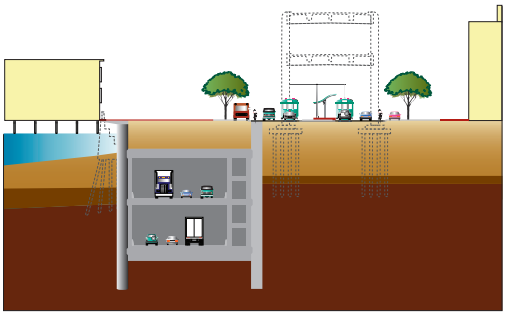
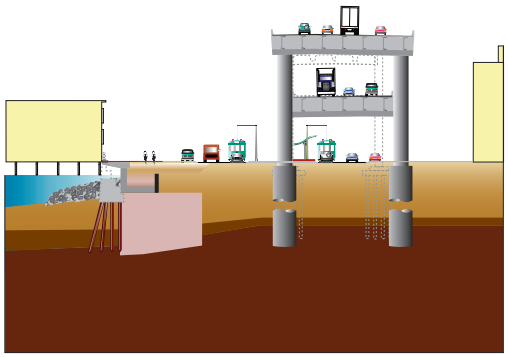
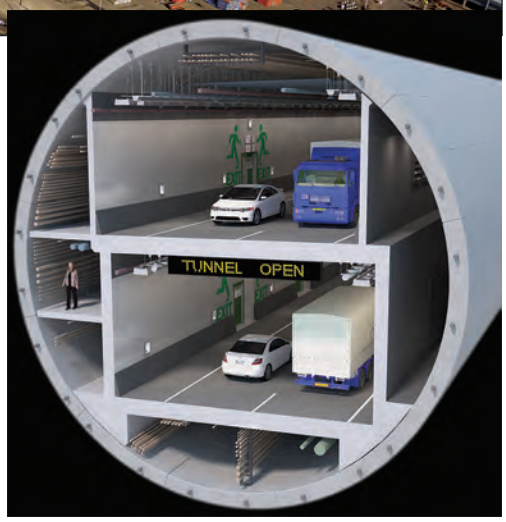
ALASKAN WAY VIADUCT REPLACEMENT PROJECT

Final Environmental Impact Statement

APPENDIX R Energy Discipline Report







Submitted by:
PARSONS BRINCKERHOFF

Prepared by:
PARSONS BRINCKERHOFF

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
Energy 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:

Parsons Brinckerhoff
999 Third Avenue, Suite 3200
Seattle, WA 98104

In association with:
Coughlin Porter Lundeen, Inc.
EnviroIssues, Inc.
GHD, Inc.
HDR Engineering, Inc.
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Magnusson Klemencic Associates, Inc.
Mimi Sheridan, AICP
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Shannon & Wilson, Inc.
William P. Ott Construction Consultants

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ACRONYMS AND ABBREVIATIONS

BTU	British thermal unit
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
eGRID	Emissions & Generation Resource Integrated Database
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
GWP	global warming potential
MMBTU	million British thermal units
MOVES	Motor Vehicle Emissions Simulator
MWh	megawatt-hour
NEPA	National Environmental Policy Act
Program	Alaskan Way Viaduct and Seawall Replacement Program
project	Alaskan Way Viaduct Replacement Project
SEPA	State Environmental Policy Act
SODO	South of Downtown
SR	State Route
TBM	tunnel boring machine
VMT	vehicle miles of travel
WSDOT	Washington State Department of Transportation

Chapter 1 INTRODUCTION AND SUMMARY

1.1 Introduction

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 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 S. Washington Street no longer intrudes into 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. As part of the NEPA process, FHWA is also 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 the subsequent 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 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 Summary

Three build alternatives are currently under consideration for replacing the Alaskan Way Viaduct: Bored Tunnel Alternative (preferred), Cut-and-Cover Tunnel Alternative, and Elevated Structure Alternative. Analyses of effects and benefits have been quantified (or described qualitatively, where applicable) for construction and operation of all three build alternatives. 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 referred to as the Alaskan Way Viaduct and Seawall Replacement Program (Program). See Exhibit 1-1.

This discipline report presents detailed technical analyses of the following:

- 2015 Existing Conditions
- 2030 Viaduct Closed (No Build Alternative)
- 2030 Bored Tunnel Alternative
- 2030 Cut-and-Cover Tunnel Alternative
- 2030 Elevated Structure Alternative

The Final EIS evaluates the cumulative effects of all the build alternatives (Chapter 7); 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.

1.3 Summary of Analysis

Energy requirements and greenhouse gas emissions associated with the project were analyzed on the city center scale and regional scale (see list in Section 1.2). The energy required to construct the facilities associated with the project and the energy required for the operational phase of the project (i.e., to propel vehicles using the affected roadways and to maintain the facilities after construction is completed) were estimated.

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

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.

Energy estimates for vehicles using the project's roadways were calculated using the 2010 Motor Vehicle Emissions Simulator (MOVES2010a) model from the U.S. Environmental Protection Agency (EPA). Construction energy estimates were calculated based on the latest construction schedule, taking into account several factors, including the equipment to be used, construction activities, equipment load factors, and fuel utilization rates.

Greenhouse gas emissions, discussed in terms of carbon dioxide equivalents (CO_2e), were calculated for both the construction and operational phases of the project. The potential direct emissions of greenhouse gases for the build alternatives were estimated using the MOVES2010a model for emissions from roadway vehicles and

the EPA's Emissions & Generation Resource Integrated Database (eGRID) emission factors for electrical usage.

The results of the energy and greenhouse gas analyses are summarized in Exhibit 1-2. In 2030, the Viaduct Closed (No Build Alternative) would result in the highest operational energy and greenhouse gas emissions. By comparison, all of the build alternatives would result in a decrease in operational energy requirements and greenhouse gas emissions. This is due mainly to projected changes in future fuel use due to speed fluctuations and vehicle miles of travel (VMT). The differences between the alternatives are negligible, as none of them differs by more than 1 percent.

Exhibit 1-2. Summarized Results of Energy and Greenhouse Gas Analyses

	2015 Existing Conditions	2030 Alternatives						
		Viaduct Closed (No Build Alternative)	Bored Tunnel (Non-Tolled)	Bored Tunnel (Tolled)	Cut-and-Cover Tunnel (Non-Tolled)	Cut-and-Cover Tunnel (Tolled)	Elevated Structure (Non-Tolled)	Elevated Structure (Tolled)
Energy								
Average daily operational energy required (MMBTU/day, including maintenance)	615,406	621,785	618,138	618,759	617,966	618,303	619,571	620,091
% difference from 2015 Existing Conditions	NA	1.0%	0.5%	0.5%	0.4%	0.5%	0.7%	0.8%
% difference from 2030 Viaduct Closed (No Build Alterative)	NA	NA	-0.6%	-0.5%	-0.6%	-0.6%	-0.4%	-0.3%
Total construction energy (MMBTU)	NA	NA	508,676	508,676	351,046	351,046	348,362	348,362
Greenhouse Gases								
Average daily CO_2e operational emissions (metric tons/day, including maintenance)	46,997	47,490	47,223	47,271	47,209	47,235	47,324	47,363
% difference from 2015 Existing Conditions	NA	1.0%	0.5%	0.6%	0.4%	0.5%	0.7%	0.8%
% difference from 2030 Viaduct Closed (No Build Alternative)	NA	NA	-0.6%	-0.5%	-0.6%	-0.5%	-0.4%	-0.3%
Total CO_2e construction emissions (metric tons)	NA	NA	99,745	99,745	63,485	63,485	72,853	72,853

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas
MMBTU = million British thermal units
NA = not applicable

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Chapter 2 METHODOLOGY

2.1 Transportation Energy

Transportation energy is the energy required to move people and goods from place to place. Transportation accounts for a major portion of the energy consumed in Washington State. Transportation energy is generally discussed in terms of operational and construction energy consumption. Operational energy consumption involves all energy consumed by vehicle propulsion. This energy is a function of traffic characteristics such as volume, speed, distance traveled, vehicle mix, and the thermal value of the fuel being used. Operational energy consumption also includes the energy required to maintain the transportation facilities. Construction energy consumption involves the non-recoverable, one-time energy expenditure involved in constructing the physical infrastructure associated with the project. Greenhouse gas emissions are discussed in terms of operational and construction emissions.

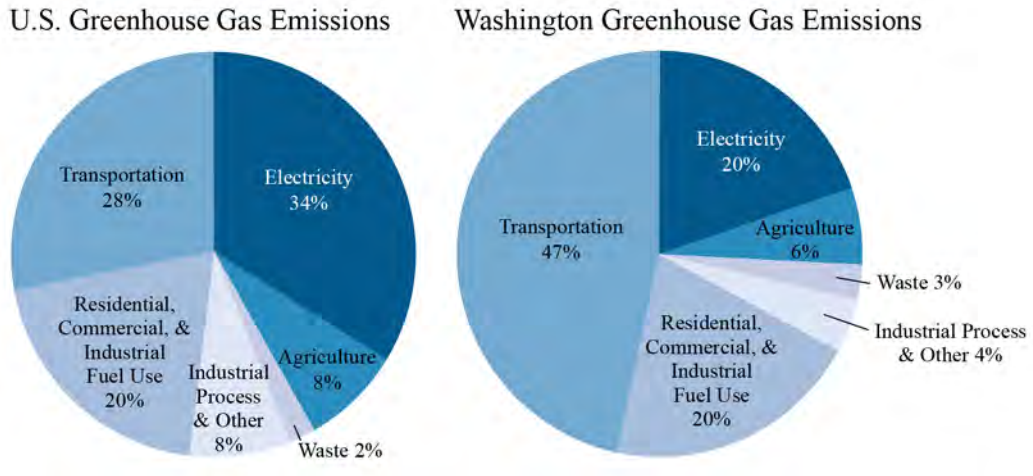
Energy is commonly measured in terms of British thermal units (BTUs). A BTU is defined as the amount of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit. Fossil fuels (e.g., gasoline, diesel fuel, and jet fuel) are the predominant source of energy for transportation in Washington.

2.2 Greenhouse Gases and Transportation

Vehicles emit a variety of gases during their operation; some of these are greenhouse gases: water vapor, carbon dioxide (CO_2), methane (also known as "marsh gas"), and nitrous oxide (used in dentists' offices and also referred to as "laughing gas"). Any process that burns fossil fuel releases CO_2 into the air. CO_2 makes up the bulk of the greenhouse gas emissions from transportation.

Vehicles are a substantial source of greenhouse gas emissions and contribute to global warming primarily through the burning of gasoline and diesel fuel. National estimates show that the transportation sector (including on-road vehicles, construction activities, airplanes, and boats) accounts for almost 30 percent of total domestic CO_2 emissions. However, in Washington State, transportation accounts for nearly half of the greenhouse gas emissions. This is because the state relies heavily on hydropower for electricity generation, unlike other states that rely on fossil fuels such as coal, petroleum, and natural gas to generate electricity. The next largest contributors to total greenhouse gas emissions in Washington are fossil fuel combustion in the residential, commercial, and industrial sectors at 20 percent, and in electricity consumption, also at 20 percent. Exhibit 2-1 shows the greenhouse gas emissions by sector, nationally and in Washington State.

Exhibit 2-1. Greenhouse Gas Emissions by Sector in 2005 for the United States and Washington State



Source: WSDOT 2010a

Greenhouse gases differ in their ability to trap heat. For example, 1 ton of CO_2 emissions has a different effect than 1 ton of methane emissions. To compare emissions of different greenhouse gases, inventory compilers use a weighting factor called the "global warming potential" (GWP).

The gases of concern for this analysis are those associated with the combustion of fossils fuels used in transportation: CO_2, methane, and nitrous oxide. The GWPs of these gases are presented in Exhibit 2-2. A larger number represents a stronger absorption and longer atmospheric residence time.

Exhibit 2-2. Greenhouse Gas Global Warming Potentials

Greenhouse Gas	Formula	Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298

Source: IPCC 2007

2.3 Study Area

The study area evaluated for energy effects includes areas likely to be affected by changes in energy use and greenhouse gas emissions as a result of the project. The energy and greenhouse gas effects were estimated for roadways within the city center area, as well as in the region. The city center area is bordered by Aloha Street on the north, 15th Avenue on the east, S. Holgate Street on the south, and Elliott Bay on the west, as shown on Exhibit 2-3. The region includes all the traffic

movements in King, Pierce, Snohomish, and Kitsap Counties; the regional study area is shown on Exhibit 2-4.

2.4 Applicable Regulations and Guidelines

The following laws, statutes, local ordinances, and guidelines address potential energy and resulting greenhouse gas effects:

- National Environmental Policy Act (NEPA)
- Presidential Executive Order 13423
- Washington State Environmental Policy Act (SEPA)
- Washington State Department of Transportation (WSDOT) *Guidance for Project-Level Greenhouse Gas and Climate Change Evaluations* (October 2010) (WSDOT 2010a)
- WSDOT *Environmental Procedures Manual* (February 2010) (WSDOT 2010b)
- City of Seattle Ordinance 122574, which requires City departments to evaluate climate impacts when performing environmental review of actions pursuant to SEPA (adopted in December 2007)
- City of Seattle Ordinance 122610, which calls for the reduction of greenhouse gases in Seattle by 30 percent from 1990 levels by 2024, and by 80 percent from 1990 levels by 2050 (adopted in December 2007)

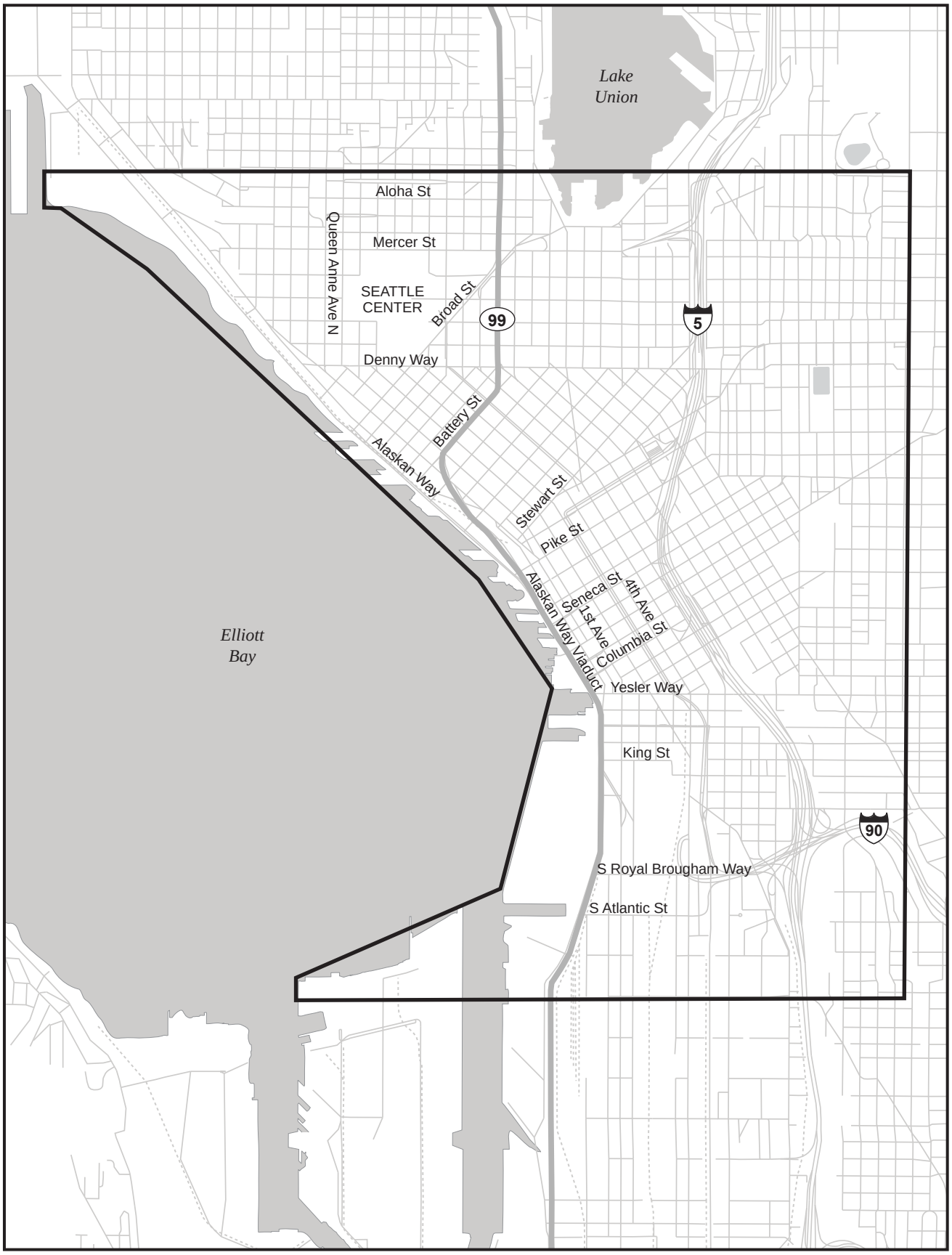
2.5 Analysis Methodology, Data Needs, and Sources

2.5.1 Operational Energy Effects

Operational effects were evaluated for the three build alternatives. Federal and Washington State environmental regulations require agencies to evaluate a no build alternative to provide baseline information about future conditions in the project area. The 2030 Viaduct Closed (No Build Alternative) assumes that the Alaskan Way Viaduct is closed. The Bored Tunnel, Cut-and-Cover Tunnel, and Elevated Structure Alternatives were analyzed for the year 2030. All three build alternatives were analyzed with and without tolling.

The effects of the alternatives on transportation-related energy consumption in the study area have been quantitatively assessed. Operational energy includes all energy consumed by the annual maintenance required by the project and the energy used in vehicle propulsion.

The energy required to maintain the project includes the energy consumed for lighting, ventilation systems, and roadway maintenance (e.g., patching, crack sealing, and landscape maintenance) for the total lane-miles resulting from the various alternatives.



11/15/10

N

0 2,500

SCALE IN FEET

Exhibit 2-3
City Center Study Area

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N

0 15

SCALE IN MILES

Exhibit 2-4
Regional Study Area

2.5.2 Traffic Data

To determine the operational energy effects of the project, data from the project's traffic demand forecasting model were used as input for this analysis. The data used included link-by-link estimates of VMT and travel speeds. For modeling purposes and documentation of the affected environment, the project team used 2015 to represent the existing conditions. The results of the traffic analyses are documented in Appendix C, Transportation Discipline Report.

The power requirement of the ventilation and lighting equipment was also obtained from the tunnel and ventilation analysis conducted for the project. The total operational energy use of the project was calculated by combining the energy requirements of the vehicles using the roadway with the energy requirements for the ventilation and lighting.

2.5.3 Construction Energy Effects

The energy required for construction was estimated based on horsepower requirements, equipment use, equipment load factors, and the construction schedule for the build alternatives. Tolling would not affect the construction effort; therefore, the energy requirements estimated for the build alternatives represent both the tolled and non-tolled facilities. Equipment unique to each build alternative, such as the tunnel boring machine (TBM) and its support system for the Bored Tunnel Alternative, were included in the quantitative analysis. All alternatives included installation of the signage for the intelligent transportation systems.

2.5.4 Construction Data

To determine the construction energy requirements of the project, the following information was used:

- Estimated earth excavation and grading quantities
- Methods for handling and transporting excavated material and debris
- Estimated hours of operation of heavy-duty diesel- and gasoline-powered construction equipment
- Estimated hours of operation of electrically powered construction equipment
- Estimated hours of operation of heavy-duty diesel trucks involved in the transport of excavated material and the delivery of construction material, both within construction areas and on local streets

2.5.5 Motor Vehicle Fuel Use Emission Factor

Energy estimates for vehicles using the project's roadways were calculated using the MOVES2010a model from EPA (EPA 2010). The EPA MOVES2010a model estimates overall fuel consumption factors based on fleet characteristics such as vehicle mix, vehicle age, and speed, as well as area-specific information for King County as defined in the MOVES2010a model. MOVES2010a was run for the years 2015 and 2030. Consumption rates were grouped into 16 speed bins, representing speeds from 2.5 to 75 mph. EPA considers the MOVES2010a model to be the model of choice for estimating fuel consumption.

Based on the EPA MOVES2010a model, the energy consumed by vehicles using a facility is affected by vehicle mix, travel speeds, and fuel efficiency. The operational energy analysis was conducted using the following factors:

- Vehicle volumes derived for each facility segment, producing VMT per roadway link. More than 250 links were analyzed individually on the city level, and more than 800 links were analyzed individually on the regional level.
- Vehicle mix (e.g., percentage of automobiles, trucks, and other vehicles) and speed were used to identify fuel consumption rates.
- Total vehicle fuel use in the study area was estimated by combining fuel use, calculated on a link-by-link basis as described above, resulting in an overall vehicle fuel use value for the study area.

2.5.6 Greenhouse Gas Emissions

The EPA MOVES2010a model was used to estimate greenhouse gas emission factors resulting from fossil fuel consumption using a combination of area-specific and national parameters to reflect the project conditions, as discussed in Section 2.5.5. The results of the MOVES2010a model and the results of the operational analyses were used to estimate potential operational emissions of greenhouse gases for the project alternatives. The results are reported as CO_2e, which represents CO_2, nitrous oxide, and methane emissions with the appropriate GWP factors applied.

It is assumed that this project would result in CO_2, nitrous oxide, and methane emissions from the combustion of motor vehicle fuel by vehicles using the facility.

2.5.7 Construction Greenhouse Gas Emissions

The greenhouse gas emissions generated from construction were estimated based on horsepower requirements, equipment use, equipment load factors, and the construction schedule for the build alternatives. Tolling would not affect the construction effort; therefore, the energy requirements estimated for the build

alternatives represent both the tolled and non-tolled facilities. Equipment unique to each build alternative, such as the TBM and its support system for the Bored Tunnel Alternative, were included in the quantitative analysis.

It is assumed that this project would result in CO_2, nitrous oxide, and methane emissions from the fuel and electricity used to construct the facility.

2.5.8 Greenhouse Gas Emission Factors for Electrical Power

Emission factors are used to estimate the amount of greenhouse gases that would be released by an activity. To determine the project's effects on greenhouse gas emissions, the project team had to select an emission factor for use of electrical energy provided by one of the following three sources:

- The U.S. Department of Energy's Energy Information Administration provides state-specific emission factors for electricity use (EIA 2007). This source considers electrical power generating sources in Washington, Oregon, and Idaho. Applying the appropriate GWP, a CO_2e emission factor of 0.148 metric ton per megawatt-hour (MWh) would be used to obtain the CO_2e emissions due to the power requirements of the project.
- EPA provides eGRID emission factors for electricity use (EPA 2009). This source considers electrical power generating sources in the entire Pacific Northwest, including Washington, Oregon, Idaho, and northern California. Also considered were Utah and parts of Montana, Nevada, Wyoming, and northern Arizona. Applying the appropriate GWP, a CO_2e non-load emission factor of 0.411 metric tons/MWh or a non-baseload emission factor of 0.608 metric tons/MWh would be used to obtain the CO_2e emissions due to the power requirements of the project.
- Seattle City Light uses the eGRID non-baseload emissions factor of 0.608 metric ton/MWh. This considers the marginal electrical power generating resources used to serve new electrical load.

The analysis in this document has applied the eGRID/SCL non-baseload emissions factor (0.608 metric tons/MWh) for electricity use. This represents the fact that the project represents a new load affecting Seattle's electric utility and thus would likely result in the use of non-baseloaded sources.

Chapter 3 STUDIES AND COORDINATION

Energy methods and analysis procedures were developed for the project in coordination with WSDOT, the City of Seattle, King County, and FHWA. On March 5, 2009, an updated methodology for energy and greenhouse gas analysis was presented to WSDOT and City of Seattle staff. Input from these agencies was considered in developing the methodology for this study. The final methodology was approved by WSDOT on July 28, 2009.

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Chapter 4 AFFECTED ENVIRONMENT

The study area evaluated for energy effects includes areas likely to affect changes in energy use and greenhouse gas emissions as a result of the project. Current energy use and the greenhouse gas emissions were estimated for roadways in the city center area and on a regional scale.

4.1 City of Seattle

According to *Seattle's Community Carbon Footprint: An Update* (City of Seattle 2008), the city's carbon footprint was about 8 percent smaller in 2005 than it was in 1990. This reduction was due to energy conservation efforts and Seattle City Light's policy of achieving "net zero" greenhouse gas emissions in delivery of electricity through the use of conservation, renewable energy, and purchase of carbon offsets. Furthermore, the shift of many households and businesses from heating oil to natural gas, a less carbon-intensive fossil fuel, has resulted in lower greenhouse gas emissions.

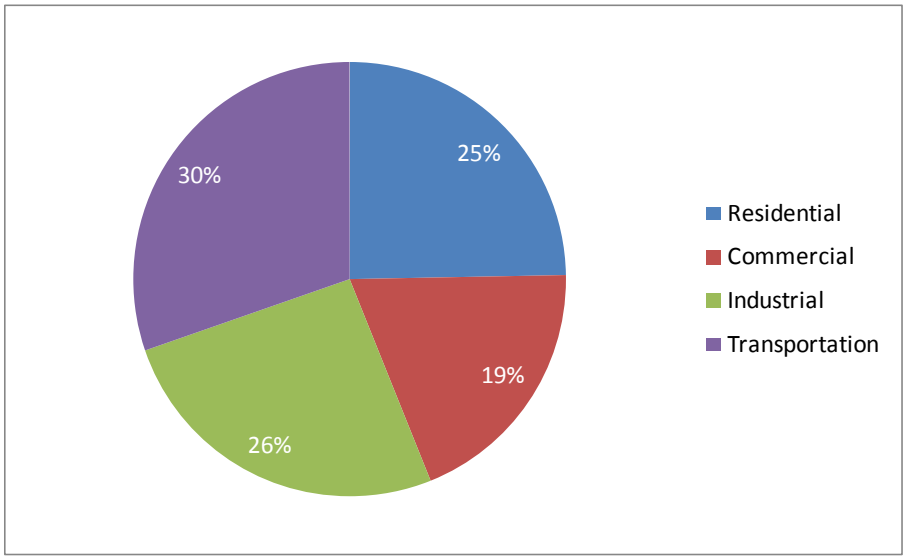
Per capita greenhouse gas emissions in Seattle were 11 percent lower in 2005 than in 1990, with per capita emissions of about 11.5 tons per year in 2005. This value compares favorably to those of Washington State (14.1 tons) and the United States (24 tons).

The emissions from transportation sources (road, rail, marine, and air), which make up roughly 60 percent of Seattle's carbon footprint, have increased about 3 percent compared to 1990. Emissions from on-road transportation (trucks, buses, vans, cars, sport utility vehicles, and light-duty trucks), which make up roughly 40 percent of Seattle's carbon footprint, were up roughly 5 percent from 1990 levels.

4.2 Washington State

As shown on Exhibit 4-1, transportation currently accounts for approximately 30 percent of the energy consumed in Washington. Washington's transportation energy consumption is approximately 621.8 trillion BTUs. Washington is ranked as the 14th largest end-use consumer of transportation energy in the United States. Petroleum (i.e., gasoline, diesel fuel, and jet fuel) is the predominant source of energy for transportation in Washington State (http://www.eia.doe.gov/emeu/states/_seds.html).

Exhibit 4-1. Washington State Energy Consumption by Sector in 2008



Source: EIA 2010

National estimates show that the transportation sector (including on-road, construction, airplanes, and boats) accounts for almost 30 percent of total domestic CO_2 emissions.[1] However, as shown on Exhibit 2-1, transportation accounts for nearly half of the greenhouse gas emissions in Washington State because the state relies heavily on hydropower for electricity generation, unlike other states that rely on fossil fuels such as coal, petroleum, and natural gas to generate electricity. The next largest contributors to total gross greenhouse gas emissions in Washington are fossil fuel combustion in the residential, commercial, and industrial sectors and in electricity generation facilities, both 20 percent.

[1] This percentage is based on 2004 data from the International Energy Administration and is consistent with 1996 guidelines on greenhouse gas emissions calculations issued by the Intergovernmental Panel on Climate Change.

Chapter 5 OPERATIONAL ENERGY EFFECTS, MITIGATION, AND BENEFITS

As required by WSDOT procedures and guidelines, a detailed energy analysis was conducted for this project due to its scope and nature. Both the energy used to maintain the transportation facility and the energy consumed by vehicles using the facility were estimated.

For this project, the 2030 Viaduct Closed (No Build Alternative) with the existing viaduct is not a viable alternative because the 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 in the future, the roadway will need to be closed. Therefore, the 2015 Existing Conditions includes the viaduct, but the 2030 Viaduct Closed (No Build Alternative) does not.

The 2030 Viaduct Closed (No Build Alternative) describes the consequences of suddenly losing the function of SR 99 along the central waterfront based on two scenarios. This report qualitatively discusses the effects of the two scenarios for the 2030 Viaduct Closed (No Build Alternative) in Section 5.1. These consequences would be short term and would last 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 Operational Energy Effects of the 2030 Viaduct Closed (No Build Alternative)

There are two scenarios for the 2030 Viaduct Closed (No Build Alternative):

- Scenario 1 involves the sudden unplanned closure of the viaduct.
- Scenario 2 involves the catastrophic and complete collapse of the viaduct.

5.1.1 Scenario 1: Sudden Unplanned Closure of the Viaduct

Under Scenario 1, there would be a sudden, unplanned closure of SR 99 between S. King Street and Denny Way due to some structural deficiency, weakness, or small earthquake event. The viaduct would be closed for an unknown period of time until a viaduct replacement could be built. Severe travel delays would be experienced, and utilities on the viaduct would likely require repair. Although current projections indicate a general increase in future vehicle traffic, the actual increase if the viaduct were no longer in service is unknown and depends on multiple factors, such as changed or canceled trips and changes in mode of travel.

The results of the 2030 Viaduct Closed (No Build Alternative) analyses are documented in Appendix C, Transportation Discipline Report.

5.1.2 Scenario 2: Catastrophic and Complete Collapse of the Viaduct

Scenario 2 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. Although current projections indicate a general increase in future vehicle traffic, the actual increase if the viaduct were no longer in service is unknown and depends on multiple factors, such as changed or canceled trips and changes in mode of travel. The results of the 2030 Viaduct Closed (No Build Alternative) analyses are documented in Appendix C, Transportation Discipline Report.

5.1.3 Comparison of Scenarios 1 and 2

Both Scenario 1 and Scenario 2 would involve the loss of use of the viaduct, which would result in severe travel delays and unknown changes in traffic patterns. However, Scenario 2 would involve greater energy consumption due to the equipment and activities needed for the cleanup of a catastrophic and complete collapse of the viaduct.

5.2 Operational Energy Effects

Operational energy consumption by vehicles under the 2015 Existing Conditions, 2030 Viaduct Closed (No Build Alternative), and 2030 build alternatives was calculated using project-specific values for VMT (shown in Exhibit 5-1) and average speed on a link-by-link basis, along with national vehicle mix information. In addition, the fuel consumption factors were derived from the EPA MOVES2010a model. The resulting estimates of energy use by vehicles are shown in Exhibit 5-2.

As shown in Exhibit 5-2, differences among the alternatives overall are small, less than 3 percent in the city center and less than 1 percent in the region. These differences are below the accuracy of the overall traffic data and therefore cannot be considered meaningful. Based on this, there are no meaningful differences in roadway vehicle energy consumption between the alternatives.

Exhibit 5-1. Roadway Vehicle Miles of Travel

Study Area	2015 Existing VMT	2030 Viaduct Closed VMT	2030 Bored Tunnel VMT	2030 Cut-and-Cover Tunnel VMT	2030 Elevated Structure VMT
City Center	2,425,096	2,371,538	2,521,520	2,545,284	2,556,547
% Change from 2030 Viaduct Closed (No Build Alternative)	NA	NA	6.3%	7.3%	7.8%
Region	97,141,512	110,820,388	109,471,937	109,498,402	109,668,514
% Change from 2030 Viaduct Closed (No Build Alternative)	NA	NA	-1.2%	-1.2%	-1.0%

Notes: VMT = vehicle miles of travel
NA = not applicable

Exhibit 5-2. Existing and 2030 Daily Roadway Vehicle Energy Consumption

Study Area	2015 Existing Conditions (MMBTU)	2030 Viaduct Closed (No Build Alternative) (MMBTU)	2030 Bored Tunnel (MMBTU)	2030 Cut-and-Cover Tunnel (MMBTU)	2030 Elevated Structure (MMBTU)
City Center	15,004	13,317	13,623	13,634	13,691
% Change from 2030 Viaduct Closed (No Build Alternative)	NA	NA	2.3%	2.4%	2.8%
Region	615,398	621,777	618,013	617,855	619,538
% Change from 2030 Viaduct Closed (No Build Alternative)	NA	NA	-0.6%	-0.6%	-0.4%

Notes: MMBTU = million British thermal units
NA = not applicable

Operational energy requirements for lighting, maintenance of the roadway, and operation of the ventilation buildings were based on estimated lighting and ventilation use and typical roadway maintenance requirements. The combined energy requirements for vehicles, maintenance, lighting, and ventilation are indicated in Exhibit 5-3.

As shown in Exhibit 5-3, overall differences among the alternatives are small, less than 1 percent within the regional study area. These differences are below the accuracy of the overall traffic data and therefore cannot be considered meaningful. Based on this, there are no meaningful differences between the alternatives.

Exhibit 5-3. Total Daily Regional Operational Energy Consumption

Energy Segment	2015 Existing Conditions (MMBTU)	2030 Viaduct Closed (No Build Alternative) (MMBTU)	2030 Bored Tunnel (MMBTU)	2030 Cut-and-Cover Tunnel (MMBTU)	2030 Elevated Structure (MMBTU)
Ventilation and lighting	0	0	116	103	25
Roadway maintenance	9	9	9	9	9
Regional vehicles using the roadway	615,398	621,777	618,013	617,855	619,538
Total	**615,406**	**621,785**	**618,138**	**617,966**	**619,571**
Percent change from 2030 Viaduct Closed (No Build Alternative)	**NA**	**NA**	**-0.6%**	**-0.6%**	**-0.4%**

Notes: Values have been rounded to the nearest whole number.
MMBTU = million British thermal units
NA = not applicable

5.3 Mitigation of Operational Energy Effects

To further optimize energy requirements, measures to reduce operational energy consumption (i.e., reduce fuel or electricity use) could include but are not limited to the following:

- Encourage use of carpools and transit to reduce VMT on roadways
- Encourage land use strategies that minimize roadway travel
- Use energy-efficient buildings, ventilation equipment, lighting, signals, and signage
- Use low-maintenance or maintenance-free vegetation along roadways
- Use variable-message signs to help drivers avoid congested areas. WSDOT will determine sign locations by using existing condition traffic counts in conjunction with the project's maintenance of traffic (MOT) plan, both of which would identify the congested areas.

5.4 Energy Benefits of the Project

In 2030, the build alternatives would result in a similar consumption of energy by vehicles in both the city center and the region compared to the energy consumption under the Viaduct Closed (No Build Alternative).

Chapter 6 CONSTRUCTION ENERGY EFFECTS AND MITIGATION

Various periods of energy use would continue for several months in any one area under each build alternative. The estimated construction periods for the three build alternatives are as follows:

- Bored Tunnel Alternative construction is anticipated to last approximately 65 months (5.4 years).
- Cut-and-Cover Tunnel Alternative construction is anticipated to last approximately 105 months (8.75 years).
- Elevated Structure Alternative construction is anticipated to last approximately 120 months (10 years).

Construction energy consumption for the build alternatives would result from the following major activities:

- Earth excavation and grading.
- Handling and transport of excavated material and debris.
- Operation of heavy-duty diesel and gasoline-powered construction equipment.
- Operation of electrically-powered equipment (including TBM, where applicable).
- Operation of heavy-duty diesel trucks involved in the transport of excavated material and the delivery of construction material, both within the construction areas and on local streets. In addition, the transport of construction material and excavated materials via barge is likely, particularly for the tunnel excavation spoils.

A wide variety of construction equipment, including specialized and custom-made machinery would be needed for the construction associated with the build alternatives and demolition of the existing viaduct structure. Throughout construction, materials and equipment would be stored primarily within the project area and existing road right-of-way.

Throughout construction, crews would use the following types of equipment:

- Tunnel Boring Machine (as applicable)
- Extended-arm trackhoes with concrete-pulverizing attachment (concrete muncher)
- Cranes
- Trucks and dump trucks

- Air compressors
- Bulldozers
- Backhoe loaders
- Front loaders
- Excavators
- Drilling rigs (including oscillator drills)
- Vibratory pile-driving equipment
- Loaders
- Forklifts and manlifts
- Jackhammers
- Various pumps
- Grading and paving equipment
- Compressors
- Generators
- Welding equipment

For viaduct demolition activities, work crews would most likely use crunching/ shearing attachments, concrete saws, concrete splitters, and cutting torches.

For soil improvements, work crews would need specialty equipment such as drilling rigs for tunnel wall work, drilling rigs with mixing augers, and slurry processing equipment.

Construction may also require additional equipment such as barges, conveyor equipment and hoppers, depending on the alternative. Other equipment such as settlement and pretreatment storage tanks would be needed for dewatering processes.

Details of the construction methods are provided in Appendix B, Alternatives Description and Construction Methods Discipline Report.

6.1 Construction Energy Effects

The energy required for each construction area was estimated based on the horsepower requirements, equipment use, equipment load factors, and construction schedule. The construction energy requirements for the build alternatives are provided in Exhibit 6-1.

Exhibit 6-1. Construction Energy Consumption

Construction Area	Bored Tunnel Alternative (MMBTU)	Cut-and-Cover Tunnel Alternative (MMBTU)	Elevated Structure Alternative (MMBTU)
Tunnel or elevated structure	298,551*	155,926	158,578
South	98,583	54,845	118,844
North	83,737	112,469	43,134
Viaduct demolition	27,806	27,806	27,806
Total	**508,676**	**351,046**	**348,362**
Construction period (years)	**5.4**	**8.75**	**10**

Notes: MMBTU = million British thermal units
* This includes 219,321 MMBTU consumed by the tunnel boring machine.

6.2 Mitigation of Construction Energy Effects

The traffic management plan for the build alternatives includes 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. Construction areas, staging areas, and material transfer sites could be set up in a way that reduces standing wait times for equipment and the associated engine idling and blockage of movements necessary for other activities on the site. Fuel consumption could be reduced by minimizing wait times and ensuring that construction equipment is operated efficiently. Due to space constraints in the project area (i.e., limited parking) and the benefit of additional emissions reductions, ridesharing and other commute trip reduction efforts could be promoted for employees working on the project.

In addition to the strategies detailed above, other measures to reduce energy consumption during construction could include the following:

- Use of relatively new, well-maintained equipment
- Use electrical equipment where feasible
- Promote ridesharing and other efforts, such as WSDOT's Commute Trip Reduction program, to reduce commute trips for employees working on the project
- Coordination of construction activities with other projects in the area to reduce the cumulative effects of concurrent construction projects (see Chapter 7 of the Final EIS)
- Traffic mitigation measures, as discussed in Appendix C (Transportation Discipline Report), to potentially reduce energy consumption

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Chapter 7 GREENHOUSE GAS EFFECTS

This section quantitatively discusses the greenhouse gas effects under 2015 existing conditions and with the 2030 alternatives:

- 2015 Existing Conditions
- 2030 Viaduct Closed (No Build Alternative)
- 2030 Bored Tunnel Alternative
- 2030 Cut-and-Cover Tunnel Alternative
- 2030 Elevated Structure Alternative

7.1 Greenhouse Gas Effects of 2015 Existing Conditions

The two sources of operational greenhouse gas emissions are vehicles using the facility or otherwise affected by the project and the power requirements for maintaining the facility (e.g., ventilation, lighting, and facility maintenance). Vehicles using the facility constitute the major operational source of greenhouse gases. Ventilation and other power requirements constitute a minor source of project-related operational greenhouse gases. Both of these sources have been included in the calculation of greenhouse gas emissions.

The estimates of operational 2015 CO_2e emissions from vehicles using the roadway network are presented in Exhibit 7-1. Exhibit 7-2 highlights the combined regional CO_2e emissions from vehicle operations, ventilation and lighting, and roadway maintenance.

Exhibit 7-1. 2015 Existing Daily CO_2e Roadway Emissions Estimates

Study Area	2015 Existing Conditions (metric tons/day)
City Center	1,145
Region	46,996

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas

Exhibit 7-2. 2015 Existing Total Regional Operational Daily CO_2e Emissions

Energy Segment	2015 Existing Conditions (metric tons/day)
Ventilation and lighting	0
Maintenance	2
Roadways	46,996
Total	**46,997**

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas

7.2 Greenhouse Gas Effects of the 2030 Viaduct Closed (No Build Alternative) and the Build Alternatives

The estimates of operational 2030 CO_2e emission burdens for the project are presented in Exhibits 7-3 and 7-4.

Regional operation CO_2e emission burden differences among the alternatives are less than 1 percent. These differences are below the accuracy of the overall traffic data and therefore cannot be considered meaningful. Based on this, there are no meaningful differences between the alternatives.

Construction of the build alternatives is currently planned to last approximately 5.4 to 10 years, depending on the alternative. The traffic management plan includes detours and strategic construction timing (like night work) to continue moving traffic through the area and reduce backups to the traveling public to the extent possible. WSDOT will seek to set up active construction areas, staging areas, and material transfer sites in a way that reduces standing wait times for equipment. WSDOT will work with relevant agencies to promote ridesharing and other commute trip reduction efforts for employees working on the project.

Estimates of CO_2e emissions based on construction energy consumption are presented in Exhibit 7-5. The values presented in Exhibit 7-5 represent the total construction emissions for the build alternatives.

Exhibit 7-3. 2015 Existing and 2030 Daily CO_2e Roadway Emissions Estimates

Study Area	2015 Existing Conditions (metric tons/day)	Viaduct Closed (No Build Alternative) (metric tons/day)	Bored Tunnel (metric tons/day)	Cut-and-Cover Tunnel (metric tons/day)	Elevated Structure (metric tons/day)
City Center	1,145	1,017	1,040	1,041	1,045
Region	46,996	47,488	47,201	47,189	47,318
% Regional difference from Viaduct Closed (No Build Alternative)	NA	NA	-0.6%	-0.6%	-0.4%

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas
NA = not applicable

Exhibit 7-4. 2015 Existing and 2030 Total Regional Operational Daily CO_2e Emissions

Energy Segment	2015 Existing Conditions (metric tons/day)	Viaduct Closed (No Build Alternative) (metric tons/day)	Bored Tunnel (metric tons/day)	Cut-and-Cover Tunnel (metric tons/day)	Elevated Structure (metric tons/day)
Ventilation and lighting	0	0	21	18	4
Maintenance	2	2	2	2	2
Roadways	46,996	47,488	47,201	47,189	47,318
Total	**46,997**	**47,490**	**47,223**	**47,209**	**47,324**
% Regional difference from Viaduct Closed (No Build Alternative)	**NA**	**NA**	**-0.6%**	**-0.6%**	**-0.4%**

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas
NA = not applicable

Exhibit 7-5. Construction CO_2e Emissions

Alternative	Years of Construction	Total CO_2e (metric tons)
Bored Tunnel*	5.4	99,745
Cut-and-Cover Tunnel	8.75	63,485
Elevated Structure	10	72,853

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas
* Includes 39,081 metric tons generated to power the tunnel boring machine.

Chapter 8 INDIRECT GREENHOUSE GAS EFFECTS

The build alternatives would result in indirect greenhouse gas emissions, which are not released by the project, but are nonetheless caused by the project. Greenhouse gases would be emitted during the production and disposal of materials used for project-related construction. For example, emissions would be released during the production of the concrete used in construction or the manufacture of the equipment used during construction.

Indirect emissions are also known as embodied and lifecycle emissions. At this time, there is no consistent and standardized method for calculating the embodied and lifecycle emissions for transportation projects. There are no tools currently available for clearly and meaningfully discerning which emissions are attributable to a specific project and which emissions would have occurred without the project. However, as with all environmental disciplines, vendors that produce equipment and materials used in project construction are subject to regulation at their facilities.

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Chapter 9 OPERATIONAL ENERGY EFFECTS, MITIGATION, AND BENEFITS OF TOLLING

This section discusses the energy effects of the build alternatives with tolling and compares them to both the Viaduct Closed (No Build Alternative) and the build alternatives without tolling.

9.1 Operational Energy Effects

The estimates of operational roadway energy consumption for the project are presented in Exhibits 9-1 through 9-3.

Differences in regional operation energy consumption among the alternatives are less than 1 percent. These differences are below the accuracy of the overall traffic data and therefore cannot be considered meaningful. Based on this, there are no meaningful differences between the alternatives.

Exhibit 9-1. 2015 Existing and 2030 Daily Regional Operational Energy Consumption, Viaduct Closed (No Build Alternative) and Bored Tunnel Alternative, Tolled and Non-Tolled

Energy Segment	2015 Existing Conditions (MMBTU)	2030 Viaduct Closed (No Build Alternative) (MMBTU)	2030 Bored Tunnel (Non-Tolled) (MMBTU)	2030 Bored Tunnel (Tolled) (MMBTU)	% Change From 2015 Existing Conditions and 2030 Bored Tunnel (Tolled)	% Change From 2030 Viaduct Closed (No Build Alternative) and 2030 Bored Tunnel (Tolled)	% Change From 2030 Bored Tunnel (Non-Tolled) and 2030 Bored Tunnel (Tolled))
Ventilation and lighting	0	0	116	116	NA	NA	NA
Maintenance	9	9	9	9	0%	0%	0%
Roadways	615,398	621,777	618,013	618,634	0.5%	-0.5%	0.1%
Total	**615,406**	**621,785**	**618,138**	**618,759**	0.5%	-0.5%	0.1%

Notes: Values have been rounded to the nearest whole number.
MMBTU = million British thermal units
NA = not applicable

Exhibit 9-2. 2015 Existing and 2030 Daily Regional Operational Energy Consumption, Viaduct Closed (No Build Alternative) and Cut-and-Cover Tunnel Alternative, Tolled and Non-Tolled

Energy Segment	2015 Existing Conditions (MMBTU)	2030 Viaduct Closed (No Build Alternative) (MMBTU)	2030 Cut-and-Cover Tunnel (Non-Tolled) (MMBTU)	2030 Cut-and-Cover Tunnel (Tolled) (MMBTU)	% Change From 2015 Existing Conditions and 2030 Cut-and-Cover Tunnel (Tolled)	% Change From 2030 Viaduct Closed (No Build Alternative) and 2030 Cut-and-Cover Tunnel (Tolled)	% Change From 2030 Cut-and-Cover Tunnel (Non-Tolled) and 2030 Cut-and-Cover Tunnel (Tolled)
Ventilation and lighting	0	0	103	103	NA	NA	NA
Maintenance	9	9	9	9	0%	0%	0%
Roadways	615,398	621,777	617,855	618,192	0.5%	-0.6%	0.05%
Total	**615,406**	**621,785**	**617,966**	**618,303**	0.5%	-0.6%	0.05%

Notes: Values have been rounded to the nearest whole number.
MMBTU = million British thermal units
NA = not applicable

Exhibit 9-3. 2015 Existing and 2030 Daily Regional Operational Energy Consumption, Viaduct Closed (No Build Alternative) and Elevated Structure Alternative, Tolled and Non-Tolled

Energy Segment	2015 Existing Conditions (MMBTU)	2030 Viaduct Closed (No Build Alternative) (MMBTU)	2030 Elevated Structure (Non-Tolled) (MMBTU)	2030 Elevated Structure (Tolled) (MMBTU)	% Change From 2015 Existing Conditions and 2030 Elevated Structure (Tolled)	% Change From 2030 Viaduct Closed (No Build Alternative) and 2030 Elevated Structure (Tolled)	% Change From 2030 Elevated (Non-Tolled) and 2030 Elevated Structure (Tolled)
Ventilation and lighting	0	0	25	25	NA	NA	NA
Maintenance	9	9	9	9	0%	0%	0%
Roadways	615,398	621,777	619,538	620,057	0.8%	-0.3%	0.08%
Total	**615,406**	**621,785**	**619,571**	**620,091**	0.8%	-0.3%	0.08%

Notes: Values have been rounded to the nearest whole number.
MMBTU = million British thermal units
NA = not applicable

9.2 Mitigation of Operational Energy Effects

To further optimize energy requirements, measures to reduce operational energy consumption (reduce fuel or electricity use) could include but are not limited to the following:

- Encourage use of carpools and transit to reduce VMT on roadways.
- Encourage land use strategies that minimize roadway travel.
- Use energy-efficient ventilation equipment, lighting, signals, and signage.
- Use low-maintenance or maintenance-free vegetation along roadways.
- Use variable-message signs to help drivers avoid congested areas.
- The buildings will be designed to LEED Silver standards, though certification may be unattainable due to current LEED definitions.

9.3 Energy Benefits of the Project

In 2030, the build alternatives would result in similar consumption of energy by vehicles in both the city center and the region compared to the energy consumption under the Viaduct Closed (No Build Alternative).

Chapter 10 GREENHOUSE GAS EFFECTS OF TOLLING

This section quantitatively discusses the greenhouse gas effects under 2015 existing conditions and with the 2030 alternatives:

- 2015 Existing Conditions
- 2030 Viaduct Closed (No Build Alternative)
- 2030 Bored Tunnel Alternative (non-tolled)
- 2030 Bored Tunnel Alternative (tolled)
- 2030 Cut-and-Cover Tunnel Alternative (non-tolled)
- 2030 Cut-and-Cover Tunnel Alternative (tolled)
- 2030 Elevated Structure Alternative (non-tolled)
- 2030 Elevated Structure Alternative (tolled)

10.1 Greenhouse Gas Effects of the Viaduct Closed (No Build Alternative) and Build Alternatives

The estimates of operational roadway 2030 CO_2e emissions for the project are presented in Exhibits 10-1 through 10-3.

Regional operation CO_2e emission burden differences among the alternatives are less than 1 percent. These differences are below the accuracy of the overall traffic data and therefore cannot be considered meaningful. Based on this, there are no meaningful differences between the alternatives.

Exhibit 10-1. 2015 Existing and 2030 Daily Regional Operational CO_2e Emissions, Viaduct Closed (No Build Alternative) and Bored Tunnel Alternative, Tolled and Non-Tolled

Energy Segment	2015 Existing Conditions (metric tons/day)	2030 Viaduct Closed (No Build Alternative) (metric tons/day)	2030 Bored Tunnel (Non-Tolled) (metric tons/day)	2030 Bored Tunnel (Tolled) (metric tons/day)	% Change From 2015 Existing Conditions and 2030 Bored Tunnel (Tolled)	% Change From 2030 Viaduct Closed (No Build Alternative) and 2030 Bored Tunnel (Tolled)	% Change From 2030 Bored Tunnel (Non-Tolled) and 2030 Bored Tunnel (Tolled)
Ventilation and lighting	0	0	21	21	NA	NA	NA
Maintenance	2	2	2	2	0%	0%	0%
Roadways	46,996	47,488	47,201	47,249	0.5%	-0.5%	0.1%
Total	**46,997**	**47,490**	**47,223**	**47,271**	0.6%	-0.5%	0.1%

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas
NA = not applicable

Exhibit 10-2. 2015 Existing and 2030 Daily Regional Operational CO_2e Emissions, Viaduct Closed (No Build Alternative) and Cut-and-Cover Tunnel Alternative, Tolled and Non-Tolled

Energy Segment	2015 Existing Conditions (metric tons/day)	2030 Viaduct Closed (No Build Alternative) (metric tons/day)	2030 Cut-and-Cover Tunnel (Non-Tolled) (metric tons/day)	2030 Cut-and-Cover Tunnel (Tolled) (metric tons/day)	% Change from 2015 Existing Conditions and 2030 Cut-and-Cover Tunnel (Tolled)	% Change From 2030 Viaduct Closed (No Build Alternative) and 2030 Cut-and-Cover Tunnel (Tolled)	% Change From 2030 Cut-and-Cover Tunnel (Non-Tolled) and 2030 Cut-and-Cover Tunnel (Tolled)
Ventilation and lighting	0	0	18	18	NA	NA	NA
Maintenance	2	2	2	2	0%	0%	0%
Roadways	46,996	47,488	47,189	47,215	0.5%	-0.6%	0.05%
Total	**46,997**	**47,490**	**47,209**	**47,235**	0.5%	-0.5%	0.05%

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas
NA = not applicable

Exhibit 10-3. 2015 Existing and 2030 Daily Regional Operational CO_2e Emissions, Viaduct Closed (No Build Alternative) and Elevated Structure Alternative, Tolled and Non-Tolled

Energy Segment	2015 Existing Conditions (metric tons/day)	2030 Viaduct Closed (No Build Alternative) (metric tons/day)	2030 Elevated (Non-Tolled) (metric tons/day)	2030 Elevated (Tolled) (metric tons/day)	% Change From 2015 Existing Conditions and 2030 Elevated (Tolled)	% Change From 2030 Viaduct Closed (No Build Alternative) and 2030 Elevated (Tolled)	% Change From 2030 Elevated (Non-Tolled) and 2030 Elevated (Tolled)
Ventilation and lighting	0	0	5	5	NA	NA	NA
Maintenance	2	2	2	2	0%	0%	0%
Roadways	46,996	47,488	47,318	47,357	0.8%	-0.3%	0.08%
Total	**46,997**	**47,490**	**47,324**	**47,363**	0.8%	-0.3%	0.08%

Notes: Values have been rounded to the nearest whole number.
CO_2e = carbon dioxide equivalents, representing an amount of greenhouse gas
NA = not applicable

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ATTACHMENT A

Energy and Greenhouse Gas Calculations

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Attachment A provides the Energy and Greenhouse Gas Calculations 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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