1990. On August 23, 1999, the state submitted a CO maintenance plan, which was approved by EPA on March 13, 2001. The plan relies on control of residential wood smoke, fugitive dust, industrial emissions, open burning, and diesel exhaust. Because this maintenance area would be affected by the project, the selected build alternative must demonstrate compliance with the Transportation Conformity Rule (40 CFR 93) before federal approval or funding.

4.3 Air Pollution Trends

Regional air pollutant trends have generally followed national patterns over the last 20 years. While the average weekday VMT in the central Puget Sound region has increased from 30 million in 1981 to 80 million in 2009 (PSRC 2010b), pollutant emissions associated with transportation sources have decreased. CO is the criteria pollutant most closely tied to transportation, with over 90 percent of the CO emissions in the Puget Sound urban areas coming from transportation sources (PSCAA 2002). Regionally, the maximum measured CO concentrations have decreased considerably over the past 20 years. Other transportation-related pollutants have followed similar but less pronounced trends.

Exhibit 4-1. Central Puget Sound Region Designated Maintenance and Nonattainment Areas

Source: PSRC 2011.

4.4 Monitored Air Quality Concentrations

Air quality data were compiled using Ecology and EPA AirData (EPA 2009a) databases for 2008, the latest calendar year for which these data are available. Since EPA is focused on the fine particulate ($PM_{2.5}$) pollution, PM_{10} monitors have largely been discontinued, and representative data for PM_{10} for the area date back to 2006. Exhibit 4-2 shows the highest recorded ambient air quality levels from representative sites that were monitored for these data and are located within or near the study area. The monitored concentrations for the criteria pollutants do not exceed national and state ambient air quality standards in the study area.

Exhibit 4-2. Monitored Ambient Air Quality Levels (2008)

Pollutant	Location (County)[1]	Averaging Time	Concentration	NAAQS
Carbon monoxide	Beacon Hill Reservoir (King)	8 hours	0.9 ppm	9 ppm
		1 hour	1.4 ppm	35 ppm
Nitrogen dioxide	Casino Drive, Anacortes (Skagit)[2]	Annual	0.011 ppm	0.053 ppm
Ozone	Beacon Hill Reservoir (King)	8 hours	0.052 ppm	0.075 ppm
Sulfur dioxide	Beacon Hill Reservoir (King)	Annual	0.001 ppm	0.03 ppm
		24 hours	0.011 ppm	0.14 ppm
		3 hours	0.030 ppm	0.5 ppm
$PM_{2.5}$	Beacon Hill Reservoir (King)	Annual	7.25 μg/m^3	15 μg/m^3
		24 hours	20.5 μg/m^3	35 μg/m^3
PM_{10}	East Marginal Way S. (King)	24 hours	51 μg/m^3	150 μg/m^3

Source: EPA 2009a.

Notes: Values shown correspond to NAAQS time periods.

μg/m^3 = micrograms per cubic meter

NAAQS = National Ambient Air Quality Standard

$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers

PM_{10} = particulate matter with diameter less than or equal to 10 micrometers

ppm = parts per million

[1] If data are available from more than one monitoring station in a county, the highest value is provided.

[2] Although this monitor is located outside of the study area, data collected at this monitor are provided because it is the only nitrogen dioxide monitor in the state with available EPA data.

4.5 Estimated Existing Air Pollutant Conditions

The following subsections provide information about conditions in the study area under existing conditions (2015). It is assumed that the existing viaduct would be in operation.

4.5.1 Results of Mobile Source CO Analysis

Exhibit 4-3 shows the results of the screening-level mobile source analysis that was conducted using WASIST. The values provided are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections under existing conditions. The estimated CO concentrations are all less than the 1-hour NAAQS of 35 ppm and the 8-hour NAAQS of 9 ppm.

Exhibit 4-3. Maximum Predicted CO Concentrations Under Existing Conditions

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	8.5	6.9
Mercer Street and Westlake Avenue N.	PM	7.4	6.1
Mercer Street and Dexter Avenue N.	PM	NA	NA
Denny Way and Dexter Avenue	PM	6.0	5.4
Denny Way and Dexter Avenue	AM	5.9	5.0
Denny Way and Aurora Avenue NB	PM	6.4	5.4
Columbia Street and First Avenue	PM	5.5	4.8
Yesler Way and First Avenue	PM	4.8	4.3

Notes: All values include a conservative background concentration of 3 ppm.
AM = morning
CO = carbon monoxide
NA = not applicable (Existing conditions for this intersection include the Broad Street underpass, which cannot be modeled using WASIST.)
NB = northbound
PM = afternoon
ppm = parts per million

WASIST uses readily available data in a user-friendly application to make a conservative estimate of project-related CO concentrations using a combination of reasonable worst-case conditions that, when occurring simultaneously, produce high CO concentrations. The purpose of the model is to allow the user to conservatively estimate the highest CO concentrations that would be found at an intersection without having to perform a more time-consuming detailed analysis. The estimated maximum CO concentrations are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. Therefore, a more in-depth mobile source air quality analysis is not required.

4.5.2 Results of Battery Street Tunnel Portal Analysis

Exhibit 4-4 shows the results of the analysis for the tunnel portals that was conducted using the AERMOD model. The values provided are the highest 1-hour and 8-hour concentrations of CO and the highest annual and 24-hour concentrations of $PM_{2.5}$ predicted at any of the receptor sites located near the tunnel portals under existing conditions. The estimated CO and $PM_{2.5}$ concentrations are all less than the NAAQS.

Exhibit 4-4. Maximum Predicted CO and $PM_{2.5}$ Concentrations Near the Battery Street Tunnel Under Existing Conditions

Portal	CO Concentrations[1] (ppm)		$PM_{2.5}$ Concentrations[2] ($\mu g/m^3$)	
	1-hour	8-hour	24-hour	Annual
North portal	8.6	3.6	23.5	8.4
South portal	12.1	4.3	24.1	8.2

Notes: CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter
$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers
ppm = parts per million
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
[2] For $PM_{2.5}$, the annual concentrations include a background concentration of 7.5 $\mu g/m^3$; the 24-hour concentrations include a background concentration of 20.2 $\mu g/m^3$. The annual NAAQS is 15$\mu g/m^3$; the 24-hour NAAQS is 35$\mu g/m^3$.

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Chapter 5 OPERATIONAL EFFECTS AND MITIGATION

This chapter describes the three build alternatives under non-tolled conditions only. For a discussion of the alternative under tolled conditions, please see Chapter 7 of this report.

5.1 Operational Effects of the 2030 Viaduct Closed (No Build Alternative)

Federal and Washington State environmental regulations require agencies to evaluate a No Build Alternative to provide baseline information about conditions in the project area. For this project, the No Build Alternative in 2030 is not a viable operational alternative since the existing viaduct is vulnerable to earthquakes and structural failure due to ongoing deterioration. Multiple studies of the viaduct's current structural conditions, including its foundations in liquefiable soils, have determined that retrofitting or rebuilding the existing viaduct is not a reasonable alternative. At some point, the roadway will need to be closed.

The Viaduct Closed (No Build Alternative) describes what would happen if the Bored Tunnel Alternative or another build alternative is not implemented. If the existing viaduct is not replaced, it will be closed, but it is unknown when that would happen. However, it is highly unlikely that the existing structure could still be in use in 2030. Therefore, the Viaduct Closed (No Build Alternative) describes the consequences of suddenly losing the function of SR 99 along the central waterfront based on the two scenarios described below. The consequences would be short term, lasting until transportation and other agencies could develop and implement a new, permanent solution. The planning and development of the new solution would have its own environmental review.

5.1.1 Scenarios Considered

Scenario 1: Sudden Unplanned Loss of the Viaduct

Under this scenario, there would be a sudden, unplanned closure of SR 99 between S. King Street and Denny Way due to some structural deficiency, weakness, or smaller earthquake event. Under this scenario, SR 99 would be closed for an unknown period until a viaduct replacement could be built. Severe travel delays would be experienced, and utilities on the viaduct would likely be damaged and require repair. Due to increased congestion and decreased travel speeds, fuel usage would likely increase, resulting in an overall increase in air pollutants compared to the existing conditions.

Scenario 2: Catastrophic and Complete Collapse of the Viaduct

This scenario considers the effects of a catastrophic failure and collapse of the viaduct. Under this scenario, a seismic event of similar or greater magnitude than the 2001 Nisqually earthquake could trigger failure of portions of the viaduct. This scenario would have the greatest effect on people and the environment. Failure of the viaduct could cause injuries and death to people traveling on or near the structure at the time of the seismic event. Travel delays would be severe. The environmental effects and length of time it would take to repair the SR 99 corridor are unknown, but the effects would be severe. Due to increased congestion and decreased travel speeds, fuel usage would likely increase, resulting in an overall increase in air pollutants compared to the existing conditions.

It is anticipated that the Battery Street Tunnel would not be in operation under either Scenario 1 or Scenario 2.

5.1.2 Results of the Mobile Source CO Analysis

The results of the screening-level mobile source analysis that was conducted using WASIST (Exhibit 5-1) represent the reasonable worst-case conditions that would occur in the project area (see Section 3.4.3). The values provided are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections for conditions in the design year (2030). The estimated maximum CO concentrations for the Viaduct Closed (No Build Alternative) are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. Therefore, a more in-depth mobile source air quality analysis is not required.

Exhibit 5-1. Design Year (2030) Maximum Predicted CO Concentrations for Viaduct Closed (No Build Alternative)

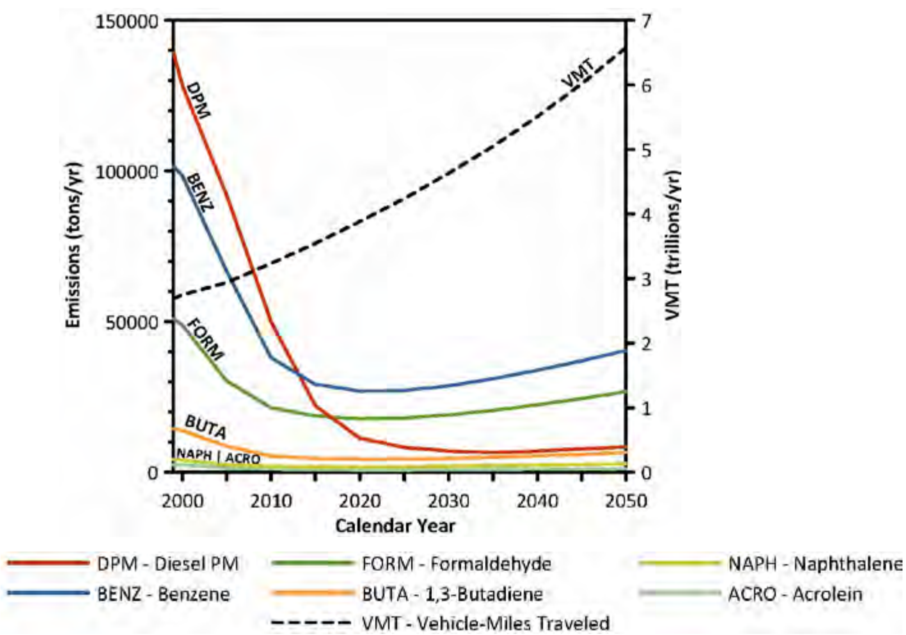
Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	9.8	7.8
Mercer Street and Westlake Avenue N.	PM	8.1	6.6
Mercer Street and Dexter Avenue N.	PM	8.2	6.6
Denny Way and Dexter Avenue	PM	6.6	5.5
Denny Way and Dexter Avenue	AM	6.5	5.4
Denny Way and Aurora Avenue NB	PM	6.6	5.5
Columbia Street and First Avenue	PM	5.6	4.8
Yesler Way and First Avenue	PM	5.4	4.7

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

5.1.3 Results of the MSAT Analysis

Future MSAT emissions likely would, in general, be lower than current levels as a result of the EPA's national control programs that are projected to reduce MSAT emissions by 72 percent from 1999 to 2050 even if the national average VMT increases by 145 percent, as shown on Exhibit 5-2. Similarly, as shown in Exhibit 5-3, MSATs in the study area are predicted to decrease dramatically in the future under all project alternatives compared to existing conditions. VMT on SR 99 is predicted to decrease by approximately 2 percent under the Viaduct Closed (No Build Alternative). Local trends differ slightly from national trends due to fleet mix and turnover, VMT growth rates, and local control measures.

Exhibit 5-2. National MSAT Emission Trends for Vehicles Operating on Roadways (1999–2050), Using EPA's MOBILE6.2 Model



Source: EPA 2009b. MOBILE6.2 Model run 20.

Notes:

Annual emissions of polycyclic organic matter were estimated at 561 tons/year for 1999, decreasing to 373 tons/year for 2050.

Trends for specific locations may differ, depending on locally derived information representing VMT, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors.

Exhibit 5-3. Predicted MSAT Emission Burdens

Condition	Daily VMT	Change in VMT From Existing Conditions (%)	MSAT (tons/year)							Change From Existing Conditions (%)						
			Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM	Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM
Existing (2015) Conditions	2,425,096	NA	0.3	28.1	1.9	6.5	6.1	21.4	2.4	NA	NA	NA	NA	NA	NA	NA
2030 Viaduct Closed (No Build Alternative)	2,371,538	-2.2%	0.3	24.1	1.8	1.3	5.4	14.3	1.7	-14.0%	-14.3%	-9.0%	-79.5%	-12.4%	-33.5%	-28.9%
2030 Non-tolled Bored Tunnel Alternative	2,521,520	4.0%	0.3	24.7	1.8	1.4	5.4	15.6	1.9	-12.7%	-12.2%	-6.5%	-78.2%	-11.2%	-27.1%	-21.2%
2030 Non-tolled Cut-and-Cover Tunnel Alternative	2,545,284	5.0%	0.3	24.7	1.8	1.4	5.5	16.1	1.9	-12.6%	-12.1%	-6.2%	-78.0%	-11.1%	-24.9%	-19.5%
2030 Non-tolled Elevated Structure Alternative	2,556,547	5.4%	0.3	24.9	1.8	1.4	5.5	16.1	1.9	-12.0%	-11.4%	-5.6%	-77.9%	-10.6%	-24.8%	-19.4%

Notes: DPM = diesel particulate matter
MSAT = mobile source air toxic
NA = not applicable
POM = polycyclic organic matter
VMT = vehicle miles of travel

The project area is in a highly developed urban area with numerous sensitive land uses. Future MSAT concentrations are projected to be lower than the existing concentrations, even with increased VMT. In addition, while there would be localized increases in some areas (e.g., near the tunnel portals), there would be a corresponding decrease in other areas (e.g., areas that are near the tunnel but away from the portals).

5.1.4 Operational Mitigation

Regional MSAT emissions are expected to decrease substantially relative to existing conditions, and no exceedances of the NAAQS are expected under the Viaduct Closed (No Build Alternative). Because no substantial adverse air quality effects are expected, no mitigation measures would be necessary. However, traffic congestion would increase along roadways and at intersections that would experience increased traffic volumes are a result of the loss of SR 99 (especially under Scenario 2), and traffic measures would likely be required to minimize these effects.

5.1.5 Operational Benefits

As noted above, all the air quality standards would be met with the Viaduct Closed (No Build Alternative). However, there would be no significant operational benefits under this alternative.

5.2 Operational Effects of the Bored Tunnel Alternative

5.2.1 Results of the Mobile Source CO Analysis

The results of the screening-level mobile source analysis that was conducted for the Bored Tunnel Alternative using WASIST (Exhibit 5-4) represent the reasonable worst-case conditions for normal operations that would occur in the project area (see Section 3.4.3). The values provided are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections for conditions in the design year (2030). The estimated maximum CO concentrations for the Bored Tunnel Alternative are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. Therefore, a more in-depth mobile source CO air quality analysis is not required.

5.2.2 Results of the Tunnel Portal and Tunnel Operations Building CO Analysis

Exhibit 5-5 shows the results of the analyses for the tunnel portals and tunnel operations buildings that were conducted using the AERMOD model. The values provided are the highest 1-hour and 8-hour concentrations of CO and the highest annual and 24-hour concentrations of $PM_{2.5}$ predicted at any of the receptor sites located near the tunnel portals and the tunnel operations buildings under 2030 conditions. The estimated CO and $PM_{2.5}$ concentrations are all less than the NAAQS.

Exhibit 5-4. Design Year (2030) Maximum Predicted CO Concentrations for the Bored Tunnel Alternative

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	9.8	7.8
Mercer Street and Westlake Avenue N.	PM	8.1	6.6
Mercer Street and Dexter Avenue N.	PM	8.2	6.6
Denny Way and Dexter Avenue	PM	6.6	5.5
Denny Way and Dexter Avenue	AM	6.5	5.4
Denny Way and Aurora Avenue NB	PM	6.6	5.5
Columbia Street and First Avenue	PM	5.6	4.8
Yesler Way and First Avenue	PM	5.4	4.7

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

Exhibit 5-5. Design Year (2030) Maximum Predicted CO and $PM_{2.5}$ Concentrations Near the Tunnel Portals and Tunnel Operations Buildings for the Bored Tunnel Alternative

Portal	CO Concentrations[1] (ppm)		$PM_{2.5}$ Concentrations[2] (µg/m³)	
	1-hour	8-hour	24-hour	Annual
North portal	15.5	5.1	22.8	8.5
South portal	12.6	5.1	24.9	8.7

Notes: CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standard
$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers
ppm = parts per million
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
[2] For $PM_{2.5}$, the annual concentrations include a background concentration of 7.5 $\mu g/m^3$; the 24-hour concentrations include a background concentration of 20.2 $\mu g/m^3$. The 24-hour NAAQS is 35 $\mu g/m^3$; the annual NAAQS is 15 $\mu g/m^3$.

5.2.3 Results of MSAT Analysis

Future emissions likely would be lower than current levels as a result of the EPA's national control programs that are projected to reduce MSAT emissions by 72 percent from 1999 to 2050 even if the national average VMT increases by 145 percent, as shown on Exhibit 5-2. Similarly, MSATs in the study area are predicted to substantially decrease in the future with the Bored Tunnel Alternative compared to existing conditions (Exhibit 5-3), even though the VMT on SR 99 is predicted to increase by 4.0 percent. Local trends differ slightly from national trends due to fleet mix and turnover, VMT growth rates, and local control measures.

5.2.4 Operational Mitigation

Regional MSAT emissions are expected to decrease substantially relative to existing conditions, and no exceedances of the NAAQS are expected with the Bored Tunnel Alternative (preferred). Because no substantial adverse effects on air quality are expected, no mitigation measures would be necessary.

5.2.5 Operational Benefits

As noted above, all the air quality standards would be met with the Bored Tunnel Alternative. There might be local differences in pollutant concentrations between the Bored Tunnel Alternative and the Viaduct Closed (No Build Alternative) (e.g., the concentrations would be lower along the tunnel sections but higher near the tunnel portals with the Bored Tunnel Alternative). However, there would be no significant operational benefits specific to the regional amounts of air pollutants emitted into the atmosphere as a result of the Bored Tunnel Alternative relative to the Viaduct Closed (No Build Alternative).

5.3 Operational Effects of the Cut-and-Cover Tunnel Alternative

5.3.1 Result of the Mobile Source CO Analysis

The results of the screening-level mobile source analysis that was conducted using WASIST (Exhibit 5-6) represent the reasonable worst-case conditions that would occur in the project area (see Section 3.4.3). The values provided are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections for conditions in the design year (2030). The estimated maximum CO concentrations for the Cut-and-Cover Tunnel Alternative are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. Therefore, a more in-depth mobile source air quality analysis is not required.

5.3.2 Results of the Tunnel Portal and Tunnel Maintenance Building CO Analysis

Exhibit 5-7 shows the results of the analysis for the tunnel portals and tunnel maintenance buildings that were conducted using the AERMOD model. The values provided are the highest 1-hour and 8-hour concentrations of CO and the highest annual and 24-hour concentrations of $PM_{2.5}$ predicted at any of the receptor sites located near the tunnel portals and the tunnel maintenance buildings under 2030 conditions. The estimated CO and $PM_{2.5}$ concentrations near the portals of SR 99 mainline cut-and-cover tunnel and the portals of the Battery Street Tunnel are all less than the NAAQS.

Exhibit 5-6. Design Year (2030) Maximum Predicted CO Concentrations for the Cut-and-Cover Tunnel Alternative

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	9.7	7.7
Mercer Street and Westlake Avenue N.	PM	8.2	6.6
Mercer Street and Dexter Avenue N.	PM	8.3	6.7
Denny Way and Dexter Avenue	PM	7.3	6.0
Denny Way and Dexter Avenue	AM	6.3	5.3
Denny Way and Aurora Avenue NB	PM	6.7	5.6
Columbia Street and First Avenue	PM	5.4	4.7
Yesler Way and First Avenue	PM	5.3	4.6

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

Exhibit 5-7. Design Year (2030) Maximum Predicted CO and $PM_{2.5}$ Concentrations Near the Tunnel Portals for the Cut-and-Cover Tunnel Alternative

Portal	CO Concentrations[1] (ppm)		$PM_{2.5}$ Concentrations[2] ($\mu g/m^3$)	
	1-hour	8-hour	24-hour	Annual
North portal of Battery Street Tunnel	14.5	4.2	22.4	8.2.
South portal of the Battery Street Tunnel/north portal of mainline cut-and-cover tunnel[3]	12.7	4.6	22.8	8.4
South portal of mainline cut-and-cover tunnel	9.2	4.8	25.0	9.2

Notes: CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standard
ppm = parts per million
$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
[2] For $PM_{2.5}$, the annual concentrations include a background concentration of 7.5 $\mu g/m^3$; the 24-hour concentrations include a background concentration of 20.2 $\mu g/m^3$. The 24-hour NAAQS is 35 $\mu g/m^3$; the annual NAAQS is 15 $\mu g/m^3$.
[3] With the Cut-and-Cover Tunnel Alternative, the south portal of the Battery Street Tunnel would be located near the north portal of the mainline tunnel. For a conservative estimate, the combined impacts of the emissions from both portals, the emissions from these portals (as well as the emissions from nearby at-grade traffic) were considered in one AERMOD modeling analysis.

5.3.3 Results of MSAT Analysis

Future emissions likely would be lower than current levels as result of the EPA's national control programs that are projected to reduce MSAT emissions by 72 percent from 1999 to 2050 even if the national average VMT increases by 145 percent, as shown on Exhibit 5-2. Similarly, as shown in Exhibit 5-3, MSATs in the study area are predicted to substantially decrease in the future with the Cut-and-Cover Tunnel Alternative compared to existing conditions, even though the VMT on SR 99 is predicted to increase by 5.0 percent. Local trends differ slightly from national trends due to fleet mix and turnover, VMT growth rates, and local control measures.

5.3.4 Operational Mitigation

Regional MSAT emissions are expected to decrease substantially relative to existing conditions, and no exceedances of the NAAQS are expected with the Cut-and-Cover Tunnel Alternative. Because no substantial adverse effects on air quality are expected, no mitigation measures would be necessary.

5.3.5 Operational Benefits

As noted above, all the air quality standards would be met with the Cut-and-Cover Tunnel Alternative. There might be local differences in pollutant concentrations between the Cut-and-Cover Tunnel Alternative and the Viaduct Closed (No Build Alternative) (e.g., the concentrations would be lower along the tunnel sections but higher near the tunnel portals with the Cut-and-Cover Tunnel Alternative). However, no significant operational benefits specific to the regional amounts of air pollutants emitted into the atmosphere are expected to result from the Cut-and-Cover Tunnel Alternative relative to the Viaduct Closed (No Build Alternative).

5.4 Operational Effects of the Elevated Structure Alternative

5.4.1 Results of the Mobile Source CO Analysis

The results of the screening-level mobile source analysis that was conducted using WASIST (Exhibit 5-8) represent the reasonable worst-case conditions that would occur in the project area (see Section 3.4.3). The values provided are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections for conditions in the design year (2030). The estimated maximum CO concentrations for the Elevated Structure Alternative are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. Therefore, a more in-depth mobile source air quality analysis is not required.

Exhibit 5-8. Design Year (2030) Maximum Predicted CO Concentrations for the Elevated Structure Alternative

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	9.9	7.8
Mercer Street and Westlake Avenue N.	PM	8.4	6.8
Mercer Street and Dexter Avenue N.	PM	8.5	6.8
Denny Way and Dexter Avenue	PM	6.6	5.5
Denny Way and Dexter Avenue	AM	6.5	5.2
Denny Way and Aurora Avenue NB	PM	7.6	6.2
Columbia Street and First Avenue	PM	6.0	5.1
Yesler Way and First Avenue	PM	5.5	5.0

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

5.4.2 Results of Battery Street Tunnel Portal CO Analysis

Exhibit 5-9 shows the results of the analysis for the tunnel portals that was conducted using the AERMOD model. The values provided are the highest 1-hour and 8-hour concentrations of CO and the annual and 24-hour concentrations of $PM_{2.5}$ predicted at any of the receptor sites located near the tunnel portals under 2030 conditions. The estimated CO and $PM_{2.5}$ concentrations are all less than the NAAQS.

Exhibit 5-9. Design Year (2030) Maximum Predicted CO and $PM_{2.5}$ Concentrations Near the Battery Street Tunnel for the Elevated Structure Alternative

Portal	CO Concentrations[1] (ppm)		$PM_{2.5}$ Concentrations[2] ($\mu g/m^3$)	
	1-hour	8-hour	24-hour	Annual
North portal	16.3	4.3	23.3	8.9
South portal	9.9	7.0	24.4	8.7

Notes: CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standard
ppm = parts per million
$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
[2] For $PM_{2.5}$, the annual concentrations include a background concentration of 7.5 $\mu g/m^3$; the 24-hour concentrations include a background concentration of 20.2 $\mu g/m^3$. The 24-hour NAAQS is 35 $\mu g/m^3$; the annual NAAQS is 15 $\mu g/m^3$.

5.4.3 Results of MSAT Analysis

Future emissions likely would be lower than current levels as a result of the EPA's national control programs that are projected to reduce MSAT emissions by 72 percent from 1999 to 2050, even if the national average VMT increases by 145 percent, as shown on Exhibit 5-2. Similarly, as shown in Exhibit 5-3, MSATs in the study area are predicted to decrease substantially with the Elevated Structure Alternative as compared to existing conditions, even though the VMT on SR 99 is predicted to increase by 5.4 percent. Local trends differ slightly from national trends due to fleet mix and turnover, VMT growth rates, and local control measures.

5.4.4 Operational Mitigation

Regional MSAT emissions are expected to decrease substantially from existing conditions, and no exceedances of the NAAQS are expected to result from the Elevated Structure Alternative. Because no substantial adverse effects on air quality are expected, no mitigation measures would be necessary.

5.4.5 Operational Benefits

As noted above, all the air quality standards would be met with the Elevated Structure Alternative. There might be local differences in pollutant concentrations between the Elevated Structure Alternative and the Viaduct Closed (No Build Alternative). No significant operational benefits specific to the regional amounts of air pollutants emitted into the atmosphere are expected to result from the Elevated Structure Alternative relative to the Viaduct Closed (No Build Alternative).

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Chapter 6 CONSTRUCTION EFFECTS AND MITIGATION

6.1 Construction Effects Common to All Alternatives

Air quality effects from construction would occur primarily as a result of emissions from heavy-duty construction equipment (e.g., bulldozers, backhoes, and cranes), diesel-fueled mobile sources (e.g., trucks, brooms, and sweepers), diesel- and gasoline-fueled generators, and on- and off-site project-related vehicles (e.g., service trucks and pickups).

Fugitive PM_{10} emissions are associated with demolition, land clearing, ground excavation, grading, cut-and-fill operations, and structure erection. PM_{10} emissions would vary from day to day, depending on the level of activity, specific operations, and weather conditions. Emission rates would depend on the soil moisture, silt content of soil, wind speed, and amount and type of operating equipment associated with project construction. Larger dust particles would settle near the source, and fine particles would be dispersed over a greater distance from the construction site.

Fugitive PM_{10} emissions from construction activities could be noticeable if uncontrolled. Mud and particulates from trucks may also be of concern if construction trucks are routed through streets near sensitive land uses (e.g., residences, schools, and parks). The project will develop a fugitive dust control plan. The plan will implement WSDOT's Memorandum of Agreement with PSCAA to comply with PSCAA regulations that require dust control during construction and to prevent deposition of mud on paved streets (PSCAA 1994, Article 9). Measures to reduce the deposition of mud and emissions of particulates are listed in Section 6.7, Construction Mitigation Common to All Alternatives.

In addition to PM_{10} emissions, heavy trucks and construction equipment powered by gasoline and diesel engines would emit $PM_{2.5}$, CO, and nitrogen oxides in their exhaust. If construction traffic and lane closures increase congestion and reduce the speed of other vehicles in the area, the emissions would increase temporarily during traffic delays. These increases would be temporary, and the effects would generally be limited to the immediate area in which the congestion occurs.

Some construction stages (particularly those involving paving operations using asphalt) would result in short-term odors, which might be detectable to some people near the site, and they would be diluted as the distance from the site increases.

6.2 Construction Effects Common to Both Tunnel Alternatives

6.2.1 South Portal

Construction of the south portal would include ground replacement, construction of the south access point and tunnel operations (or maintenance) building, and south end surface improvements. The major activities would include earth excavation and grading, handling and transport of excavated material and debris, operation of heavy-duty diesel- and gasoline-powered equipment, and trucking activities.

6.2.2 North Portal

Construction of the north portal would include utility relocation, construction of the north access point and tunnel operations (or maintenance) building, and north end surface improvements. The major activities would include earth excavation and grading, handling and transport of excavated material and debris, operation of heavy-duty diesel- and gasoline-powered equipment, and trucking activities.

6.3 Construction Effects of the Bored Tunnel Alternative

Construction associated with the Bored Tunnel Alternative would include construction of a power substation for the tunnel boring machine, operation of the tunnel boring machine and construction of the bored tunnel structure, demolition of the Battery Street Tunnel, and operation of an intelligent transportation system. The major activities would include earth excavation and grading, handling and transport of excavated material and debris, operation of heavy-duty diesel- and gasoline-powered equipment, and trucking activities.

One likely option for decommissioning the Battery Street Tunnel with this alternative is to fill the void space with suitable material (potentially recycling the concrete rubble from the demolition of the viaduct structure), close all of the street access vents, and block off the portals at both ends of the tunnel. The major activities would include handling and transport of excavated material and debris, operation of heavy-duty diesel- and gasoline-powered equipment, and trucking activities.

6.4 Construction Effects of the Cut-and-Cover Tunnel Alternative

Construction associated with the Cut-and-Cover Tunnel Alternative would include construction of the cut-and-cover tunnel structure and demolition of the Battery Street Tunnel. The major activities would include earth excavation and grading, handling and transport of excavated material and debris, operation of heavy-duty diesel- and gasoline-powered equipment, and trucking activities.

6.5 Construction Effects of the Elevated Structure Alternative

Construction associated with the Elevated Structure Alternative would include utility relocations, demolition of the Alaskan Way Viaduct, and removal of spoils. The major activities would include earth excavation and grading, handling and transport of excavated material and debris, operation of heavy-duty diesel- and gasoline-powered equipment, and trucking activities.

6.6 Construction Effects of Other Roadway Elements

Construction of other roadway elements of the Program (Bored Tunnel Alternative) would result in a temporary increase in pollutant emissions from equipment and activities. Lane closures or detours could temporarily increase traffic congestion and decrease travel speeds, resulting in an overall increase in pollutant emissions during construction.

6.7 Construction Mitigation Common to All Alternatives

During construction activities, PSCAA would regulate particulate emissions (in the form of fugitive dust). WSDOT would take reasonable precautions to prevent these emissions from becoming airborne and would have to maintain and operate the source (i.e., construction equipment) to minimize emissions.

A Memorandum of Agreement between WSDOT and PSCAA is in place to help eliminate, confine, or reduce construction-related emissions for WSDOT projects. WSDOT will develop a plan for controlling fugitive dust during construction. This fugitive dust control plan would reduce air pollutant emissions near the construction site, including residences located along Battery Street adjacent to the open grates in the Battery Street roadway. Some measures that will be included in the plan are the following:

- Cover all trucks transporting materials to reduce particulate emissions during transportation on paved public roadways.
- When feasible and where practicable, route construction trucks away from residential and business areas to minimize annoyance from dust.
- Coordinate construction activities between WSDOT and the Seattle Department of Transportation with respect to other projects in the area to reduce the cumulative effects of concurrent construction projects.

The project's traffic management plan will include detours and strategic construction planning (e.g., weekend work, parking restrictions, and signal timing enhancements) to continue moving traffic through the area and reduce backups for the traveling public to the extent possible. It will also include provisions for reducing vehicle emissions resulting from vehicle idling and traffic congestion. Construction areas, staging areas (see Appendix B, Alternatives Description and Construction Methods Discipline Report), and material transfer sites would be set up in a way that reduces standing wait times for equipment, engine idling, and the need to block vehicle movement associated with other activities on the site. These strategies would reduce fuel consumption by reducing wait times and ensuring that construction equipment operates efficiently, thereby mitigating the effects of vehicle emissions on air quality. Due to space constraints at the work site and the benefit of additional emissions reductions, ridesharing and other efforts to reduce commute trips may be encouraged for employees working on the project.

In addition to the strategies detailed above, other possible measures for reducing air pollutant emissions near construction areas include the following (Associated General Contractors of Washington 1997):

- Spray exposed soil with water or other dust palliatives to reduce emissions of PM_{10} and deposition of particulate matter.
- Remove particulate matter deposited on paved public roads to reduce mud and windblown dust on area roadways.
- Require appropriate emission-control devices (e.g., diesel oxygen catalyst, diesel particulate filters, and particulate traps) on large pieces of diesel-powered equipment to reduce CO, nitrogen oxide, and particulate emissions in vehicle exhaust.
- Enclose conveyor systems transporting dirt from the tunnel excavation sites to the waterfront, if barges are used.
- Use electrical equipment as feasible.
- Use relatively new, well-maintained equipment to reduce CO and nitrogen oxide emissions.
- Require the use of low or ultra-low sulfur fuels in construction equipment to allow the use of effective particulate-emission control devices on diesel vehicles.

6.8 Concurrent Construction

Construction of the other projects in the Program and other independent projects would result in a temporary increase in pollutant emissions from construction equipment and construction activities. Lane closures or detours could temporarily increase traffic congestion and decrease travel speeds, resulting in an overall increase in pollutant emissions during construction.

Chapter 7 TOLLING

7.1 General Description of Tolling

A range of tolling proposals was considered and analyzed. The considerations included using low, medium, or high tolls; varying the toll by time of day; applying a peak-only toll; tolling the tunnel segment only; or tolling the tunnel and the SR 99 corridor by charging drivers who use the corridor to get to or through downtown Seattle from points north and south of the tunnel for the Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative. For the Elevated Structure, the tolling points would be north and south of the midtown ramps. The analysis assumed that neither transit nor carpools would pay a toll.

Tolling is not expected to have any substantial effects on air quality in the study area.

Further detail on tolling, the variables tested, and the analysis is provided in Appendix C, Transportation Discipline Report.

A major potential effect of tolling at any rate level or location is the diversion of traffic to other routes, which is discussed in Appendix C, Transportation Discipline Report. People who do not want to pay the toll would choose to travel on a more congested route to save money. The tolling estimates assumed for this report were derived from the traffic modeling analysis. These estimates provided the percentage of drivers who would choose alternate routes. Much of the diverted traffic would use the closest alternate routes to SR 99: Alaskan Way or First Avenue/First Avenue S. Appendix C, Transportation Discipline Report discusses measures that would be implemented to mitigate the traffic impacts.

7.2 Operational Effects of the Tolled Bored Tunnel Alternative

7.2.1 Results of the Mobile Source CO Analysis

The results of the screening-level mobile source analysis (using WASIST) (Exhibit 7-1) represent the reasonable worst-case conditions that would occur in the project area (see Section 3.4.3). The values are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections for conditions in the design year (2030). The estimated maximum CO concentrations for the tolled Bored Tunnel Alternative are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. The estimated maximum CO concentrations for both the tolled and non-tolled Bored Tunnel Alternative are below the NAAQS. Therefore, a more in-depth mobile source air quality analysis is not required.

Exhibit 7-1. Design Year (2030) Maximum Predicted CO Concentrations for the Tolled Bored Tunnel Alternative

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	10.0	7.9
Mercer Street and Westlake Avenue N.	PM	8.4	6.8
Mercer Street and Dexter Avenue N.	PM	8.0	6.5
Denny Way and Dexter Avenue	PM	6.6	5.5
Denny Way and Dexter Avenue	AM	6.5	5.4
Denny Way and Aurora Avenue NB	PM	7.5	6.2
Columbia Street and First Avenue	PM	5.8	5.0
Yesler Way and First Avenue	PM	5.8	5.0

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

7.2.2 Results of the Tunnel Portal and Tunnel Operations Building CO Analysis

Exhibit 7-2 shows the results of the analysis (using the AERMOD model) for the tunnel portals and tunnel operations buildings. The values provided are the highest 1-hour and 8-hour concentrations of CO and the highest annual and 24-hour concentrations of $PM_{2.5}$ predicted at any of the receptor sites located near the tunnel portals and the tunnel operations buildings under 2030 conditions. The estimated CO and $PM_{2.5}$ concentrations are all less than the NAAQS for both the tolled and non-tolled Bored Tunnel Alternative.

Exhibit 7-2. Design Year (2030) Maximum Predicted CO and $PM_{2.5}$ Concentrations Near the Tunnel Portals and Tunnel Operations Buildings for the Tolled Bored Tunnel Alternative

Portal	CO Concentrations[1] (ppm)		$PM_{2.5}$ Concentrations[2] (μg/m³)	
	1-hour	8-hour	24-hour	Annual
North portal	12.2	3.8	22.0	8.2
South portal	10.7	4.5	23.1	8.1

Notes: CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standard
pm = parts per million
$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
[2] For $PM_{2.5}$, the annual concentrations include a background concentration of 7.5 $\mu g/m^3$; the 24-hour concentrations include a background concentration of 20.2 $\mu g/m^3$. The 24-hour NAAQS is 35 $\mu g/m^3$; the annual NAAQS is 15 $\mu g/m^3$.

7.2.3 Results of MSAT Analysis

Future emissions likely would be lower than current levels as a result of the EPA's national control programs that are projected to reduce MSAT emissions by 72 percent from 1999 to 2050 even if the national average VMT increases by 145 percent, as shown on Exhibit 5-2. Similarly, as shown in Exhibit 7-3, MSATs in the study area are predicted to dramatically decrease in the future with the tolled Bored Tunnel Alternative compared to existing conditions (even though VMT on SR 99 is predicted to increase by 4.5 percent). Emissions of acrolein, benzene, 1,3-butadiene, DPM, and formaldehyde under tolled conditions are predicted to be greater than those under non-tolled conditions. Emissions of naphthalene are predicted to be approximately the same, and emissions of POM under tolled conditions are predicted to be less than those under non-tolled conditions. These burdens, however, are all substantially lower than existing (2015) levels. Local trends differ slightly from national trends due to fleet mix and turnover, VMT growth rates, and local control measures.

7.2.4 Operational Mitigation

Regional MSAT emissions are expected to decrease substantially relative to existing conditions, and no exceedances of the NAAQS are expected with the tolled Bored Tunnel Alternative. Because no substantial adverse effects on air quality are expected, no mitigation measures would be necessary.

7.2.5 Operational Benefits

As noted in Chapter 5, all the air quality standards would be met with the Bored Tunnel Alternative. There might be local differences in pollutant concentrations between the tolled Bored Tunnel Alternative and the non-tolled Bored Tunnel Alternative. However, no significant operational benefits are expected specific to the regional amounts of air pollutants emitted into the atmosphere for the tolled Bored Tunnel Alternative relative to the non-tolled Bored Tunnel Alternative.

7.3 Operational Effects of the Tolled Cut-and-Cover Tunnel Alternative

7.3.1 Results of Mobile Source CO Analysis

The results of the screening-level mobile source analysis (using WASIST) (Exhibit 7-4) represent the reasonable worst-case conditions that would occur in the project area (see Section 3.4.3). The values provided are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections for conditions in the design year (2030). The estimated maximum CO concentrations for the tolled Cut-and-Cover Tunnel

Exhibit 7-3. Predicted MSAT Emission Burdens – Existing (2015) and Design Year (2030) Conditions for the Tolled Bored Tunnel Alternative

Condition	Daily VMT	Change in VMT From Existing Conditions (%)	MSAT (tons/year)							Change From Existing Conditions (%)							Change From Non-Tolled Bored Tunnel (%)						
			Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM	Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM	Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM
Existing conditions (2015)	2,425,096	NA	0.3	28.1	1.9	6.5	6.1	21.4	2.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2030 Non-tolled Bored Tunnel Alternative	2,521,520	4.0	0.3	24.7	1.8	1.4	5.4	15.6	1.9	-12.7	-12.2	-6.5	-78.2	-11.2	-27.1	-21.2	NA	NA	NA	NA	NA	NA	NA
2030 Tolled Bored Tunnel Alternative	2,534,286	4.5	0.3	25.6	1.9	1.4	5.7	15.6	1.9	-8.7	-8.8	-3.0	-78.1	-7.0	-27.1	-22.0	4.6	3.9	3.7	0.5	4.7	0.0	-1.0

Notes: DPM = diesel particulate matter
MSAT = mobile source air toxic
NA = not applicable
POM = polycyclic organic matter
VMT = vehicle miles of travel

Exhibit 7-4. Design Year (2030) Maximum Predicted CO Concentrations for the Tolled Cut-and-Cover Tunnel Alternative

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	9.9	7.8
Mercer Street and Westlake Avenue N.	PM	8.3	6.7
Mercer Street and Dexter Avenue N.	PM	8.4	6.8
Denny Way and Dexter Avenue	PM	6.9	5.7
Denny Way and Dexter Avenue	AM	6.9	5.7
Denny Way and Aurora Avenue NB	PM	7.8	6.4
Columbia Street and First Avenue	PM	5.6	4.8
Yesler Way and First Avenue	PM	5.4	4.7

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

Alternative are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. Therefore, a more in-depth mobile source air quality analysis is not required. The estimated maximum CO concentrations for both the tolled and non-tolled Cut-and-Cover Tunnel Alternative are all less than NAAQS.

7.3.2 Results of Tunnel Portal and Tunnel Operations Building CO Analysis

Exhibit 7-5 show the results of the analysis (using the AERMOD model) for the tunnel portals and tunnel maintenance buildings under 2030 conditions. The values provided are the highest 1-hour and 8-hour concentrations of CO and the highest annual and 24-hour concentrations of $PM_{2.5}$ predicted at any of the receptor sites located near the tunnel portals and the tunnel maintenance buildings. The estimated CO and $PM_{2.5}$ concentrations near the portals of the SR 99 mainline cut-and-cover tunnel and the portals of the Battery Street Tunnel are all less than the NAAQS. The estimated CO and $PM_{2.5}$ under both the tolled and non-tolled Cut-and-Cover Tunnel Alternatives are all less than the NAAQS.

Exhibit 7-5. Design Year (2030) Maximum Predicted CO and $PM_{2.5}$ Concentrations Near the Tunnel Portals for the Tolled Cut-and-Cover Tunnel Alternative

Portal	CO Concentrations[1] (ppm)		$PM_{2.5}$ Concentrations[2] ($\mu g/m^3$)	
	1-hour	8-hour	24-hour	Annual
North portal of the Battery Street Tunnel	8.8	3.0	21.9	8.3
South portal of the Battery Street Tunnel/north portal of mainline cut-and-cover tunnel[3]	8.4	3.4	22.7	8.4
South portal of mainline cut-and-cover tunnel	6.8	3.4	22.6	8.4

Notes: CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standard
ppm = parts per million
$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
[2] For $PM_{2.5}$, the annual concentrations include a background concentration of 7.5 $\mu g/m^3$; the 24-hour concentrations include a background concentration of 20.2 $\mu g/m^3$. The 24-hour NAAQS is 35 $\mu g/m^3$; the annual NAAQS is 15 $\mu g/m^3$.
[3] With the Cut-and-Cover Tunnel Alternative, the south portal of the Battery Street Tunnel would be located near the north portal of the mainline tunnel. For a conservative estimate of the combined impacts of the emissions from both portals, the emissions from these portals (as well as the emissions from nearby at-grade traffic) were considered in one AERMOD modeling analysis.

7.3.3 Results of MSAT Analysis

Future emissions likely would be lower than current levels as a result of EPA's national control programs that are projected to reduce MSAT emissions by 72 percent from 1999 to 2050, even if the national average VMT increases by 145 percent, as shown on Exhibit 5-3. Similarly, as shown in Exhibit 7-6, MSATs in the study area are predicted to decrease dramatically with the tolled Cut-and-Cover Tunnel Alternative compared to existing conditions (even though the VMT on SR 99 is predicted to increase by 4.7 percent). Emissions of acrolein, benzene, 1,3-butadiene, and formaldehyde under tolled conditions are predicted to be greater than those under non-tolled conditions. Emissions of DPM, naphthalene, and POM under tolled conditions are predicted to be less than those under non-tolled conditions. These burdens, however, are all substantially less than existing (2015) levels.

Exhibit 7-6. Predicted MSAT Emission Rates – Existing (2015) and Design Year (2030) Conditions for the Tolled Cut-and-Cover Tunnel Alternative

Condition	Daily VMT	Change in VMT From Existing Conditions (%)	MSAT (tons/year)							Change From Existing Conditions (%)							Change From Non-Tolled Cut-and-Cover Tunnel Alternative (%)						
			Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM	Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM	Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM
Existing conditions (2015)	2,425,096	NA	0.3	28.1	1.9	6.5	6.1	21.4	2.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2030 Non-tolled Cut-and-Cover Tunnel Alternative	2,545,284	5.0	0.3	24.7	1.8	1.4	5.5	16.1	1.9	-12.6	-12.1	-6.2	-78.0	-11.1	-24.9	-19.5	NA	NA	NA	NA	NA	NA	NA
2030 Tolled Cut-and-Cover Tunnel Alternative	2,539,923	4.7	0.3	25.7	1.9	1.4	5.7	15.6	1.9	-8.4	-8.6	-2.8	-78.0	-6.7	-27.2	-22.1	4.8	3.9	3.6	-0.2	5.0	-3.1	-3.3

Notes: DPM = diesel particulate matter
MSAT = mobile source air toxic
NA = not applicable
VMT = vehicle miles of travel

7.3.4 Operational Mitigation

Regional MSAT emissions are expected to decrease substantially relative to existing conditions, and no exceedances of the NAAQS are expected with the tolled Cut-and-Cover Tunnel Alternative. Because no substantial adverse effects on air quality are expected, no mitigation measures would be necessary.

7.3.5 Operational Benefits

As noted in Chapter 5, all the air quality standards would be met with the Cut-and-Cover Tunnel Alternative. However, there may be local differences in pollutant concentrations between the tolled Cut-and-Cover Tunnel Alternative and non-tolled Cut-and-Cover Tunnel Alternative. However, no significant operational benefits specific to the regional amounts of air pollutants emitted into the atmosphere are expected for the tolled Cut-and-Cover Tunnel Alternative relative to the non-tolled Cut-and-Cover Tunnel Alternative.

7.4 Operational Effects of the Tolled Elevated Structure Alternative

7.4.1 Results of Mobile Source CO Analysis

The results of the screening-level mobile source analysis (using WASIST) (Exhibit 7-7) represent the reasonable worst-case conditions that would occur in the project area (see Section 3.4.3). The values provided are the highest 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections for conditions in the design year (2030). The estimated maximum CO concentrations for the tolled Elevated Structure Alternative are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. Therefore, a more in-depth mobile source air quality analysis is not required. The estimated maximum CO concentrations for both the tolled and non-tolled Elevated Structure Alternative are below the NAAQS.

7.4.2 Results of Tunnel Portal CO Analysis

Exhibit 7-8 shows the results of the analysis (using the AERMOD model) for the Battery Street tunnel portals. The values provided are the highest 1-hour and 8-hour concentrations of CO and the highest annual and 24-hour concentrations of $PM_{2.5}$ predicted at any of the receptor sites located near the Battery Street tunnel portals under 2030 conditions. The estimated CO and $PM_{2.5}$ concentrations are all less than the NAAQS under both the tolled and non-tolled conditions.

Exhibit 7-7. Design Year (2030) Maximum Predicted CO Concentrations for the Tolled Elevated Structure Alternative

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	10.2	8.0
Mercer Street and Westlake Avenue N.	PM	8.4	6.8
Mercer Street and Dexter Avenue N.	PM	8.2	6.6
Denny Way and Dexter Avenue	PM	8.2	6.6
Denny Way and Dexter Avenue	AM	6.4	5.4
Denny Way and Aurora Avenue NB	PM	6.8	5.7
Columbia Street and First Avenue	PM	6.4	5.4
Yesler Way and First Avenue	PM	5.8	5.0

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

Exhibit 7-8. Design Year (2030) Maximum Predicted CO and $PM_{2.5}$ Concentrations Near the Battery Street Tunnel for the Tolled Elevated Structure Alternative

Portal	CO Concentrations[1] (ppm)		$PM_{2.5}$ Concentrations[2] ($\mu g/m^3$)	
	1-hour	8-hour	24-hour	Annual
North portal	10.0	3.1	21.6	8.1
South portal	8.8	3.5	21.7	7.9

Notes: CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standard
ppm = parts per million
$PM_{2.5}$ = particulate matter with diameter less than or equal to 2.5 micrometers
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
[2] For $PM_{2.5}$, the annual concentrations include a background concentration of 7.5 $\mu g/m^3$; the 24-hour concentrations include a background concentration of 20.2 $\mu g/m^3$. The 24-hour NAAQS is 35 $\mu g/m^3$; the annual NAAQS is 15 $\mu g/m^3$.

7.4.3 Results of MSAT Analysis

Future emissions likely would be lower than current levels as a result of the EPA's national control programs that are projected to reduce MSAT emissions by 72 percent from 1999 to 2050 even if the national average VMT increases by 145 percent, as shown on Exhibit 5-2. Similarly, as shown in Exhibit 7-9, MSATs

Exhibit 7-9. Predicted MSAT Emission Rates – Existing (2015) and Design Year (2030) Conditions for the Tolled Elevated Structure Alternative

Condition	Daily VMT	Change in VMT From Existing Condition (%)	MSAT (tons/year)							Change From Existing Conditions (%)							Change From Non-Tolled Elevated Structure (%)						
			Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM	Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM	Acrolein	Benzene	1,3-Butadiene	DPM	Formaldehyde	Naphthalene	POM
Existing conditions (2015)	2,425,096	NA	0.3	28.1	1.9	6.5	6.1	21.4	2.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2030 Non-tolled Elevated Structure Alternative	2,556,547	5.4	0.3	24.9	1.8	1.4	5.5	16.1	1.9	-12.0	-11.4	-5.6	-77.9	-10.6	-24.8	-19.4	NA	NA	NA	NA	NA	NA	NA
2030 Tolled Elevated Structure Alternative	2,551,056	5.2	0.3	25.7	1.9	1.4	5.7	15.7	1.9	-8.4	-8.5	-2.8	-77.9	-6.8	-26.9	-21.8	4.0	3.3	3.0	-0.2	4.2	-2.8	-3.0

Notes: DPM = diesel particulate matter
MSAT = mobile source air toxic
NA = not applicable
POM = polycyclic organic matter
VMT = vehicle miles of travel

in the study area are predicted to dramatically decrease in the future with the tolled Elevated Structure Alternative compared to existing conditions (even though the VMT on SR 99 is predicted to increase by 5.2 percent).

Emissions of acrolein, benzene, 1,3-butadiene, and formaldehyde under tolled conditions are predicted to be greater than those under non-tolled conditions. Emissions of DPM, naphthalene, and POM under tolled conditions are predicted to be less than those under non-tolled conditions. These burdens, however, are all substantially lower than the existing (2015) levels.

7.4.4 Operational Mitigation

Regional MSAT emissions are expected to decrease substantially relative to existing conditions, and no exceedances of the NAAQS are expected with the tolled Elevated Structure Alternative. Because no substantial adverse effects on air quality are expected, no mitigation measures would be necessary.

7.4.5 Operational Benefits

As noted in Chapter 5, all the air quality standards would be met with the Elevated Structure Alternative. However, while there might be local differences in pollutant concentrations between the tolled Elevated Structure Alternative and the non-tolled Elevated Structure Alternative, there would be no significant operational benefits specific to the regional amounts of air pollutants emitted into the atmosphere for the tolled Elevated Structure Alternative relative to the non-tolled Elevated Structure Alternative.

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Chapter 8 REGULATORY COMPLIANCE

As part of the conformity compliance determination, detailed traffic analyses were completed for the year of opening (2015) and the LRTP analysis year (2040) only for the Bored Tunnel alternative (preferred). The 2015 and 2040 traffic analyses are described in Attachment D of this report.

8.1 Compliance With NAAQS

Maximum predicted 1-hour and 8-hour CO concentrations for the year of opening (2015) and the LRTP analysis year (2040) are provided for the non-tolled and the tolled Bored Tunnel Alternative in Exhibits 8-1, 8-2 and 8-3. The values presented are the highest concentrations obtained at each of the receptor sites using methods described in Chapter 3. Estimated pollutant concentrations at all the receptor sites are less than the NAAQS. No significant adverse effects on air quality effects are expected to result from the Bored Tunnel Alternative.

Exhibit 8-1. Year of Opening (2015) and Long-Range Transportation Plan Analysis Year (2040) Maximum Predicted CO Concentrations for the Non-Tolled Bored Tunnel Alternative

Intersection	Peak Period (AM or PM)	CO Concentrations in 2015 (ppm)		CO Concentrations in 2040 (ppm)	
		1-hour	8-hour	1-hour	8-hour
Mercer Street and Fairview Avenue N.	PM	8.6	6.9	9.9	7.8
Mercer Street and Fairview Avenue N.	AM	7.6	6.2	8.4	6.8
Mercer Street and Westlake Avenue N.	PM	7.2	5.9	8.0	6.5
Mercer Street and Dexter Avenue N.	PM	7.6	6.2	8.2	6.6
Denny Way and Dexter Avenue	PM	5.9	5.0	6.5	5.4
Denny Way and Dexter Avenue	AM	6.0	5.1	6.5	5.4
Denny Way and Aurora Avenue NB	PM	6.1	5.2	6.7	5.6

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
ppm = parts per million

Exhibit 8-2. Year of Opening (2015) and Long-Range Transportation Plan Analysis Year (2040) Maximum Predicted CO Concentrations for the Tolled Bored Tunnel Alternative

Intersection	Peak Period (AM or PM)	CO Concentrations 2015 (ppm)		CO Concentrations 2040 (ppm)	
		1-hour	8-hour	1-hour	8-hour
Mercer Street and Fairview Avenue N.	PM	8.8	7.1	10.1	8.0
Mercer Street and Fairview Avenue N.	AM	7.7	6.3	8.5	6.8
Mercer Street and Westlake Avenue N.	PM	7.6	6.2	8.5	6.8
Mercer Street and Dexter Avenue N.	PM	7.4	6.1	8.2	6.6
Denny Way and Dexter Avenue	PM	6.2	5.2	7.4	6.1
Denny Way and Dexter Avenue	AM	6.0	5.1	6.5	5.4
Denny Way and Aurora Avenue NB	PM	6.3	5.2	7.7	6.3

Notes: All values include a background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
NB = northbound
PM = afternoon
ppm = parts per million

Exhibit 8-3. Maximum Predicted CO Concentrations for the Non-Tolled and Tolled Bored Tunnel Alternative

	Non-Tolled Bored Tunnel CO Concentrations[1] (ppm)				Tolled Bored Tunnel CO Concentrations[1] (ppm)			
	2015		2040		2015		2040	
Portal	1-hour	8-hour	1-hour	8-hour	1-hour	8-hour	1-hour	8-hour
North portal	19.4	6.0	16.2	5.2	12.1	3.7	12.2	3.7
South portal	15.8	6.8	13.6	6.0	12.1	4.9	10.9	4.7

Notes: CO = carbon monoxide
μg/m³ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standard
ppm = parts per million
[1] For CO, the 1-hour concentrations include a background concentration of 2.3 ppm; the 8-hour concentrations include a background concentration of 1.5 ppm. The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.

8.2 Compliance With Conformity Rule

8.2.1 Operational Effects

The study area is within a CO maintenance area. Projects located in a maintenance area must comply with the project-level and regional conformity criteria in EPA's Transportation Conformity Rule (40 CFR 93) and with WAC 173-420. Based on the results presented in Chapters 5 and 7 of this discipline report, as well as the results of a WASIST analysis for the year of opening (2015) and the area's LRTP analysis year (2040) (Exhibits 8-1, 8-2, and 8-3), the for the Bored Tunnel Alternative (with or without the tolls) would not cause or exacerbate an exceedance of the NAAQS for CO. Therefore, it would meet the project-level conformity requirements in accordance with 40 CFR 93.123. In addition, the project is included in the Metropolitan Transportation Plan (PSRC 2001 and the Statewide Transportation Improvement Program (WSDOT 2010a), demonstrating that it conforms with the Puget Sound region's Air Quality Maintenance Plan.

8.2.2 Construction Effects

Because the total construction period is projected to last longer than 60 months, the project is also subject to the Transportation Conformity Rule (40 CFR 93) during construction. Therefore, a construction-phase mobile source analysis was conducted to determine whether the Bored Tunnel Alternative would conform with the NAAQS for CO near the congested intersections that would be most affected by construction-related vehicles during the reasonable worst-case long-term construction period. Appendix C, Transportation Discipline Report, provides more information on the construction period and the expected durations of the construction stages associated with the Bored Tunnel alternative.

Exhibit 8-4 shows the results of the screening-level mobile source CO analysis that was conducted using WASIST. The values provided are the maximum 1-hour and 8-hour CO concentrations predicted at any of the receptor sites near the selected intersections during the reasonable worst-case construction year (2012) without the incorporation of any mitigation measures. The estimated CO concentrations are all less than the 1-hour and 8-hour NAAQS of 35 and 9 ppm, respectively. The results of this analysis indicate that a more in-depth mobile source air quality analysis is not required and that the project would meet the project-level conformity requirements in accordance with 40 CFR 93.123.

Exhibit 8-4. Maximum Predicted 1-Hour and 8-Hour CO Concentrations During Construction of the Bored Tunnel Alternative With No Mitigation

Intersection	Peak Period (AM or PM)	1-hour Concentration (ppm)	8-hour Concentration (ppm)
Mercer Street and Fairview Avenue N.	PM	9.9	7.8
Mercer Street and Westlake Avenue N.	PM	8.5	6.8
Mercer Street and Fairview Avenue N.	AM	9.9	7.8
Mercer Street and Ninth Avenue N.	PM	8.2	6.6
Mercer Street and Dexter Avenue N.	PM	8.9	7.1

Notes: All values include a conservative background concentration of 3 ppm.
The 1-hour NAAQS is 35 ppm; the 8-hour NAAQS is 9 ppm.
AM = morning
CO = carbon monoxide
NAAQS = National Ambient Air Quality Standard
PM = afternoon
ppm = parts per million

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ATTACHMENT A

WASIST Input and Output Tables

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Attachment A provides the WASIST Input and Output Tables used for the analysis discussed in the body of the discipline report. This attachment is too large (either in length or file size) to include in the document, but is available upon request.

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ATTACHMENT B

EMIT Input and Output Tables

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Attachment B provides the EMIT Input and Output Tables used for the analysis discussed in the body of the discipline report. This attachment is too large (either in length or file size) to include in the document, but is available upon request.

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ATTACHMENT C

Tunnel and Ventilation Modeling Input and Output Tables

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Attachment C provides the Tunnel and Ventilation Modeling Input and Output Tables used for the analysis discussed in the body of the discipline report. This attachment is too large (either in length or file size) to include in the document, but is available upon request.

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ATTACHMENT D

Traffic Data for 2015 and 2040

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ATTACHMENT D

Detailed traffic analyses were completed for the Bored Tunnel Alternative (preferred) under tolled and non-tolled conditions for the year of opening (2015) and the long-range transportation plan (LRTP) analysis year (2040) as part of the conformity compliance determination. This attachment details the transportation data collection process, specifies the methods for performing travel forecasting and traffic analysis, and describes the types of transportation effects investigated and how those effects were evaluated for the 2015 Bored Tunnel Alternative and the 2040 Bored Tunnel Alternative.

2015 Bored Tunnel Alternative

The project's travel demand forecasting model was used to derive estimated changes in travel patterns and traffic volumes for the future year of 2015 for the non-tolled and tolled Bored Tunnel Alternative. Detailed analysis was conducted for the 2015 Bored Tunnel Alternative as the project year of opening. The results of this analysis were not included in Appendix C, Transportation Discipline Report.

Changes in Travel Patterns and System-wide Performance Measures

The travel demand forecasting model was used to estimate potential changes in travel patterns in 2015 under non-tolled and tolled conditions for the Bored Tunnel Alternative. Traffic volumes on regional transportation corridors, including Interstate 5 (I-5), State Route (SR) 99, and major arterials in central Seattle, were compared at study area screenline locations south of, within, and north of downtown Seattle.

Estimates of transit ridership and total person-throughput (for total vehicles and transit modes) were prepared at the screenline level. Additionally, region-wide morning (AM) peak period, afternoon (PM) peak period, and daily vehicle miles of travel, vehicle hours of travel, and vehicle hours of delay were forecasted, as well as daily transit mode shares to and from the Center City area.

Traffic Operations on SR 99

Travel speeds during the AM and PM peak periods were evaluated along with levels of service for all mainline segments and ramps on SR 99 for both non-tolled and tolled conditions under the 2015 Bored Tunnel Alternative. These data were estimated from VISSIM traffic simulation modeling. In addition, 24-hour volumes including truck percentages were provided for use in this analysis.

Traffic Operations at Key Arterial Intersections

Average vehicle delay and level of service were estimated for the AM and PM peak period under non-tolled and tolled conditions for the 2015 Bored Tunnel Alternative at key intersections in the study area that were consistent with the locations evaluated for existing conditions (2015 Existing Viaduct). Additionally, any intersections that would be newly created or reconfigured under the build alternatives were included in the evaluation.

Peak-period volumes used for these intersection analyses were estimated based on changes in traffic volumes predicted by the project's travel demand model. For each intersection location, existing counts were adjusted by the modeled change in traffic volumes to derive the appropriate volume under future conditions. This "postprocessing" of model volumes helps ensure that forecasts derived from the model are calibrated to the observed field conditions. In cases of new intersections, estimates are based on modeled volumes adjusted to balance those at nearby intersections.

2040 Bored Tunnel Alternative

A "high-level" year 2040 assessment of the Bored Tunnel Alternative was conducted by analyzing projected population and employment growth both in the region and in the Center City area. The potential effects on transportation operational performance in 2030 are discussed in Chapter 5 of Appendix C, Transportation Discipline Report.

Growth rates were estimated for the year 2040 and provided for use in the analysis. The 2040 growth rate was estimated using year 2015 and year 2030 travel demand models for the Bored Tunnel Alternative and year 2010 through year 2040 land use forecasts from the Puget Sound Regional Council. The resulting growth rates in vehicle volumes from 2030 to 2040 are as follows:

- AM peak period: 2.0 percent
- PM peak period: 3.2 percent
- Daily: 3.8 percent