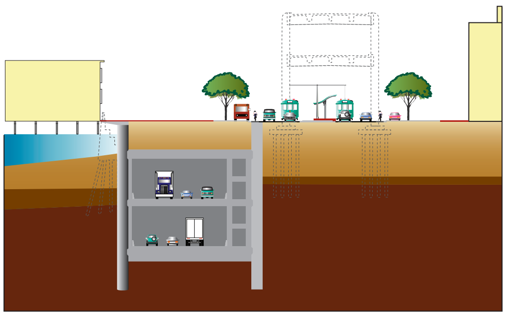
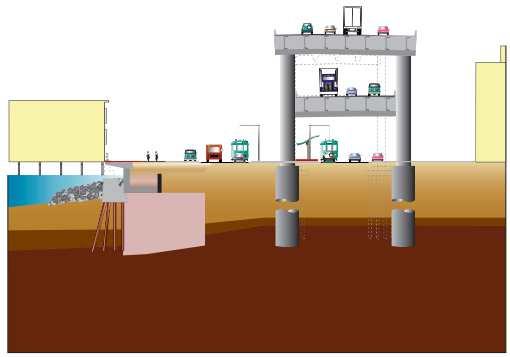
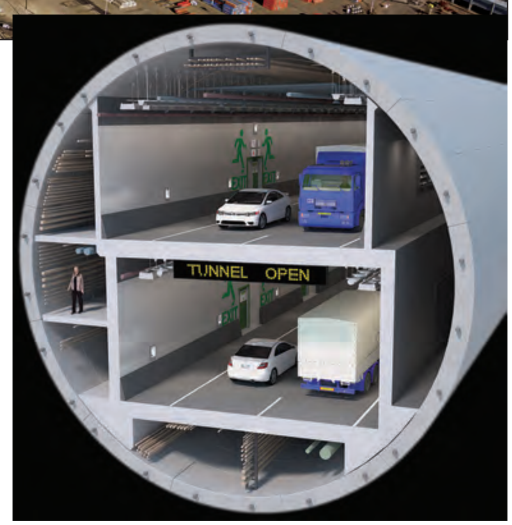
ALASKAN WAY VIADUCT REPLACEMENT PROJECT
Final Environmental Impact Statement

APPENDIX K Public Services and Utilities 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

Public Services and Utilities 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), 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.
Jacobs Engineering Group, Inc.
Magnusson Klemencic Associates, Inc.
Mimi Sheridan, AICP
Parametrix, Inc.
Power Engineers, Inc.
Shannon & Wilson, Inc.
William P. Ott Construction Consultants

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TABLE OF CONTENTS

LIST OF EXHIBITS

ACRONYMS AND ABBREVIATIONS

BMP	best management practice
City	City of Seattle
DoIT	Seattle Department of Information Technology
EBI	Elliott Bay Interceptor
EIS	Environmental Impact Statement
ELI	Electric Lightwave, LLC
FWHA	Federal Highway Administration
I-5	Interstate 5
kV	kilovolt
LOS	level of service
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NRDS	North Recycling and Disposal Station
Program	Alaskan Way Viaduct and Seawall Replacement Program
project	Alaskan Way Viaduct Replacement Project
PSE	Puget Sound Energy
SCL	Seattle City Light
SFD	Seattle Fire Department
SODO	South of Downtown
SPD	Seattle Police Department
SPU	Seattle Public Utilities
SR	State Route
SRDS	South Recycling and Disposal Station
TBM	tunnel boring machine
WAC	Washington Administrative Code
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: the Bored Tunnel Alternative (preferred), the Cut-and-Cover Tunnel Alternative, and the 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. 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 (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

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 evaluates the cumulative effects (Chapter 7) 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 Alternative 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 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 transitions out of the cut-and-cover tunnel near the Pike Street Hillclimb and would cross over the BNSF Railway rail 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, updated 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 each way 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. In addition, Thomas and Harrison Streets would be reconstructed as bridges crossing over the lowered SR 99 to reconnect the street grid for vehicles and pedestrians.

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 two lanes in each direction 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. However, 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 viaduct.

Aurora Avenue would be modified from the north portal of the Battery Street Tunnel, from Denny Way north 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 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 Summary

This section describes the existing environment and summarizes the key findings of the analysis of project-related effects on public services and utilities under each of the build alternatives.

1.3.1 Characteristics of Existing Public Services and Utilities

Public Services Characteristics

The affected environment for public services includes the following services that are provided by governmental agencies or private companies:

- Fire suppression and emergency medical services
- Public school transportation services
- Solid waste collection, disposal, and recycling
- Postal services
- Law enforcement services
- Disaster preparedness and emergency management

Utilities Characteristics

The affected environment for utilities includes the following utilities that are owned, operated, and maintained by governmental agencies or private companies:

- Electrical power
- Water
- Sanitary sewer, storm drainage, and combined sewer conveyance systems and outfalls
- Natural gas
- Steam
- Petroleum
- Telecommunications

1.3.2 Operational Effects and Mitigation

The operational effects on public services and utilities, which are described in detail in Chapter 5, are summarized in the following subsections.

Operational Effects on Public Services

The potential operational effects of the three build alternatives on public services are as follows:

- **Emergency management.** Although the transport of hazardous materials through the bored tunnel and the cut-and-cover tunnel would generally not be allowed, spilled wastes from vehicle accidents or natural or human-caused hazards could occur in the tunnel under either the Bored Tunnel Alternative or the Cut-and-Cover Tunnel Alternative. The operational effect of such spills would be increased because of the difficulty of accessing the tunnel during an incident

- **Fire suppression services.** The bored tunnel and the cut-and-cover tunnel would be equipped with fire suppression infrastructure. The potential operational effects of the Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative on fire suppression services are noted in Chapter 5.
- **Law enforcement services; emergency medical services; disaster preparedness; solid waste collection, disposal, and recycling; school buses; and postal services.** All three build alternatives would modify the transportation network in and around downtown, but they are not expected to result in significant adverse operational effects on the provision of these public services. Depending on the route used, some public service providers would experience increased traffic-related delay relative to that resulting from the Viaduct Closed (No Build Alternative); others would experience decreased traffic-related delay.

Operational Effects on Utilities

Utility providers would likely experience an increase in operational requirements after project construction. Although the majority of new utility systems (such as tunnel ventilation or drainage) would be located within areas with limited access and would, therefore, be the responsibility of the Washington State Department of Transportation (WSDOT) to maintain, utility providers would likely experience some operational effects after the utility relocation process is completed. Many utilities would need to be redesigned and/or rerouted to avoid the new SR 99 facilities. As a result, many utilities would need to increase the number of linear feet of pipe, cable, and other materials in their distribution/transmission systems, which would result in an operational effect.

The vertical and horizontal location of the roadway alignment and configuration of support structures could change access to and complicate long-term maintenance of overhead and underground utilities when these structures are located in the immediate vicinity of the utility. Designation of a limited-access area surrounding the SR 99 facility could result in additional operational effects on utility providers due to restricted access to utility infrastructure. Many of these effects could be minimized or avoided through refinements in the project design.

Mitigation of Operational Effects on Public Services

The potential mitigation measures for operational effects on public services are as follows:

- **Fire suppression services.** Prohibit the transport of flammable and hazardous materials in the bored tunnel and the cut-and-cover tunnel in accordance with the City of Seattle (City) amendments to National Fire Protection Association (NFPA) 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways.

- **Law enforcement services; emergency medical services; disaster preparedness; solid waste collection, disposal, and recycling; school buses; and postal services.** None of the build alternatives is expected to result in significant adverse operational effects on the provision of these public services. Therefore, mitigation for these services is not warranted.

Mitigation of Operational Effects on Utilities

Mitigation of operational effects includes measures that may be needed during the life of the facility to mitigate increased operational requirements, changes in utility access, or the increased length of some relocated infrastructure. The potential mitigation measures for operational effects on utilities are as follows:

- Continue coordinated discussions with utility providers to determine utility upgrades and the associated maintenance responsibilities.
- As the design process proceeds, address access and long-term maintenance requirements, including access in limited-access areas.
- Design the drainage system for the bored tunnel or the cut-and-cover tunnel to discharge to the combined sewers at a rate that would not exceed the capacity of the sewer system. This analysis and design would be required for permitting due to the operation of the fire suppression systems in the tunnels and, therefore, would not apply to the Elevated Structure Alternative. The drainage system for the bored tunnel or the cut-and-cover tunnel would comply with City and King County codes.

1.3.3 Construction Effects and Mitigation

Construction effects are short-term effects that occur during construction only. The construction effects on public services and utilities are discussed in detail in Chapter 6 and summarized in the following subsections.

Construction Effects on Public Services

Construction effects are anticipated for all public service providers, mainly because of traffic delays during construction. Major sources of construction-related congestion that may affect response or service times for public services include the following:

- Increased traffic volumes on surface streets
- Limited travel lanes for the existing viaduct and the Alaskan Way surface street

Construction Effects on Utilities

Construction effects are anticipated for utility providers because utility relocation or protection would be required during construction. Identification of specific construction effects is occurring during ongoing coordination between WSDOT, Seattle Public Utilities, Seattle City Light, and others. Generally, construction of the project may result in the following additional work:

- Field observation/inspection, for potholing, where appropriate
- Relocation of existing utilities or protection in place
- Temporary utility shutoffs
- Temporary water mains and/or services
- Connections to existing utility systems
- Emergency repairs due to unforeseeable circumstances, such as inadvertent damage to utilities
- Surveys of utility facilities before and after construction
- Settlement monitoring (or locating monitors)

Mitigation of Construction Effects on Public Services

The potential mitigation measures for effects on public services during construction are as follows:

- Hold coordination meetings with public service providers to maintain emergency response times or provide satisfactory mitigation.
- Coordinate with City, King County Metro Transit, and Port of Seattle police and fire departments, utility providers, transportation divisions, and other appropriate agencies during the final design and operation of the proposed facilities to maintain reliable emergency access; identify alternative plans or routes to avoid delays in response times; and ensure that general emergency management services are not compromised.
- Coordinate planning and preparation for tunnel rescue services with the Seattle Fire Department (for the two tunnel alternatives).
- Ensure emergency egress from structures.
- Notify the Seattle Fire Department regarding any compromised fire and life safety systems, including power and communications, and establish alternative supply lines.
- Coordinate with construction personnel and the Seattle Police Department to ensure adequate staffing for the control of traffic and pedestrian movements.
- Provide additional temporary law enforcement or security officers for site security.

Mitigation of Construction Effects on Utilities

Mitigation for effects on utilities during construction is being developed during the ongoing coordination process between WSDOT, Seattle Public Utilities (SPU), Seattle City Light (SCL), and other providers. Some of the potential mitigation measures for effects on utilities during construction are as follows:

- Review utilities on a case-by-case basis to determine those that need to be protected and supported in place during construction.
- Before final design and construction, field-verify (by potholing, where appropriate) the exact locations and depths of underground utilities and check conditions as necessary.
- Develop and implement a monitoring plan for all identified utilities as determined in collaboration with the utility owner(s).
- Coordinate with public and private utility providers to develop a cost-effective solution and schedule for potential infrastructure relocations.
- Provide on-site electrical generation to minimize or eliminate power outages to customers, as determined by SCL on a case-by-case basis.
- Coordinate with Puget Sound Energy during construction near natural gas mains.
- Develop schedules, contingency measures, and policies with utility providers to manage potential utility service disruptions so that customers can be prepared for potential service outages.
- Ensure that traffic control plan measures and traffic revision equipment and personnel are provided during utility relocations or repair. Reduce construction activities during peak hours of traffic, when possible, to lessen traffic effects.
- Provide utility protective measures to minimize or avoid potential damage to exposed utilities and contingency measures to repair or replace utilities damaged during construction.
- Use construction techniques, such as drilled shafts in lieu of driven piles, to avoid or minimize vibration effects on utilities.
- Coordinate with SCL, Puget Sound Energy (PSE), and the Seattle Fire Department (SFD) to provide safety watch during construction, and establish emergency electrical and natural gas protection and power restoration procedures to minimize the potential for interruption of electrical and natural gas service.
- Coordinate construction-related mitigation with other major projects in the vicinity to minimize utility and traffic disruptions.
- Coordinate schedule, sequencing, and areas of outages with utility providers.
- Address hazardous materials encountered during utility construction and mitigation in accordance with Appendix Q, Hazardous Materials Discipline Report.

- Address archaeological resources encountered during utility construction and mitigation in accordance with Appendix I, Historic, Cultural, and Archaeological Resources Discipline Report.
- Use construction methods as needed to minimize the transport of hazardous material or contaminated media along utility trenches in accordance with Appendix Q, Hazardous Materials Discipline Report.
- Relocate or preserve access to existing utilities within proposed staging and construction areas.

1.3.4 Tolling Effects and Mitigation

Tolling Effects on Public Services

Similar to the build alternative under non-tolled conditions, additional traffic on surface streets could result in changes in traffic patterns. These changes could result in additional delays for emergency and nonemergency service providers, reduced access to public services due to traffic congestion, and changes in the transportation system. As with the non-tolled build alternatives, coordination with public service providers would be needed to ensure continued provision of services.

Tolling Effects on Utilities

If tolling is implemented, all three build alternatives would require additional electrical and telecommunications infrastructure to operate the toll collection and enforcement devices. This infrastructure would likely be within the WSDOT limited-access area, and WSDOT would be responsible for maintaining it. No other effects on utilities are anticipated, other than those identified for the three build alternatives under non-tolled conditions.

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Chapter 2 METHODOLOGY

2.1 Study Area

The south and north boundaries of the study area for public services and utilities are approximately S. Atlantic Street and Aloha Street, respectively. In general, public services and utilities within three to five blocks of existing or proposed facilities are identified as being within the study area for potential construction or operational effects. There are exceptions to this rule; some facilities (such as hospital emergency rooms) are located outside of the study area but have been included in the analysis because they offer critical services to the study area. Also, utility relocations may affect utility infrastructure and customers outside the study area.

2.2 Applicable Regulations and Guidelines

The following regulations and guidelines provided information that was considered in evaluating effects on public services and utilities within the study area:

- WSDOT *Utilities Manual* (M 22-87.01)
- WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* (M 41-10)
- Code of Federal Regulations, Title 23 (Subpart A): Reimbursement for Utility Relocation
- WSDOT Utilities Accommodation Policy (M 22-86.01)
- Washington Administrative Code, Chapter 468.34 (WAC 468.34): Utility Franchises and Permits
- Washington State Department of Health Water System Design Manual
- Revised Code of Washington, Chapter 47.44: Franchises on State Highways
- WAC 173-201A: Water Quality Standards for Surface Waters of the State of Washington
- WAC 173-204: Sediment Management Standards
- WAC 173-221: Discharge Standards and Effluent Limitations for Domestic Wastewater Facilities
- WAC 173-226: Waste Discharge General Discharge Program
- WSDOT *Environmental Procedures Manual* (M 31-11)
- FHWA Technical Advisory T6640.8A
- WAC Part Q, Sections 296-155-725–730: Underground Construction
- City Ordinances and Director's Rules

- City of Seattle Fire Code
- City of Seattle Franchise Agreements With Other Agencies
- Seattle City Light Material Standards
- Seattle City Light Network Construction Guidelines
- *City of Seattle Comprehensive Plan*
- Seattle City Light Construction Guidelines
- *Standard Plans for Municipal Construction* and *Standard Specifications for Road, Bridge, and Municipal* Construction (City of Seattle 2008a, 2008b)
- Seattle Municipal Code, Titles 21 and 22

2.3 Data Needs and Sources

The data sources were conceptual project drawings and various utilities reports provided by the project design team.

2.4 Analysis of Existing Conditions

Existing conditions for public services were analyzed for the study area. Some facilities that are located outside of the study area, such as hospital emergency rooms, were also considered. The following types of public services are discussed in Chapter 4, Affected Environment:

- Fire suppression and emergency medical services
- Public school transportation services
- Solid waste collection, disposal, and recycling
- Postal services
- Law enforcement services
- Disaster preparedness and emergency management

The analysis of existing conditions for utilities included providers within the study area and locations of existing utility infrastructure likely to be affected by the build alternatives. The following types of utilities are discussed in Chapter 4, Affected Environment:

- Electrical power
- Water
- Sanitary sewer, storm drainage, and combined sewer conveyance systems and outfalls
- Natural gas
- Steam
- Petroleum
- Telecommunications

2.5 Analysis of Environmental Effects

Potential direct and indirect operational and construction effects were identified and analyzed. This analysis included establishing thresholds for levels of effect by type of utility or service.

2.5.1 Operational Effects

Potential operational effects on public services were determined by reviewing the traffic analysis and the level of service (LOS) results for the Viaduct Closed (No Build Alternative), the Bored Tunnel Alternative, the Cut-and-Cover Tunnel Alternative, and the Elevated Structure Alternative in Appendix C, Transportation Discipline Report. Factors considered for the analysis of operational effects included increased demands on public services, impaired access to public services, and potential risks to public services posed by the three build alternatives. Potential benefits to the provision of public services were also considered.

Potential effects on utilities were determined by reviewing the existing utility placement and the project design. Also analyzed was the ability to maintain access to utilities, including utilities in limited-access areas.

2.5.2 Construction Effects

Potential construction effects on public services were determined by reviewing the traffic analysis and the LOS results for the Viaduct Closed (No Build Alternative), the Bored Tunnel Alternative, the Cut-and-Cover Tunnel Alternative, and the Elevated Structure Alternative in Appendix C, Transportation Discipline Report. Factors considered for the analysis of construction effects included LOS reductions due to lane closures and related congestion during construction.

Potential construction effects on utilities were determined by reviewing the existing utility placement and the project design. Utilities in conflict with proposed construction activities were identified. As part of the ongoing coordination process between utility providers and WSDOT, plans to relocate or protect conflicting utilities in place are being discussed. This coordination process will continue throughout final design.

2.6 Determination of Mitigation Measures

The proposed mitigation measures are based on NEPA requirements, WSDOT and City policies, mitigation proposed for other projects, and discussions with agencies during the planning process. The mitigation measures will be refined and augmented as the planning and design process continues.

Potential mitigation measures for operational and construction effects on public services have been developed in the following ways:

- Coordination with the Seattle police and fire departments, the Port of Seattle police, utility agencies, and other appropriate agencies to ensure reliable emergency access and alternative plans or routes to avoid delays in response times
- Coordination with transit providers to maintain services and alternative routes during construction
- Consideration of implementing intelligent transportation systems, such as intelligent traffic signalization measures

Operational effects on utilities will be reduced by designing systems according to City and Washington State guidelines and code requirements. Relevant operational utility policies and strategies listed in the Utilities Element of the *City of Seattle Comprehensive Plan* will be followed (City of Seattle 2005a). Potential construction mitigation measures for utilities will continue to be developed during the design process through coordination with utility providers, building on the work already underway to develop memoranda of agreement.

Chapter 3 STUDIES AND COORDINATION

This section describes the coordination and studies that were used to identify existing facilities and providers of public services and utilities in the study area. Many resources were used to analyze the affected environment, including various regulations, municipal plans, Internet and website information, literature review, and discussions with public service and utility providers. Coordination was also conducted with authors of other discipline reports.

3.1 Studies

Information related to existing conditions for public services and utilities in the study area was obtained from the following documents, and these documents are incorporated by reference.

3.1.1 Public Services

- *Emergency Traffic Management and Closure Plan for the Alaskan Way Viaduct and Surface Alaskan Way* (City of Seattle 2005b)
- *City of Seattle Comprehensive Plan*, Capital Facilities Appendix (City of Seattle 2005c)
- *City of Seattle Comprehensive Plan*, Utilities Appendix (City of Seattle 2005d)
- *Prevention and Control of Highway Tunnel Fires* (FHWA 2003)
- *Times of Change: Seattle Police Department 2008Annual Report* (SPD 2008)
- *Seattle All-Hazards Mitigation Plan* (SEM 2009a)
- *Mayor's Recommendations: Seattle Central Waterfront Concept Plan* (City of Seattle 2006)

3.1.2 Utilities

- *Hydraulic Report* (CH2M HILL 2010)
- *Utility Impact Report – Bored Tunnel Alternative* (Jacobs 2009)
- *SR 99 Bored Tunnel Alternative: Summary Level Stormwater Report* (Parsons Brinckerhoff 2009)
- *Draft Steam and Petroleum Systems Relocation Basis of Design Report – Tunnel Alternative* (Jacobs Civil 2007a)
- *Draft Communications Systems Relocation Basis of Design Report – Tunnel Alternative* (Jacobs Civil 2007b)
- *Draft Natural Gas System Relocation Basis of Design Report – Tunnel Alternative* (Jacobs Civil 2007c)
- *Draft Waterfront Tunnel Drainage Study Technical Memorandum* (RWE 2007)

- *Draft Water Transmission and Distribution Valve Structure Siting Study for the Tunnel Alternative* (RWE 2006a)
- *Draft Electrical Transmission and Distribution Facilities Basis of Design* (POWER Engineers 2006)
- *Draft Drainage Basis of Design Report for the Tunnel Alternative* (RWE 2006b)
- *Draft Water Infrastructure Basis of Design – Tunnel Alternative* (RWE 2006c)
- *Draft CSO and Stormwater Outfall Basis of Design* (Cosmopolitan Engineering Group, Inc. et al. 2006)
- *SR 99: Alaskan Way Viaduct and Seawall Replacement Program Basis of Design Report for the Combined Sewer System* (HDR 2007)
- *Final Utilities Design Criteria and Standards, SR 99: Alaskan Way Viaduct and Seawall Replacement Project* (Parsons Brinckerhoff 2004)
- *City of Seattle Comprehensive Plan*, Capital Facilities Appendix (City of Seattle 2005c)
- *City of Seattle Comprehensive Plan*, Utilities Appendix (City of Seattle 2005d)
- *Draft Utilities Design Criteria and Standards, SR 99: Alaskan Way Viaduct Project* (RWE 2002a)
- *Final Drainage Technical Memorandum, SR 99: Alaskan Way Viaduct Project* (RWE 2002b)
- *Final Existing Utilities Technical Memorandum, SR 99: Alaskan Way Viaduct Project* (RWE 2002c)
- Conceptual Design Maps, SR 99: Alaskan Way Viaduct Project (RWE 2002d)
- *Design Criteria for Relocation of Electrical Transmission and Distribution Facilities* (PB Power 2002)

3.1.3 Coordination

3.1.4 Public Agencies and Service Providers

The following public agencies and service providers or their websites were consulted for information on the facilities and services in the study area:

- Bonneville Power Administration
- Seattle Fire Department (SFD)
- Seattle Police Department (SPD)
- Seattle Public Schools
- Seattle Public Utilities (SPU)
- Seattle Department of Information Technology (DoIT)
- Seattle City Light (SCL)
- Seattle Department of Transportation Street Use and Utilities Franchises

- Seattle Emergency Management
- Port of Seattle
- King County Wastewater Treatment Division
- King County Solid Waste Management
- King County Metro
- U.S. Postal Service

3.1.5 Private Utility or Service Providers

The following private organizations or their websites were consulted for information on the facilities and services in the study area:

- Puget Sound Energy (PSE) (natural gas)
- Seattle Steam
- Allied Waste Systems

3.1.6 Communications Providers

Communications providers in the study area include the following:

- 360networks
- AboveNet (formerly Metromedia Fiber Network)
- Allstream (formerly Starcom and AT&T Canada)
- Broadstripe (formerly Millennium Digital Media)
- Comcast (formerly TCI/AT&T)
- Electric Lightwave, LLC (ELI) (owned by Integra Telecom)
- Global Crossing (also known as US Crossings, Inc.)
- Level 3 (acquired Looking Glass Network)
- Qwest (acquired OnFiber)
- Sprint/Nextel
- TW Telecom of Washington, LLC (formerly GST)
- Verizon Business (formerly MCI WorldCom and MFS)
- XO Communications
- Yipes Enterprise Services (owned by Reliance Globalcom)

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Chapter 4 AFFECTED ENVIRONMENT

4.1 Public Services

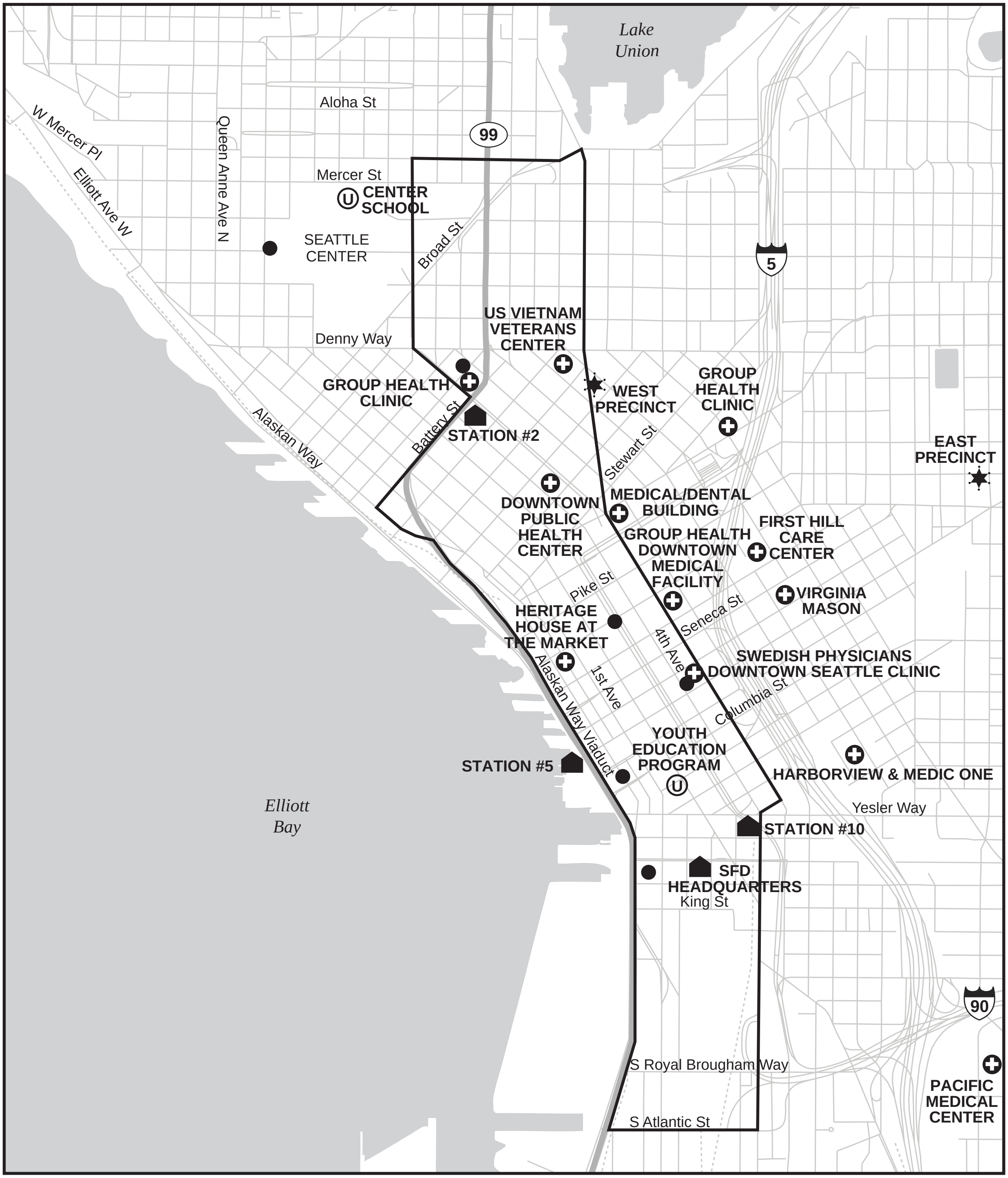
This section includes descriptions of the public services that would be affected by any of the three build alternatives. Other community services are discussed in Appendix H, Social Discipline Report. Exhibit 4-1 shows the locations of public services in the study area.

4.1.1 Fire Stations and Emergency Medical Services

SFD provides fire suppression and emergency medical services to a metropolitan population of more than 560,000 people within a land area of approximately 83.9 square miles and approximately 193 miles of waterfront (U.S. Census Bureau 2000). In 2009, SFD responded to approximately 78,000 incidents (SFD 2010a).

The department employs more than 1,100 uniformed and non-uniformed personnel serving Seattle at 34 fire stations and other facilities located throughout the city. At its disposal are 33 fire engines, 12 ladder trucks, 4 aid units (basic life support), 7 medic units (advanced life support), 2 air trucks, 4 fireboats, 2 hose wagons, and 1 foam trailer. Miscellaneous special equipment is also used by the following specializations: mobile communications and command unit, marine unit, hazardous materials unit, mobile ventilating unit, mobile air compressor unit, mobile generator and carbon dioxide unit, mass casualty incident unit, urban search and rescue, metropolitan medical strike team, weapons of mass destruction decontamination trailer, and technical rescue unit (high angle, confined space, trench, and dive rescue) (SFD 2010b).

Seattle fire stations serving the study area are listed in Exhibit 4-2. Eight SFD stations are available for first response to fire and medical emergencies within the study area. Fire Station No. 10, Fire Station No. 2, and SFD headquarters are within the study area, and two others (including the Medic One Headquarters at Harborview Medical Center) are near the study area, as shown on Exhibit 4-1. The remaining three stations are not shown on Exhibit 4-1 (see Exhibit 4-2 for their addresses). The Seattle Fire Alarm Center is located at Fire Station No. 10, at 400 S. Washington Street. Emergency fire and medical units are generally dispatched from the station nearest the call site, although units can be dispatched from other stations as well. SFD's average 2008 response times (from the time units were dispatched after a 911 call to their arrival time at the site) are as follows: 4.32 minutes for fire and hazardous materials responses, 3.75 minutes for basic life support responses (fire and aid cars), and 3.76 minutes for advanced life support (Medic One) (SFD 2010c).



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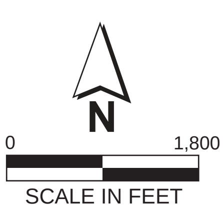

- Postal Services
- Fire Stations
- Police
- Medical Facilities
- Schools
- Approximate Study Area

Exhibit 4-1
Public Services Within or Near the Study Area

Exhibit 4-2. Seattle Fire Stations in or Near the Study Area

Station	Location	Equipment and Personnel
14	3224 Fourth Avenue S.	Aid unit, ladder, and rescue unit
10	400 S. Washington Street	Aid unit, ladder, engine, deputy chief/shift commander, hazardous materials unit, and staff coordinator
5	925 Alaskan Way	Fireboat, engine
25	1300 E. Pine Street	Aid unit, ladder, engine, battalion chief, hose wagon, and power/carbon dioxide unit
2	2334 Fourth Avenue	Aid unit, ladder, engine, and safety chief
8	100 Lee Street	Ladder, engine
SFD headquarters	301 Second Avenue S.	Administrative functions
Harborview Medic One	325 Ninth Avenue, Harborview Medical Center	Two medic units

Fire Station No. 5 is located at the Elliott Bay Seawall, in the immediate vicinity of the Alaskan Way Viaduct. It currently houses one marine company that operates the fireboat (Engine 4) and one land-based company that operates Engine 5 and acts as marine backup. Current response constraints for Engine 5 include delays due to ferry traffic and traffic on Alaskan Way, as well as delays associated with the railroad crossing at Broad Street.

4.1.2 Law Enforcement Services

Seattle Police Department

SPD provides law enforcement and responds to 911 emergency calls throughout Seattle and the study area. SPD has approximately 1,250 sworn personnel and nearly 500 civilian personnel (SPD 2010a).

SPD is divided into five precincts: the South Precinct (3001 S. Myrtle Street), the Southwest Precinct (2300 S.W. Webster Street), the East Precinct (1519 12th Avenue), the West Precinct (810 Virginia Street), and the North Precinct (10049 College Way N.). Additionally, SPD headquarters shares the Seattle Justice Center at 610 Fifth Avenue with the Seattle Municipal Court. This office opened in 2002 and does not function as a precinct (SPD 2010b). The study area is located within the West Precinct (Exhibit 4-1).

In 2008, SPD's 911 Center received more than 800,000 incoming calls. Of that number, more than 220,000 calls were dispatched to patrol units (SPD 2008). Seattle police precinct locations adjacent to but outside the study area are shown in Exhibit 4-1.

Port of Seattle Police Department

The Port of Seattle Police Department also maintains jurisdiction along the central waterfront and Elliott Bay at Port-owned properties such as Pier 69 and Terminals 25, 30, and 46. The Port of Seattle Police Department provides law enforcement response and patrol services for the commercial properties located at the piers and terminals in this geographic area. The U.S. Department of Homeland Security also has customs staff and facilities at Terminal 46 to inspect container cargo and respond to emergencies. The container terminals are located in the south harbor area, and crimes related to the unloading and loading of container cargo include the smuggling of people, drugs, and equipment into the United States and the export of stolen cars.

Bell Street Pier/Pier 66 provides moorage for Norwegian Cruise Lines. Typical crimes affecting cruise lines include drug smuggling, theft aboard ship during transit, and travelers who have outstanding warrants for their arrest. There are no reports of tourists being targeted by pickpocket activities.

Crime Data

The City maintains statistics related to crime in its jurisdiction. Crimes are typically divided into Part I and Part II crimes. In general, Part I crimes (also known as the "Crime Index") are more serious and include felony crimes such as homicide, rape, robbery, aggravated assault, burglary, theft, auto theft, and arson. Part II crimes include all other crimes, such as simple assault, vandalism, forgery, prostitution, weapons offenses, drug and liquor violations, disorderly conduct, and loitering.

Through August 2010, SPD reported 2,630 violent crimes, a 9 percent decrease compared to 2009. During the same time period, SPD reported 22,594 property crimes, a 1 percent increase compared to 2009. In general, crime rates in Seattle have been slowly declining over the past decade (SPD 2010c).

The study area lies within the area of Seattle listed as "Considerably Above the Median" (i.e., it includes approximately 15 percent of the census tracts with the most offenses) for both violent crimes and property crimes (SPD 2008).

4.1.3 Postal Services

Several postal facilities are located within the study area. Facilities west of Fourth Avenue and within the study area are shown in Exhibit 4-1 and summarized in Exhibit 4-3. Each of the primary post offices distributes mail to its respective surrounding area and has counter service for residents to purchase stamps and mail parcels.

Exhibit 4-3. Postal Services in the Study Area

Neighborhood Center	Location	Facilities
Pioneer Square	91 S. Jackson Street	Post office
Federal Finance Facility	909 First Avenue	Post office
Bank of America	1001 Fourth Avenue	Post office
Midtown Post Office	301 Union Street	Post office and automated services
CPU Harbor Heights 111	2512 Fifth Avenue	Post office

Source: USPS 2009.

4.1.4 Disaster Preparedness and Emergency Management

Seattle Department of Transportation

In *Emergency Traffic Management and Closure Plan for the Alaskan Way Viaduct and Surface Alaskan Way* (City of Seattle 2005b), the Seattle Department of Transportation describes the emergency response approaches for four viaduct closure scenarios:

1. Complete closure of the existing viaduct and Alaskan Way surface street
2. Complete closure of the existing viaduct with Alaskan Way open
3. Traffic-incident-based temporary closure of the existing viaduct
4. Additional weight restrictions

The management plan addresses communication among several agencies and the public and identifies major routes to be used during the closure. It is possible that these routes would also be used during some construction phases of the project.

In August 2010, WSDOT began installing a system designed to automatically close the viaduct in the event of a moderate to severe earthquake in the greater Seattle area. The new system consists of nine traffic gates strategically placed on the ramps to the viaduct and controlled by an earthquake detection system. When the earthquake monitoring system detects significant ground movement, it will simultaneously lower all nine traffic gates and safely close the viaduct in 2 minutes (WSDOT 2010). The project was completed in 2011.

Seattle Office of Emergency Management

The Office of Emergency Management is a City agency devoted to citywide disaster preparedness, response, recovery, and mitigation (SEM 2009b). The unit consists of 12 staff members whose principal responsibilities involve encouraging individual and community preparedness and providing a key liaison function between the City and its state and federal emergency management counterparts (SEM 2009b).

The primary functions of the Office of Emergency Management include (1) maintaining the City's emergency command center, (2) developing disaster plans, (3) educating the public, (4) protecting and repairing City infrastructure, (5) coordinating mitigation projects and managing recovery processes, (6) managing outside assistance, and (7) planning and conducting emergency exercises and training.

4.1.5 Public Schools

With more than 45,000 students, Seattle Public Schools is the largest school district in Washington State. The system includes 63 elementary schools, 10 middle schools, 12 high schools, and a number of alternative schools and special programs (Seattle Public Schools 2010a). Three public school facilities operate within the study area (Exhibit 4-1). Other schools are discussed in Appendix H, Social Discipline Report.

The Center School serves approximately 280 high school students inside the Center House, on the Seattle Center grounds. The Youth Education Program, which is part of Interagency Academy, is located at 810 Third Avenue in the central section of the study area. This school serves nearly 90 students.

The north section of the study area is located within the Queen Anne/Magnolia region of the Seattle Public School District. The school nearest to the north section is John Hay Elementary (K–5), which is within seven blocks of Aloha Street. According to the Facilities Department of the Seattle School District, enrollment in the 2009–2010 school year at John Hay Elementary was 467 students (Seattle Public Schools 2010b).

Seattle Public School transportation services in the study area are summarized in Exhibit 4-4.

Exhibit 4-4. Distribution of Seattle Public School Transportation in the Study Area

Trip Times	Trip Status	Total Buses
6:00–7:30 a.m.	Drivers only	10
7:00–9:00 a.m.	Students aboard	19
8:45–9:30 a.m.	Drivers only	28
1:20–3:00 p.m.	Drivers only	35
2:25–4:15 p.m.	Students aboard	19
4:00–5:00 p.m.	Drivers only	8
4:30–6:00 p.m.	Students aboard	7

Source: Seattle Public Schools 2010c.

Although student transportation within the study area is provided by contract with First Student (Seattle Public Schools 2010c), coordination of routes is managed by the Seattle School District Transportation Office. Buses serving Seattle Public Schools travel in the study area on a daily (weekday) basis. School buses make 45 trips along the viaduct corridor daily. Driver-only buses, traveling to and from bus yards, make an additional 81 daily trips through the study area. Detailed information about exact routes and times has been withheld for security reasons. However, it is assumed that the bus routes travel through the study area along the adjacent surface streets in downtown Seattle. In addition, Seattle Public School students use King County Metro regular bus routes for transportation to and from schools.

4.1.6 Solid Waste Collection, Disposal, and Recycling

SPU currently contracts with the following private firms to collect and haul residential and commercial waste and recyclable materials and to provide hauling services. The firm that provides the service is based on geographic location.

- Waste Management of Washington, Inc.
- CleanScapes

Collected residential or commercial waste or self-haul waste is delivered to one of two City-owned facilities operated by SPU or to one of two private facilities. The City-owned facilities are the North Recycling and Disposal Station (NRDS), located immediately north of Lake Union, and the South Recycling and Disposal Station (SRDS), located in the South Park area (SPU 2009). The two private transfer stations are Waste Management's Eastmont Station (located in the South Park area near the City's SRDS) and the Allied Waste Systems–owned station (located at Third Avenue S. and S. Lander Street). Materials from the NRDS and SRDS, as well as materials from the Eastmont or Allied Waste Systems transfer stations that are to be disposed of, are transferred to the Argo Intermodal Facility in south Seattle, where they are transported by rail to the Columbia Ridge Landfill in Oregon. Some material from the Allied Waste Systems transfer station may also be transported to the Roosevelt Landfill in eastern Washington. Waste material includes general municipal solid waste and construction demolition waste.

Self-haul recyclable materials may be taken to any of the four stations, where they are subsequently delivered to the recycle processor. Collected residential and commercial recyclable materials are taken directly to the recycle processor. Recyclable materials that are delivered to the NRDS, the SRDS, the Eastmont Station, or the Allied Waste Systems station are subsequently hauled to the recycle processor. Recyclable materials include metals, paper, wood, glass, plastics, tires, and used oil.

Capacity of Waste Processing Facilities

The NRDS and SRDS have the current available capacity to process 300,000 to 400,000 tons of waste per year. In 2002, the NRDS and SRDS processed more than 153,500 and 171,400 tons, respectively. The Eastmont and Allied Waste Systems transfer stations have the current available capacity to process 300,000 to 400,000 tons of waste per year, including waste from Seattle's businesses. In 1999, the two stations processed 225,000 tons of garbage from Seattle (City of Seattle 2005d). Waste Management's Alaska Street facility has an annual capacity of approximately 500,000 tons of waste; in 2008, it handled approximately 398,000 tons of waste, including contaminated soils.

The Columbia Ridge Landfill in Oregon opened in 1990 and has a current unused capacity of 284 million tons. The Roosevelt Landfill in Washington has a lifespan of 100+ years and had an initial capacity of 217 million tons. The landfill handles approximately 2.5 million tons of waste per year and has a current available capacity of 199 million tons. The local transfer and recycling stations and the regional landfills have indicated that their facilities have sufficient capacity to handle increases in the amount of solid waste expected from demolition of the Alaskan Way Viaduct (Whiteman 2009).

Disposal of Materials From Roadway and Building Demolition Projects

In terms of the disposal of materials, the difference between a roadway demolition project and a building demolition project lies primarily in the type of materials generated. Roadway demolition projects generate materials such as asphalt, concrete, and steel, whereas building demolition projects generate wood, metal, drywall, roof shingles, and other wastes. Some companies, such as Construction Waste Management, use a construction contractor to sort the materials on site and direct the materials to different processing and recycling facilities.

Currently, as much as 40 percent of construction and demolition waste is recyclable, and recycling is considerably less expensive than the traditional disposal in landfills. As a result, recycling on construction projects is increasing. Asphalt and concrete are two materials that can be recycled. Recycled concrete can be ground into a finer material and used for retaining wall blocks or gravel for temporary roads or as a base course for permanent roads. Asphalt can be reused for temporary roads on construction sites or in a final blacktop product.

Building materials such as wood and metal are sent to the Eastmont and Allied Waste Systems transfer stations, where they are compacted and then transferred by rail to landfills in Oregon and Washington. While the Columbia Ridge and Roosevelt Landfills handle a range of solid wastes, several demolition-only landfills for inert materials are located in western Washington; they are regulated by the Washington State Department of Ecology according to guidance in the Washington Administrative Code.

Disposal of Contaminated Materials

Contaminated soils are either buried at a disposal facility or burned to remove contaminants. This cleaned soil can then be reused as fill for construction or land reclamation projects or as an ingredient in making cement.

Recycling

Two private material recovery facilities serve as the processing and transfer facilities for most of the recyclable materials collected from Seattle residents. In 2000, these facilities processed nearly 320,000 tons of recyclable materials. Recycle Seattle is located south of downtown (on S. Lander Street in the South Park area) (City of Seattle 2005d).

Residential Organics

In 2008, SPU collected nearly 70,000 tons of leaves, grass clippings, vegetative food waste, and food-soiled paper (SPU 2009). Seattle's food and yard waste collection service reduces garbage, saves landfill space, and reduces landfill methane (a potent greenhouse gas). The collected materials are processed into compost and used in local parks and gardens (SPU 2010).

4.2 Utilities

4.2.1 Electrical Power

SCL supplies electrical power to customers in Seattle and some portions of King County north and south of the city limits, including the study area. SCL, a municipal electricity utility, serves approximately 131 square miles and generates 56 to 75 percent of the energy that it sells to retail customers from its own facilities. SCL owns and maintains approximately 656 miles of 115-kilovolt (kV) and 230-kV transmission lines that carry power to its distribution substations. SCL also owns and maintains 2,515 circuit miles of distribution lines within Seattle that deliver power from the principal distribution stations to more than 380,000 customers (SCL 2009). Electrical power is dispersed from these substations via primary voltage feeder lines to numerous smaller distribution substations and overhead and underground transformers, which reduce the voltage to required levels for customers.

In the study area, the SCL system uses a combination of overhead and underground electrical transmission and distribution lines. SCL has a combination of transmission and distribution lines running along and under the existing viaduct structure.

The study area is served by 115-kV transmission lines 1, 2, 3, and 4. Transmission lines 1 and 2 are attached to the existing viaduct. As part of the S. Massachusetts Street to Railroad Way S. Electrical Line Relocation Project, these lines were relocated south of Railroad Way S. Existing transmission lines 1 and 2 continue north, attached to the viaduct, to viaduct bent No. 71W near University Street. At University Street, these lines turn east to Western Avenue and then north to the Union Street Substation. SCL will remove these lines from the viaduct, regardless of the outcome of this environmental process. Transmission lines 3 and 4 are located beneath the existing SR 99 on- and off-ramps at Railroad Way S.; these lines continue beneath the existing viaduct and are located between the column footings. At Union Street, they turn east and connect to the Union Street Substation.

The downtown area is also served by a 13.8-kV network service and 26-kV distribution service. This system serves the downtown area from S. King Street to Denny Way, and east to First Hill. Substations in the study area include the Massachusetts Substation, the Union Substation, and the Broad Substation. Overhead and underground distribution lines are also located along many streets in the study area. Although the system is designed and operated to minimize the likelihood that a problem in one area would cascade into other areas, the system must still be approached as an integrated whole because one area could affect another.

4.2.2 Water

SPU provides potable water to more than 1.3 million King County customers (City of Seattle 2010a) from two surface water sources: the Cedar River and the South Fork Tolt River. The Cedar River provides approximately 70 percent of the SPU service area's annual average consumption (City of Seattle 2010b), and the South Fork Tolt River provides approximately 30 percent (City of Seattle 2010c). The major water mains located within the study area include sections of 20- and 21-inch-diameter welded steel lines along the Alaskan Way surface street, sections of 24-inch-diameter ductile-iron pipe and 20- and 16-inch-diameter cast-iron pipe along First Avenue S., sections of 24- and 30-inch-diameter cast-iron pipe along Bell Street, and sections of 20-inch-diameter cast-iron pipe along Mercer Street, Dexter Avenue N., Western Avenue (Jacobs 2009). Other mains about the existing viaduct corridor at major intersections, including Broad Street, Union Street, Madison Avenue, Yesler Way, S. Main Street, S. Jackson Street, S. King Street, S. Washington Street, and S. Atlantic Street.

The majority of the water mains within the study area are 8- to 12-inch-diameter cast-iron pipes with lead joints. These water mains also constitute the majority of the lines that would be potentially affected by settlement. The system consists of transmission and distribution mains, fire hydrants, water services and service lines, corrosion protection systems and valves, and water valve chambers. The entire study area is served by a single pressure zone (RWE 2002e). SPU owns, operates, maintains, inspects, and repairs the water system. SPU also installs water services, hydrants, or other appurtenances on any charged water system. SFD tests all city hydrants annually.

Typically, water lines are located about 3 to 6 feet underground and run beneath and parallel to streets. They are customarily configured to loop back to the source, which improves water pressure and allows SPU to perform maintenance on one section of the line without disrupting service to customers elsewhere on the line.

4.2.3 Sanitary Sewer and Storm Drainage

Within the study area, the storm drainage, sanitary sewer, and combined sewer systems vary by function and jurisdiction (e.g., King County and City). Seattle has a combined sewer system in the downtown area. Within the study area, the sanitary sewer and storm drainage system consists of combined, separated, and partially separated sewer areas, with a variety of pipes, regulator structures, low-flow diversions, and outfalls. The King County Department of Natural Resources, Wastewater Treatment Division (formerly Metro), provides sewage treatment for flows collected in the study area.

SPU operates, maintains, inspects, and repairs wastewater (sewer) pipes in the study area to protect public health and prevent property and environmental damage due to overflows, backups, and flooding from both the sanitary sewer system and the combined sewer system. Wastewater in the study area is conveyed to King County's West Point Treatment Plant, which processes an average of 133 million gallons per day (King County 2010). The pipelines and other conveyance facilities within the study area are owned, operated, and maintained by SPU or the King County Wastewater Treatment Division. Individual sewer service and service drain lines, up to the tee on the mainline pipe, are owned privately by the property owners they serve.

Major King County Combined Sewer Interceptors

The major King County combined sewer facilities in the vicinity of the project area include the Elliott Bay Interceptor (EBI), the Lake Union Tunnel, the Mercer Street Tunnel, and the Central Trunk at Dexter Avenue N. (RWE 2002b). Within the study area, the EBI extends from S. Atlantic Street north to Denny Way. The EBI is subdivided into several sections of various dimensions and materials. From S. Atlantic Street to S. King Street, the EBI runs parallel to Colorado Avenue S., turning east at S. Massachusetts Street. It then proceeds north on Occidental Avenue S. to approximately S. King Street as a 96-inch-diameter concrete pipe. At S. King Street, it intersects a 30- to 42-inch-diameter pipe leading from the King County regulator. From approximately S. King Street to Denny Way, the EBI runs below Second Avenue as a 102-inch-diameter tunnel, reaching its maximum depth of 140 feet below the surface at Pike Street. A lateral adit structure pipe connects to the EBI and also crosses over the location of the proposed bored tunnel at Pike Street (RWE 2002b).

The Lake Union Tunnel is a 72-inch-diameter brick-lined tunnel that extends from the Denny Way regulator northeast to Lake Union at Terry Avenue N. and Republican Street (RWE 2002b).

The Mercer Street Tunnel is a 6,200-foot-long pipe with a diameter of 14 feet, 8 inches that runs primarily beneath Mercer Street from Eighth Avenue W. to Elliott Avenue W. This tunnel was designed to store flows diverted from the EBI, the Lake Union Tunnel, the Dexter Central Trunk, and the Elliott West combined sewer overflow pipeline. The Mercer Street Tunnel can store up to 7.2 million gallons until the EBI has the available capacity to transport the wastewater to the West Point Treatment Plant.

The Elliott West Combined Sewer Overflow Control Facility is located at the west end of the Mercer Street Tunnel, near Elliott Avenue W. Connected to this facility are the Elliott West pipelines, which consist of a south-flowing 96-inch-diameter effluent pipeline connected to the Elliott West outfall and a north-flowing 84-inch-diameter combined sewer overflow pipeline that connects the Denny Way diversion structure to the Elliott West Combined Sewer Overflow Control Facility.

A central sewer trunk line owned by King County is located beneath Dexter Avenue N., near South Lake Union. As part of the Elliott West Combined Sewer Overflow Control Facility project, a new pipeline and a diversion structure were constructed to connect this line to the Mercer Street Tunnel. This project was a joint effort of King County and the City to control combined sewer overflows into Lake Union and Elliott Bay. The new Mercer/Elliott West combined sewer overflow control system was brought online in May 2005 (King County 2008).

New South Lake Union combined sewer pipelines, a trunk diversion structure, and the Lake Union Tunnel regulator now connect to the Mercer Street Tunnel for storage.

Outfalls and Drainage System

Most stormwater in the study area drains into Puget Sound; however, a small quantity at the north end of the project area drains into Lake Union. Stormwater flowing into the combined sewer system is transported to the West Point Treatment Plant for treatment and then discharged directly to Puget Sound. Separated stormwater is discharged untreated into Elliott Bay through City outfalls. During peak events, when the quantity of combined sewer discharge exceeds the conveyance capacity, excess combined sewage is discharged to Elliott

Bay as combined sewer overflows through either SPU or King County combined sewer overflow structures. Discharges into Elliott Bay are ultimately transported by currents to Puget Sound.

These study area outfalls drain to Elliott Bay:

- City separated storm drainage outfalls located at Pine Street, Seneca Street, and S. Washington Street (untreated).
- City shared outfalls, which discharge both stormwater and combined sewer overflows, located at Madison Street and University Street (untreated).
- City combined sewer overflow structures located at Vine Street (untreated).
- King County combined sewer overflow structures at Denny Way and S. King Street (untreated).
- The Kingdome/Connecticut outfall structure, which has shared ownership between the City and King County. The outfall pipe is owned and maintained by the City, the storm drain flows are considered City discharges, and the combined sewer overflows are King County discharges (untreated).
- King County Elliott West Combined Sewer Overflow Control Facility outfall located near Denny Way (treated).
- Multiple smaller formal and informal outfalls (untreated).

These study area outfalls drain to Lake Union:

- City separated storm drainage outfalls located at Broad Street (untreated)
- King County combined sewer overflow structures at Dexter Avenue (untreated)

This study area outfall drains to Puget Sound:

- King County West Point Treatment Plant outfall (treated)

Within the study area, bridge drains from the existing viaduct connect to the existing drainage system and/or combined sewer system via a series of downspouts. These downspouts are attached to the exterior of bent columns on the existing viaduct structure. Some locations do not have bridge drains, possibly because portions of the existing viaduct are super-elevated, with bridge drains on the lower side of the structure. However, settlement may have occurred since the initial construction, creating low spots in the deck that result in ponding (RWE 2002b). For more detailed analysis of surface water and storm drainage (including wet weather flow capabilities for secondary and primary treatment), refer to Appendix O, Surface Water Discipline Report.

4.2.4 Natural Gas

PSE provides natural gas service throughout the study area, serving more than half of the residents of Washington State over a 6,000-square-mile service area. PSE's nearly 750,000 natural gas customers are located primarily in western Washington (PSE 2010).

Natural gas service is provided throughout the streets, alleys, public properties, and private properties located within the study area. Natural gas is distributed through a network of high-pressure natural gas mains, district regulators that reduce natural gas pressures, mains, service lines, valves, and meters, all of which are located underground, except for the meters. A 12-inch-diameter high-pressure gas main is located within the study area in S. Main Street and along Bell Street (RWE 2002a).

4.2.5 Steam

Privately owned Seattle Steam Company provides steam service within the study area. The steam distribution lines in the study area include a 12-inch-diameter intermediate-pressure line running north-south along First Avenue and low-pressure and high-pressure lines running north-south along Western Avenue. Seattle Steam continues to pump steam through four main boilers, with an operating pressure of 140 pounds per square inch, to service an 18-mile system of underground pipes dating back to the late 1880s.

Originally called the Seattle Steam Heat and Power Company when it opened in 1893, Seattle Steam currently operates in Seattle under a franchise agreement with the City (PSBJ 2001). Seattle Steam operates around the clock, every day of the year, using natural gas to make nearly 500,000 pounds of steam per hour (average during the winter peak season). In the summer, it produces about 100,000 pounds of steam per hour. More than 200 downtown buildings are customers. The three largest users are Swedish, Harborview, and Virginia Mason medical centers, which use steam to heat their buildings and to sterilize instruments. Hotels are the next largest customers, using steam to heat their and to generate hot water for showers and laundry (PSBJ 2001).

4.2.6 Petroleum

No active petroleum lines are located within the study area.

4.2.7 Telecommunications

Qwest provides local telephone service throughout Seattle, including the study area. It also provides service to the Port of Seattle. Telephone lines in urban areas are typically located within street rights-of-way, aboveground on utility poles in most areas and underground in some areas (including part of downtown Seattle). Qwest has fiber-optic lines in the study area, as well as underground feeders located along Broad, Wall, Pike, Spring, Marion, and S. Washington Streets (RWE 2002d).

Comcast (formerly AT&T Cable Services) is the primary provider of cable television and fiber-optic services in Seattle and the study area.

Several private companies and public utilities also own fiber-optic cable or provide long-distance or other telecommunication services in downtown Seattle and the surrounding area. These providers include but are not limited to 360networks, AboveNet (formerly Metromedia Fiber Network), Allstream (formerly Starcom and AT&T Canada), Broadstripe (formerly Millennium Digital Media), DoIT, Comcast, ELI, Global Crossing (also known as US Crossings, Inc.), Level 3 (acquired Looking Glass Network), Qwest (acquired OnFiber), Sprint/Nextel, TW Telecom of Washington, LLC (formerly GST), Verizon Business (formerly MCI WorldCom and MFS), XO Communications, and Yipes Enterprise Services (owned by Reliance Globalcom) (Jacobs 2009).

DoIT provides telecommunications, telephone, data network, and cable management services in the study area. DoIT provides a data network connecting the City's computers and City departments. It also operates and maintains the City's private telephone network, consisting of about 12,000 telephones, voicemail, a telephone management system, and the City's telecommunications and data networking functions (City of Seattle 2005d). DoIT also provides telecommunications to Washington State Ferries facilities at Colman Dock.

The basic fiber-optic system typically consists of cables, manholes, conduits, and switching stations. Switching stations are usually located inside buildings. Conduits and cables are buried in public rights-of-way throughout the study area, including under Alaskan Way. Conduits and cables are also mounted on the existing viaduct or separate overhead infrastructure and are routed down the columns in various locations and into manholes to allow connections to the buried system. Fiber-optic companies sometimes find it necessary to lease copper wire space from the telephone company to access the switching station locations within the buildings (RWE 2002a, 2002b, 2002c, 2002d, and 2002e).

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Chapter 5 OPERATIONAL EFFECTS, MITIGATION, AND BENEFITS

Operational effects are those that occur over the long term once the facility is in operation. Unless otherwise noted, the potential operational effects discussed in this chapter apply to all portions of the study area.

The build alternatives would modify the transportation network, resulting in increased delay for some public service providers and decreased delay for others, depending on the route used. The Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative could also affect the provision of emergency management and fire suppression services because of reduced access.

Utility providers are expected to experience an increase in operational requirements after project construction. Although the majority of new utility systems (such as tunnel ventilation and drainage) would be located within limited-access areas and would, therefore, be the responsibility of WSDOT to maintain, operational effects on utility providers would likely result after the utility relocation process (described in Chapter 6, Construction Effects). Many utilities would need to be redesigned and/or rerouted to avoid the new SR 99 facilities. As a result, many utilities would need to increase the number of linear feet of pipe/cable/etc. in their distribution and transmission systems, which would result in an operational effect.

The vertical and horizontal location of the roadway alignment and the configuration of support structures could change access to and complicate long-term maintenance of overhead and underground utilities when these structures are located in the immediate vicinity of the utility. Designation of a limited-access area surrounding the SR 99 facility could result in additional operational effects on utility providers because of restricted access to utility infrastructure. Many of these effects could be minimized or avoided through refinements in the project design.

The *Utility Impact Report: Bored Tunnel Alternative* (Jacobs 2009) was prepared in support of the 2010 Supplemental Draft EIS (WSDOT et al. 2010). The report was based on existing project utility mapping; City geographic information system (GIS) mapping of gravity and water utilities; City Franchise Utility Maps; records from PSE natural gas, Seattle Steam, and multiple telecommunications providers; and site visits. The analysis of effects in this chapter relied on information from this report.

The operational effects discussed in this chapter summarize the potential risks and benefits of the three build alternatives.

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

Federal and Washington State regulations require agencies to evaluate a No Build Alternative to provide baseline information about existing conditions in the project area. For this project, the No Build Alternative is not a viable alternative, because the existing viaduct is vulnerable to earthquakes and structural failure due to ongoing deterioration. Multiple studies have found that retrofitting or rebuilding the existing viaduct is not a reasonable alternative (TY Lin 2005). At some point in the future, the roadway will need to be closed.

The Viaduct Closed (No Build Alternative) describes what would happen if none of the build alternatives is implemented. We know that if the existing viaduct is not replaced it will be closed, but it is unknown when that would happen. However, it is very unlikely that the existing structure could be in use in 2030. For these reasons, this report compares the effects of each of the proposed build alternatives to a 2030 Viaduct Closed (No Build Alternative).

The Viaduct Closed (No Build Alternative) describes the consequences of suddenly losing SR 99 along the central waterfront based on the two scenarios described below. These consequences would last until transportation and other agencies could implement a new, permanent solution. The planning and development of the new solution would have its own environmental review.

The Viaduct Closed (No Build Alternative) considers two scenarios that would eliminate the use of SR 99 for approximately 110,000 vehicle trips daily:

- Scenario 1 – Sudden unplanned closure of the viaduct due to structural damage from a minor earthquake or other causes of partial structural failures that would render the viaduct unsafe or unusable.
- Scenario 2 – Catastrophic failure and 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 structural deficiency, weakness, or damage from a minor earthquake. Under this scenario, SR 99 would be closed for an unknown period until a viaduct replacement could be built. Severe travel delays and congestion would be experienced, and utilities on and underneath the viaduct would likely be damaged and would require repair or replacement.

This disruption would considerably affect utilities and public services, including operations for disaster preparedness (Seattle Office of Emergency Management, Port of Seattle, Washington State Ferries, and WSDOT), Fire Stations No. 5 and No. 14, and SFD headquarters.

Underground utilities could be damaged and services to the piers could be disrupted. Potential loss of utility services on or underneath the existing viaduct due to damaged utility lines or an inability to access lines in need of maintenance could also occur. The sudden, unplanned loss of these utility lines would substantially affect the operations of utilities and public services because "fire flow" to piers would be eliminated, along with electricity to power alarm systems and security lighting. Damage to the combined sewer system could result in sewage overflows and backups. Potential loss of traffic lanes related to this scenario could also restrict and inhibit access by emergency and nonemergency public service vehicles and overall mobility within the corridor.

5.1.2 Scenario 2: Catastrophic Failure and Collapse

Scenario 2 considers the effects of a catastrophic failure and collapse of SR 99. 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. This type of event could cause buildings to be damaged or collapse and cause extensive damage to utilities. 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 substantial.

The ripple effect from this catastrophic event would include disruption to all public services and utilities in the study area. Failure of the existing viaduct would cause significant interruption of utilities within the downtown area. Such utility interruption would affect a large portion of the downtown area. Other direct effects may include damage to the economy due to loss of business, the displacement of housing (due to loss of utility services such as heat, power, and potable water), traffic detours (related to signal outages), and corresponding delays in response time and travel time for public service providers.

In addition to potential loss of services due to damaged utility lines or an inability to access lines in need of maintenance, the following are also potential results:

- Flooding and soil loss related to broken water mains, storm drain pipes, or sewer pipes.
- Fire events related to damaged or exposed electrical equipment and natural gas, as well as fires related to heating system failures.
- Large-scale power outage due to the inaccessibility of failed electrical transmission lines suspended from and buried below the existing viaduct; full restoration of power could take several weeks, and permanent restoration of transmission lines could take several months or longer. SCL

is planning to relocate the electric transmission lines suspended from the viaduct, even under the Viaduct Closed (No Build Alternative), but there would still be a potential for disruption to the electrical system under Scenario 2.

- Hazardous materials seepage related to damaged natural gas pipes.

The proximity of electrical systems to natural gas lines could produce a second catastrophic incident if sparks ignite flammable materials or result in an explosion. Loss of water flow due to damaged water pipes could prevent firefighters from containing an incident in a reasonable amount of time to ensure public safety.

Other effects would include delays in emergency service responses due to decreased mobility in the corridor and increased demand on emergency management agencies (e.g., the City, the Seattle Office of Emergency Management, the Port of Seattle, and the Washington State Ferries) for disaster readiness and response.

5.2 Operational Effects of the Build Alternatives on Public Services

Operational effects on public services typically include potential changes in demands on law enforcement services, fire services, emergency medical services, public schools, postal services, and solid waste and recycling services. In addition, the primary differences among the three build alternatives involve location-specific changes in access for public services and related roadway changes and transportation conditions, which may affect response times and travel times. In most cases, the demand for public services would be similar for the three build alternatives. Therefore, the analysis focused on the relative differences between each of the build alternatives and the Viaduct Closed (No Build Alternative). All of the build alternatives would reduce delay for public service providers relative to the Viaduct Closed (No Build Alternative); therefore, no adverse effects on public services are expected to result from any of the three build alternatives.

For changes in access locations, see Appendix C, Transportation Discipline Report. Effects on public services as a result of changes in traffic patterns could include delays for both emergency and nonemergency service providers, reduced access to public services due to traffic congestion, changes in the transportation system, and reduced parking spaces. For a detailed comparison of roadway LOS between each of the build alternatives and the Viaduct Closed (No Build Alternative), refer to Appendix C, Transportation Discipline Report.

Although the transport of hazardous materials through the bored tunnel and the cut-and-cover tunnel would generally not be allowed, spilled wastes from vehicle accidents or natural or human-caused hazards could occur in either tunnel. The operational effect of such spills would be increased because of the difficulty of accessing the tunnel during an incident. Depending on the location and extent of the spill, the incident could affect a number of emergency management agencies, including the Seattle Office of Emergency Management, the Port of Seattle, the Washington State Ferries, and the City. The existing viaduct currently operates within the jurisdiction of each of these agencies, and emergency management functions are in place.

The project is subject to compliance with the Americans With Disabilities Act, and the final design of the project will meet all the necessary requirements of the act. However, the bored tunnel and the cut-and-cover tunnel are not pedestrian facilities; therefore, travelers would not be allowed to leave their vehicles or walk through the tunnel other than during emergency situations when directed to evacuate. The current project design allows for two 8-foot shoulders in the bored tunnel (one in each direction) and one 10-foot shoulder in the cut-and-cover tunnel, which are reasonable widths for vehicles to pull off the road in an emergency. WSDOT believes that during an emergency evacuation, transit operators would be able to maneuver their vehicles sufficiently to allow deployment of wheelchair lifts, although they may need to encroach on the adjacent lane to do so. During an emergency evacuation, all traffic would be directed to stop; therefore, transit maneuvers into the adjacent lane would not present a traffic safety problem.

WSDOT has worked very closely with SFD on developing safety measures and procedures to ensure that the tunnels meet applicable safety criteria during emergencies. Exiting the tunnels in an emergency would require the use of stairs, the same as an emergency exit from an office building when all the elevators are recalled to the lobby. As explained in the 2010 Supplemental Draft EIS and this Final EIS, people who are unable to use the stairs to exit the tunnels would wait in an enclosed, protected refuge area for assisted rescue. The refuge areas and egress corridor would provide a safe environment for evacuees. They would be ventilated separately with fresh air, isolated from the roadway traffic and the emergency situation by continuous walls, accessible without requiring evacuees to step over a curb.

WSDOT has developed a detailed emergency response plan, including information on emergency response and coordination with first responders, such as SFD, the Washington State Patrol, and SPD. The emergency response plan would include provisions for assisting mobility impaired and incapacitated people.

5.2.1 Response Times for Public Services

Roadway LOS is one of the most common measures used to describe how "good" or "bad" traffic is projected to be. LOS is one measure used to determine the effects on response time for public services such as police, fire, and emergency medical aid. LOS is a measure of roadway congestion and ranges from LOS A (least congested) to LOS F (most congested).

All three build alternatives would modify the transportation network in and around downtown, but they are not expected to result in significant adverse operational effects on the provision of public services. Depending on the route used, some public service providers would experience increased traffic-related delay. Others would experience less traffic-related delay. For example, improved access at the south portal from the S. Royal Brougham Way ramps would result in improved response times in that area.

Impacts on public services as a result of changes in traffic patterns could include delays for police, fire, and emergency service vehicles; postal services; and school buses. Changes in traffic patterns could also result in reduced access to public services in some areas due to traffic congestion, changes in the transportation system (e.g. transit travel), and/or a reduction in parking. Benefits to public services could include reduced levels of congestion and improved access. For a detailed discussion of roadway LOS under each of the build alternatives compared to the Viaduct Closed (No Build Alternative), see Appendix C, Transportation Discipline Report.

Specific potential impacts of the three build alternatives on emergency service response times are difficult to quantify because response times depend on several factors, such as time of day, level of traffic congestion, land uses in the area, extent of construction activity in the neighborhood, and how the response times are calculated.

2030 Viaduct Closed (No Build Alternative)

Intersection performance under the Viaduct Closed (No Build Alternative) was not analyzed. Traffic conditions without the viaduct would be extremely congested. Detailed traffic models are not reliable or accurate in these circumstances; therefore, congested intersections cannot be meaningfully evaluated and instead are qualitatively discussed.

The Viaduct Closed (No Build Alternative) would displace a large number of trips from SR 99 to other routes, leading to a high level of traffic congestion throughout the day. Although not specifically analyzed in terms of intersection operations, the Viaduct Closed (No Build Alternative) is likely to result in a considerable increase in the number of intersections operating at LOS E and F and an increase in delay at many of these locations well beyond the LOS F threshold, leading to substantial congestion and delay. This is especially likely for intersections in the north and south subareas and along north-south arterials through the central waterfront and downtown because traffic would shift from the SR 99 corridor to alternate surface street routes. For more details, see Attachment B, Analysis of Viaduct Closed (No Build Alternative), of Appendix C, Transportation Discipline Report, of the 2010 Supplemental Draft EIS (WSDOT et al. 2010).

The congested intersections could result in response delays and travel time delays for fire suppression, law enforcement services, and other public services, such as solid waste and recycling services, postal services, and school buses.

2030 Bored Tunnel Alternative

Under the 2030 Bored Tunnel Alternative, highly congested conditions would occur at three intersections:

- Dexter Avenue at Denny Way (LOS F during the AM peak hour)
- Westlake Avenue N. and Mercer Street (LOS F during the PM peak hour)
- Fairview Avenue N. and the Interstate 5 (I-5) ramp (LOS F during the PM peak hour)

2030 Cut-and-Cover Tunnel Alternative

Under the 2030 Cut-and-Cover Tunnel Alternative, highly congested conditions would occur at three intersections:

- Aurora Avenue at Denny Way (LOS F during the PM peak hour)
- Westlake Avenue N. and Mercer Street (LOS F during the PM peak hour)
- Fairview Avenue N. and the I-5 ramp (LOS F during the PM peak hour)

2030 Elevated Structure Alternative

Under the 2030 Elevated Structure Alternative, highly congested conditions would occur at five intersections:

- Aurora Avenue at Denny Way (LOS F during the PM peak hour)
- Dexter Avenue at Denny Way (LOS F during the PM peak hour)
- Dexter Avenue at Mercer Street (LOS F during the PM peak hour)
- Westlake Avenue N. and Mercer Street (LOS F during the PM peak hour)
- Fairview Avenue N. and the I-5 ramp (LOS F during the PM peak hour)

Response Times Conclusion

In general, under the three build alternatives, surface streets are expected to operate with less congestion and delay than that expected for the Viaduct Closed (No Build Alternative) as a result of much lower traffic volumes. Response times for public service providers under any of the three build alternatives would be improved relative to response times under the Viaduct Closed (No Build Alternative).

5.2.2 Accidents and Safety (SR 99 Mainline and Ramps)

The new ramps at the south section would be constructed to current standards and are expected to reduce congestion and improve safety. Active traffic management systems are planned for the SR 99 mainline, which are designed to reduce the accident rate.

In the north section, restricted access (right-on and right-off) from the side streets would no longer be allowed at John, Thomas, Harrison, or Republican Streets with any of the build alternatives. In addition, the off-ramp to Mercer Street would be eliminated. On- and off-ramps at Republican Street would improve safety along this portion of SR 99 (refer to Appendix C, Transportation Discipline Report).

5.2.3 Hazardous Materials

Other operational effects include the potential for catastrophic spills of hazardous materials or wastes resulting from accidents. Specifically for the Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative, such an incident would represent an additional risk factor for public services in terms of emergency service response and/or fire and life safety concerns. Firefighting within an enclosed tunnel is difficult and dangerous. Even with ventilation and fire suppression systems in place, tunnel fires can quickly become unmanageable and require fire personnel to allow them to burn out before approaching (FHWA 2003). Therefore, the transport of flammable and hazardous materials in the bored tunnel and the cut-and-cover tunnel would be prohibited in accordance with the City amendments to NFPA 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways.

5.3 Build Alternatives Operational Effects on Utilities

Potential operational risks associated with utilities include design elements that could result in increased maintenance for and changes in access to utilities. Examples of these potential risks are discussed below, although they are expected to be minimized or avoided through refinements in the project design.

Utility providers are expected to experience an increase in maintenance requirements after project construction is completed. Although the majority of the new utility systems (such as the tunnel ventilation and drainage systems) would be located within WSDOT limited-access areas and would, therefore, be the responsibility of WSDOT to maintain, utility providers would likely experience some operational effects after the utility relocation process is completed (described in Chapter 6, Construction Effects). Many utilities would need to be redesigned and/or rerouted to avoid the new SR 99 facilities. As a result, many utilities would need to increase the number of linear feet of pipe, cable, and other materials in their distribution/transmission systems, which would result in an operational effect.

Access to utilities would change after project construction is completed. The vertical and horizontal location of the roadway alignment and the configuration of support structures could complicate long-term maintenance of overhead and underground utilities when these structures are located in the immediate vicinity of the utility, although the utility locations would be considered in the roadway design. Designation of a limited-access area surrounding the SR 99 facility could result in additional operational effects on utility providers due to restricted access to utility infrastructure. Where foundations or structures might limit access to utilities, these issues would be addressed on a case-by-case basis during final design.

The construction and operation of the new facility would largely be within public rights-of-way, where utilities are also generally located. The project design would accommodate, to the extent practicable, utility zones that would allow utilities that are currently within the right-of-way to be relocated within the right-of-way. However, depending on the constraints of the final design of the selected alternative, private utilities may need to obtain permanent easements outside the project right-of-way. The need for private utilities to obtain permanent easements would be determined as the design proceeds. Access requirements for private utilities located in easements outside the right-of-way would be determined by the private providers separately from the project.

The impairment of access and maintenance functions could result in operational effects on utilities. Closures of roadways that are heavily used and frequently congested would require frequent interagency coordination and advance planning. Emergency repairs could potentially lead to secondary effects on traffic, primarily due to the necessity of closing traffic lanes that may be needed to access utilities. Access and maintenance functions are being addressed as the design proceeds, and efforts are being made to reduce conflicts wherever possible. Therefore, these risks are discussed only as potential effects.

5.3.1 Operational Effects on Utilities Common to All Build Alternatives

Electrical Power

All of the build alternatives could require additional electrical facilities, which would require the reconfiguration of the existing electrical system. This reconfiguration could result in maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Water

All of the build alternatives would reconfigure the existing water supply system. This reconfiguration could result in maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Sanitary Sewer and Storm Drainage

All of the build alternatives would reconfigure the existing sanitary sewer and storm drainage system and add green system infrastructure. This reconfiguration could result in maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Natural Gas

No operational changes to the natural gas utility infrastructure are anticipated. The natural gas lines would typically be relocated under roadways adjacent to SR 99; therefore, long-term maintenance and access procedures would be unaffected.

Telecommunications

All of the build alternatives would reconfigure the existing telecommunications system. This reconfiguration could result in maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

5.3.2 Bored Tunnel Alternative Operational Effects on Utilities

This section describes the potential operational effects on utilities resulting from the Bored Tunnel Alternative.

Electrical Power

To satisfy life safety requirements, additional uninterrupted electrical power would be necessary for tunnel lighting, ventilation, pump operation, and impressed current for corrosion control. Pump operation would be required to discharge stormwater, groundwater seepage, and water used for fire suppression to the storm drainage system or the combined sewer system. The additional use of electricity is discussed in Appendix R, Energy Discipline Report. The electrical infrastructure for new systems associated with the bored tunnel would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. However, the new electrical infrastructure would need to be extended from the existing electrical lines to enter the bored tunnel at its portals. This effect is consistent with the maintenance effects noted for all three build alternatives resulting from the increased length of the relocated infrastructure and changes in utility access.

Water

Inside the bored tunnel, the fire suppression system would be operated during emergencies and also periodically for system testing and maintenance. Drainage of water from the tunnel after operation of the fire suppression system and other discharges to the sewer system are discussed in the following section, Sanitary Sewer and Storm Drainage.

Sanitary Sewer and Storm Drainage

Additional inflows to the storm drainage and/or combined sewer system are likely to occur as a result of periodic testing of the fire suppression system, groundwater seepage from the tunnel, and discharge from the tunnel's fire suppression system during an emergency. The amount of inflow from the fire suppression system during an actual event would depend on the duration of the event. Drainage of water from the tunnel after operation of the fire suppression system and other discharges to the sewer system are regulated activities, and WSDOT would comply with the permitting requirements. Compliance would include adherence to the water quality standards and limits on dewatering flows that enter the City and King County drainage/sewer facilities. The drainage system would need to protect the conveyance capacity of the downstream storm drainage system or combined sewer system. If the amount of water applied to the tunnel by the fire suppression system is expected to exceed the capacity of downstream systems, the pumping rate would need to be restricted. If the pumping rates are restricted, in-line storage may be required, such as that provided by a vault or a larger-diameter pipe. Also, the pumping system would need to be designed to shut down in the event of an actual emergency to prevent discharges of hazardous materials to downstream systems. The pumping rates, need for in-line storage, water quality treatment, method of conveyance, and locations of pumping and discharge would need to be determined during ongoing coordination among the design team, King County, SPU, and SFD as the drainage system design proceeds. In-line storage, pumping, and conveyance infrastructure for new systems associated with the bored tunnel would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. Therefore, the effects on utilities would be limited to maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Natural Gas

No operational changes to the natural gas utility infrastructure are anticipated. The natural gas lines would typically be relocated under roadways adjacent to

SR 99; therefore, lane closures for maintenance access would continue to be necessary.

Telecommunications

Additional connections to the telecommunication infrastructure would be needed for the telecommunication systems required for the tunnel, as well as cellular service. New telecommunications infrastructure related to tunnel operation would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. New cellular infrastructure would be located in space leased to and maintained by cellular service providers.

5.3.3 Cut-and-Cover Tunnel Alternative Operational Effects on Utilities

This section describes the potential operational effects on utilities resulting from the Cut-and-Cover Tunnel Alternative.

Electrical Power

For the cut-and-cover tunnel, additional electrical power would be required for lighting, pump operation, and impressed current for corrosion control. Pump operation would be required to discharge stormwater, groundwater seepage, and water used for fire suppression to the storm drainage system or the combined sewer system. The additional use of electricity is discussed in Appendix R, Energy Discipline Report. Electrical infrastructure for new systems associated with the cut-and-cover tunnel would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. However, new electrical infrastructure would need to be extended from the existing electrical lines to enter the tunnel at its portals. This effect is consistent with the maintenance effects noted for all the build alternatives resulting from the increase length of the relocated infrastructure and changes in utility access.

Water

In addition to operation during emergencies, the fire suppression system in the cut-and-cover tunnel would be periodically operated for system testing and maintenance.

Although the Battery Street Tunnel currently has a fire suppression system, the improvements provided by the Cut-and-Cover Tunnel Alternative would increase the amount of water delivered inside the tunnel. In addition, the water line in Second Avenue within the roof structure would be covered by new fire protection board attached to the bottom of the roof beams. Maintenance access to the enclosed water line would be provided.

Infrastructure for the new fire suppression system associated with the cut-and-cover tunnel would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. Therefore, the effects on utilities would be limited to maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Sanitary Sewer and Storm Drainage

Additional inflows to the storm drainage and/or combined sewer system are likely to occur as a result of periodic testing of the fire suppression system, groundwater seepage from the tunnel, and discharge from the fire suppression system during an emergency. The amount of inflow from the fire suppression system during an actual event would depend on the duration of the event. Drainage of water from the tunnel after operation of the fire suppression system and other discharges to the sewer system are regulated activities, and WSDOT would comply with the permitting requirements. Compliance would include adherence to the water quality standards and limits on dewatering flows that enter the City and King County drainage/sewer facilities. The drainage system would need to protect the conveyance capacity of the downstream storm drainage system or combined sewer system. If the amount of water applied to the tunnel by the fire suppression system is expected to exceed the capacity of the downstream systems, the pumping rate would need to be restricted. If the pumping rates are restricted, in-line storage may be required, such as that provided by a vault or a larger-diameter pipe. Also, the pumping system would need to be designed to shut down in the event of an actual emergency to prevent discharges of hazardous materials to downstream systems.

The pumping rates, need for in-line storage, water quality treatment, method of conveyance, and locations of pumping and discharge would need to be determined during ongoing coordination among the design team, King County, SPU, and SFD as the drainage system design proceeds. In-line storage, pumping, and conveyance infrastructure for the new systems associated with the tunnel would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. Therefore, the effects on utilities would be limited to maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Telecommunications

Additional connections to the telecommunication infrastructure would be needed for the telecommunications systems required for the tunnel. New telecommunications infrastructure would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. Therefore, the effects on utilities would be limited to maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

5.3.4 Elevated Structure Alternative Operational Effects on Utilities

This section describes the potential operational effects on utilities resulting from the Elevated Structure Alternative.

Electrical Power

The Elevated Structure Alternative would have additional electrical requirements for changes in lighting compared to the Viaduct Closed (No Build Alternative). However, these additional electrical requirements are likely to be less than those for either the Bored Tunnel Alternative or the Cut-and-Cover Tunnel Alternative. The additional use of electricity is discussed in Appendix R, Energy Discipline Report. Electrical infrastructure for the new systems associated with the elevated structure would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. Therefore, the effects on utilities would be limited to maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Water

Some additional water demand for the fire suppression system in the Battery Street Tunnel is likely. In addition to emergencies, the fire suppression system would be operated periodically for testing and maintenance. Although the Battery Street Tunnel currently has a fire suppression system, the improvements provided by the Elevated Structure Alternative would increase the amount of water delivered inside the tunnel. In addition, the water line in Second Avenue within the roof structure would be covered by new fire protection board attached to the bottom of the roof beams. Maintenance access to the enclosed water line would be provided.

Infrastructure for the new fire suppression system associated with the Battery Street Tunnel would be located within the WSDOT limited-access area and would be the responsibility of WSDOT to maintain. Therefore, the effects on utilities would be limited to maintenance effects due to the increased length of the relocated infrastructure and changes in utility access.

Sanitary Sewer and Storm Drainage

The Elevated Structure Alternative would not replace the fire suppression system in the Battery Street Tunnel; therefore, discharges to the sanitary sewer and storm drainage systems would be smaller than those resulting from the Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative.

Telecommunications

There would be no operational effects on telecommunications systems specific to the Elevated Structure Alternative.

5.4 Mitigation of Operational Effects

Mitigation of operational effects includes measures needed during the life of the facility to mitigate the increased operational requirements.

5.4.1 Public Services

The following list summarizes the potential mitigation measures for operational effects on public services:

- **Fire suppression services.** Prohibit the transport of flammable and hazardous materials in the bored tunnel and the cut-and-cover tunnel in accordance with the City amendments to NFPA 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways.
- **Law enforcement services; emergency medical services; disaster preparedness; solid waste collection, disposal, and recycling; school buses; and postal services.** None of the build alternatives is expected to result in significant adverse operational effects on the provision of these public services. Therefore, mitigation for these services is not warranted.

To minimize the potential risk associated with a tunnel fire, a variety of measures would be implemented. The following are examples of materials that would be prohibited from the bored tunnel and the cut-and-cover tunnel:

- Explosives
- Poisonous gases
- Materials that are dangerous when wet
- Materials that pose inhalation hazards
- Materials that must be kept away from foodstuffs
- Flammable materials
- Oxidizers
- Radioactive materials

Transport of these materials through tunnels either in tanks or containers is currently prohibited; their transport is already prohibited in the Battery Street Tunnel at all times and on the existing Alaskan Way Viaduct during peak hours of traffic. There are also restrictions on empty tank vehicles that have transported certain types of materials. Other measures include designs to provide emergency access and evacuation. Access to the bored tunnel and the cut-and-cover tunnel would need to be maintained at all times to ensure prompt response times and the safety of both passengers and service providers.

5.4.2 Utilities

The following list summarizes the potential mitigation measures for operational effects on utilities.

- Continue coordinated discussion with utility providers to determine utility upgrades and the associated maintenance responsibilities.
- As the design process proceeds, address access and long-term maintenance, including access in limited-access areas.

Along with the design aspects of the utilities systems, following the guidelines and regulations listed below would help to reduce operational effects on utilities:

- City and state energy, building, fire, and other applicable code requirements for all design aspects of the roadway facility.
- Relevant operational utility policies and strategies listed in the adopted *City of Seattle Comprehensive Plan,* Utilities Element (i.e., LOS, conservation strategies, and coordination of service providers) (City of Seattle 2005a).
- City amendments to NFPA 502 that prohibit flammable and hazardous materials in the bored tunnel and the cut-and-cover tunnel.

During use of the fire suppression system, the amount of water applied to the bored tunnel and the cut-and-cover tunnel could exceed the capacity of the existing combined sewer system. Consequently, the discharge rates may need to be restricted. If the discharge rates are restricted, in-line storage may be required. Such storage could be provided in the tunnel in a vault at the pump, in a storage system at a tunnel operations building, or in a larger-diameter pipe. Also, the pumping system would need to be designed to shut down in the event of an actual emergency to prevent discharges of hazardous materials to the storm drainage or combined sewer system. The pumping rates and the need for in-line storage would be determined during continued, ongoing coordination among the design team, King County, SPU, and SFD as the design of the drainage system proceeds. Groundwater seepage may be conveyed to the same pump systems for discharge into the City's sewer system. The method of conveyance and pumping and the discharge locations would need to be determined during ongoing coordination among the design team, King County, SPU, and SFD as the drainage system design proceeds.

5.5 Operational Benefits

There is a potential for utility infrastructure upgrades at selected locations. The details of these upgrades would be specified later in consultation with the utility providers, as part of the final design. In effect, utility system upgrades that enhance system reliability and/or capacity could result in a long-term operational benefit. Utilities replaced as part of the project may result in an operational benefit due the presumed better condition of new facilities and the opportunity to plan the redesigned system properly. Furthermore, implementation of any of the build alternatives would significantly reduce the risk associated with a catastrophic failure of the existing facilities under the Viaduct Closed (No Build Alternative), which would result in moderate to severe effects on utilities.

Operation of the three build alternatives would benefit public services by providing enhanced mobility through the study area, which would reduce traffic congestion and improve access on some routes.

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Chapter 6 CONSTRUCTION EFFECTS AND MITIGATION

Construction effects are those that occur during the relatively short period of project-related construction including construction staging and sequencing. This chapter describes the potential effects of project-related construction on public services and utilities.

6.1 Construction Effects Common to All Build Alternatives

6.1.1 Construction Effects on Public Services

During construction, public services would be affected by increased traffic congestion and delays on the primary roads affected by construction and on roads around the construction area. The increased congestions and delays would have a direct effect on emergency vehicle access to and through the construction area. Response times for police, fire, and emergency medical services to locations within and near the construction area would likely increase.

Increased travel time could also be experienced by other public services, such as solid waste collection, disposal, and recycling services; postal services; and school buses.

Potential construction effects are specifically related to areas where earthwork is expected or where the physical placement of project-related temporary or permanent facilities or structures would occur on or adjacent to public services or travel routes of public services providers. These activities could result in disruptions to access, response times, and mobility in the corridor. Generally, the project-related effects on public services fall into two main categories: increased travel times and increased demand. Travel times for emergency vehicles could be increased as a result of lane or road closures, restrictions in access through the construction area, impedance of emergency egress from structures, or increases in traffic in other locations. Increased travel time for emergency vehicles can be a serious problem during life safety emergencies and for disaster preparedness. Construction activities could also result in increased demand for public services, such as police or emergency medical services.

Fire and Emergency Medical Services

Lane closures, traffic routing, detours, and construction staging could affect overall traffic congestion on roadways under construction and on adjacent roadways. Emergency response times could increase due to traffic congestion and lane or roadway closures. Fire and emergency medical services outside the study area also could be affected due to changes in traffic patterns on local roads. For a discussion of construction effects on LOS, see Appendix C, Transportation Discipline Report.

During construction, fire hydrants may need to be relocated. Most of these relocations would occur along at-grade sections (surface streets) requiring sidewalk and street curb relocations. Water line relocations during construction could temporarily affect water supplies for fire suppression. Water service and hydrant relocations on live systems are typically performed by SPU.

Construction of the bored tunnel and the cut-and-cover tunnel would require appropriate tunnel rescue services in accordance with the state's Safety Standards for Underground Construction Work (WAC 296-155-730[10]). Tunnel rescue can be provided either by construction personnel or by SFD. SFD currently provides similar services for other projects, such as the Sound Transit Link Light Rail Project, including the University Link Tunnel.

Law Enforcement Services

Construction in some high-volume traffic and pedestrian areas could require additional police support services to direct and control traffic and pedestrian movements. Traffic mobility during construction in heavily traveled areas could be most affected, especially during peak hours. The project would be responsible for maintaining security at construction and staging areas during construction.

School Buses

Delays for school buses and other school-related traffic could occur due to traffic congestion and lane or roadway closures. Construction would delay buses traveling on, crossing, or making turns on the roadway under construction. Key intersections on major north-south school bus thoroughfares, including the Alaskan Way surface street and adjacent surface streets, would likely be affected. School bus routes outside the study area also may be affected as a result of changes in traffic patterns on local roads. Refer to Appendix C, Transportation Discipline Report.

Solid Waste Collection, Disposal, and Recycling

Solid waste haulers could experience delays or disruptions in collection routes during construction activities, especially along sections of routes that include curbside, driveway, or other collection points that could be closed or more difficult to access. Collection and haul routes outside the study area also may be affected as a result of changes in traffic patterns on local roads.

In addition, waste and debris generated during construction would need to be collected and disposed of.

Disaster Preparedness

Construction could affect disaster preparedness and result in delayed response times for emergency services. This may affect operations of the Seattle Office of Emergency Management, the Port of Seattle, WSDOT, and the Washington State Ferries, especially during peak hours of traffic.

6.1.2 Constructions Effects on Utilities

Before the construction of the selected alternative, the exact locations and depths of critical utilities and the potential effects of construction on them would be researched further and verified with utility providers during the design process. During final design, specific construction methods and best management practices (BMPs) would be developed in consultation with the utility providers to provide protection measures specific to each site. These measures would ensure access; minimize damage to facilities due to settlement, vibration, groundwater dewatering, and hazardous materials; and help with erosion and sediment control. Utility relocations would be performed according to agency regulations and permits, utility provider requirements, and proper BMPs.

The potential construction effects on utilities are described broadly in this section. The three build alternatives are designed to accommodate, where feasible, the utilities currently located in the study area. However, it is important to note that construction would require some utility relocations.

Utilities could be directly affected during construction, depending on their depth below grade, their material composition, the construction excavation limits, the exact location of the proposed transportation facility, the associated foundation, and other factors. Additionally, relocation of some utilities may have a subsequent effect on other utilities near the relocation activities.

All underground utility relocations involve similar construction activities and result in similar effects, including pavement demolition, excavation, repaving, installation of ground support systems, groundwater control, relocation effects on other localized utilities, dust and noise control measures, traffic disruptions, and lane or sidewalk closures. For aboveground utilities, the direct effects typically include the placement of new or temporary poles. Direct effects on all utilities would include disruptions to utility service during the cutover from existing to temporary service feeds, and again when the permanent utilities are completed.

All utilities would be reviewed and approved on a case-by-case basis before they are relocated. Construction effects on utilities would potentially include the following:

- **Examples of effects on underground utilities.** Construction is expected to involve the removal of concrete pavement and the installation of foundations or other structures, with potential adverse effects on underground utilities that are sensitive to vibration and settlement, such as water lines. Lead-jointed cast-iron water lines, sewers, and drains could require replacement or joint reinforcement before these construction activities begin. The temporary or permanent relocation of these utilities might be required before the construction of support walls or excavation-retaining walls, fill embankments, foundations, or soil improvements. Underground utilities beneath or near fill might settle or displace laterally, or they could experience vertical and/or lateral loading due to embankment loading and settlement of subgrade soils beneath the fill. In addition, abandoned utilities that have not been plugged could become conduits for water or gases, which could affect existing and future facilities. Other utilities may need to be relocated to facilitate the construction activities.

- **Interruptions of service.** Several major construction activities could require a temporary interruption to utility service for customers within the study area. Portions of the utility system would need to be removed to connect new facilities to the existing facilities. These outages would be planned in advance and coordinated with the utility owner. In addition, access to water lines and fire hydrants could be obstructed, which could affect utility services and fire suppression capabilities if alternative supplies are not provided.
- **Encounters with hazardous materials.** Effects could result if contaminated soil or groundwater is encountered during construction activities such as utility relocations, drilling of shafts or piles, deep soil mixing, soil strengthening, or excavation. Some existing electrical transmission lines in the study area are high-pressure systems containing a highly refined dielectric fluid; these transmission lines would need to be carefully handled throughout the construction period. For additional discussion of hazardous materials, see Appendix Q, Hazardous Materials Discipline Report.
- **Inadvertent damage.** Inadvertent damage to utilities could occur during construction. Although such incidents do not occur frequently, they could temporarily disrupt service and result in effects on environmental elements, such as water quality, and public health, if not properly mitigated.
- **Unanticipated effects.** Other typical construction effects relate to the accuracy of the base mapping and subsurface utility information. If required, certain utilities or locations could be field-verified during design. If these utilities or locations are not field-verified during design,

then effects caused by differences in invert elevations, materials, sizes, or utility quantities could occur during construction.

Potentially affected utilities within the study area that have been considered in the *Utility Impact Report: Bored Tunnel Alternative* (Jacobs 2009) are summarized in the following list. The final design will need to account for all existing utilities, such as utility lines that are smaller than those indicated here. The potential utility effects described below are general because the engineering data are at the conceptual stage. The conceptual engineering data will continue to be refined, and more detailed information will be available later in the design process.

- Wet vaults or regulators, which are underground structures that are typically larger than appurtenances such as catch basins and manholes. These structures may be used for water quality treatment, flow control, containment of discharges during fire suppression events, or control of diversions to the combined sewer outfalls.
- Water distribution mains (8- to 12-inch-diameter lines), large water feeder mains (16- to 48-inch-diameter lines), water services, and hydrants.
- Sanitary sewer mains (8- to 12-inch-diameter lines), large conveyances (16- to 48-inch-diameter, 60-inch-diameter, and larger), and manholes.
- Storm drainage and combined sewer facilities, which vary depending on the system design. For further discussion, see Appendix O, Surface Water Discipline Report.
- Natural gas facilities including low-pressure, intermediate-pressure, and high-pressure mains, district regulators to reduce pressures (including vaults), metering equipment, and valves.
- Low-pressure and high-pressure steam lines, valves, and vaults.
- Telephone service and fiber-optic cable lines would likely be relocated into a common duct bank for the entire duration of construction. These relocations would occur before roadway construction and the relocation of most other utilities.
- Electrical distribution network (underground), electrical distribution non-network, and transmission lines. For the electrical distribution network (underground), categories include trench, primary lines, secondary lines, individual lines, manholes/handholes, vaults, transformers, and switches. For the electrical distribution non-network, categories include overhead primary, overhead secondary, underground primary, and underground secondary facilities, which include transformers, switches, ducts, vaults, and manholes. The transmission

facilities include ducts, vaults, and high-voltage pressurized dielectric underground cable.

- Electrical systems (underground and overhead wire) serving transit systems.

6.2 Effects of Concurrent Construction

Construction activities associated with concurrent projects may add to the effects on public services and utilities resulting from the three build alternatives.

6.2.1 Effects on Public Services

Multiple projects under construction at the same time could lead to additional lane closures, which in turn could cause longer emergency response times and travel time delays for other public service vehicles. Lane closures and traffic delays from multiple projects in the same areas or adjacent areas of the city could result in difficulties in determining efficient routes for these services. If the construction of the I-5 improvements and any of the build alternatives coincide, vehicle travel would be extremely constrained in and around the downtown core, which could result in additional response time and travel time delays for fire, police, and emergency service vehicles.

In addition, overlapping construction schedules for utility relocations could result in temporary disruptions to water services necessary to support fire suppression in the study area.

If the construction associated with any of the build alternatives overlaps the construction associated with other planned actions, project-related construction and demolition activities would generate additional solid waste that could result in additional effects on solid waste management facilities.

6.2.2 Effects on Utilities

Overlapping construction schedules due to concurrent construction activities could increase the risk and frequency of service disruption or potential damage to existing infrastructure. Potential utility outages would affect business and residential customers, as well as public services. Services to customers could be temporarily disconnected each time a utility line is relocated. Multiple relocations of utilities could affect the local economy by increasing the risk of frequent and/or accidental loss of service to retail and commercial businesses.

The utility construction sequencing for any of the build alternatives would be a major undertaking in and of itself. If construction of any of the build alternatives overlaps the construction associated with other planned actions, the multiple utility relocations would require utility providers to secure permitting, skilled personnel, and specialized equipment in large quantities and to commit to completing relocation work at an accelerated pace, if it is not provided as part of a project.

6.3 Bored Tunnel Alternative Utilities Effects

This section describes potential construction effects on utilities resulting from the Bored Tunnel Alternative.

6.3.1 South Portal

The south portal of the bored tunnel would be constructed with a combination of techniques, including cut-and-cover and open trench. Both of these techniques require a type of shoring or bracing system to allow excavation, such as a secant pile wall, soldier pile wall, slurry wall system, or other yet-to-be-determined methods. Regardless of the technique used, numerous relocations of public and private utilities would be required.

Electrical Power

SCL's transmission lines would be affected by the south portal construction. These facilities would be monitored during construction and as the design process proceeds and would be either relocated or protected in place. Relocation work for the 115-kV system would need to consider lead times required to obtain cable and specialty electrical equipment and SCL system outage windows during construction. SCL would need to be consulted to ascertain the latest clearance lead times. Once a preferred plan is selected, load flow, soil thermal conductivity, and cable-rating studies may be required to ensure that capacity requirements are met by any temporary or permanent modifications to the existing 115-kV system (POWER Engineers 2008). Electrical lines would be extended to the new substation supplying power to the tunnel boring machine (TBM). The substation itself would be within the limited-access area and would be the responsibility of WSDOT.

Water

Water lines and water mains would be affected by the south portal construction activities. These facilities would be monitored as the design process proceeds and would be either relocated or protected in place. Coordination with SPU would be required to determine the appropriate fire flow rating to the south portal corridor that must be maintained during and after the south portal construction.

Consideration must be given to excavation, ground loading, or other construction in the vicinity of existing water mains. Some of the cast-iron pipe was constructed as early as 1891 and is more subject to failure due to construction effects because of the brittle properties of cast iron and the susceptibility of the lead joints to vibration and settlement (RWE 2006d). Cathodic protection may be required, depending on the soil conditions.

It is expected that existing fire hydrants, water valves, and water services would need to be relocated to accommodate the new road layout and other south portal construction activities.

Sanitary Sewer and Storm Drainage

Coordination with SPU and King County would be required to determine the best way to maintain service connections in the south portal area.

The large-diameter pipes in S. Royal Brougham Way are not expected to be affected by south portal construction. The large-diameter pipes in S. King Street could be affected by the south portal construction and would need to be monitored.

The outfalls at S. Royal Brougham Way and S. King Street are not expected to be affected by the Bored Tunnel Alternative.

Natural Gas

PSE's natural gas facilities would be affected by the south portal construction. These facilities would be monitored as the design process proceeds and would be either relocated or protected in place.

Telecommunications

The Broadstripe, Comcast, ELI, Qwest, Sprint, TW Telecom of Washington, Verizon, and XO Communications systems may be affected by the south portal construction. These facilities would be monitored as the design process proceeds and would be either relocated or protected in place.

6.3.2 Bored Tunnel

Tunnel boring could induce settlement that may affect utilities along the bored tunnel alignment. The amount of settlement would vary depending on the location along the tunnel alignment. For more information about settlement and the condition of subsurface soils, refer to Appendix P, Earth Discipline Report.

The following utilities are expected to be most affected by tunnel boring-induced settlement: SCL clay tile duct banks, brick vaults, Orangeburg duct banks, lead-jointed cast-iron water mains, water main thrust blocks, gravity utilities, side sewers, water services, steam lines, and natural gas mains. Coordination with SPU, King County, SCL, DoIT, private communications providers, PSE, and Seattle Steam should occur to verify that they are aware of potential settlement and vibration caused by tunnel boring and to seek their guidance regarding mitigation.

Lead-jointed cast-iron water mains are susceptible to settlement. Per City Standard Specification 1-07.16(1), "…cast iron pipe joints have been known to develop leakage when disturbed by shifting earth, or excessive vibrations, or adverse effects of any other construction excavation work" (City of Seattle 2008b).

For gravity utilities, if the ground settles significantly, the flow, capacity, structural integrity, and joints of pipelines could be affected. Coordination with SPU and King County would be needed to determine the amount of settlement that is acceptable to their gravity systems. Special consideration should be given to the 48-inch-diameter pile-supported brick-lined concrete sewer aligned in S. King Street.

Some steam lines are installed with a slope to allow the drainage of condensate. If the ground settles significantly, the drainage of the steam lines could be affected. If steam lines are affected, asbestos abatement may be required. Coordination with Seattle Steam would be needed to determine the amount of settlement that is acceptable to its systems.

Emergency repairs would be required if settlement caused by the TBM either during construction or for an extended period after construction results in damage to utilities. These repairs could result in traffic delays due to lane closures and surface excavations.

6.3.3 North Portal

The north portal of the bored tunnel would be constructed with a combination of techniques, including cut-and-cover and open trench. Both of these techniques require a shoring or bracing system to allow excavation, such as a secant pile wall, soldier pile wall, slurry wall system, or some other yet-to-be-determined method. Regardless of the technique used, numerous relocations of public and private utilities would be required.

Electrical Power

The existing circuits in the duct bank in Sixth Avenue N., the circuits in the duct banks crossing SR 99 at Thomas and Harrison Streets, the Broad Substation, and the 115-kV transmission line in Thomas Street would be affected by the north portal construction. These systems would need to remain in service during and after construction. These facilities would be monitored as the design process proceeds and would be either relocated or protected in place.

Coordination with utility providers would be needed to minimize service disruptions before, during, and after construction.

Water

SPU water lines would be affected by the north portal construction. It may be possible to reroute the water system to adjacent lines or to a temporary location adjacent to the north portal, but this action must be reviewed with SPU. Coordination with SPU would be required to ensure continued service performance, regulatory code compliance, and an appropriate fire flow rating to the north portal corridor.

Consideration must be given to excavation, ground loading, or other construction near existing water mains. Some cast-iron pipe was constructed as early as 1891 and is more subject to failure due to construction effects because of its less forgiving lead joints and the brittle properties of cast iron (RWE 2006d). Cathodic protection may be required, depending on the soil conditions.

It is expected that existing fire hydrants, water valves, and water services would need to be relocated to accommodate the new road layout and other north portal construction activities.

Sanitary Sewer and Storm Drainage

The existing combined sewers near the centerlines of SR 99 and Broad Street and the sewer lines aligned in Sixth Avenue N., Republican Street, Mercer Street, and Harrison Street would be affected by the north portal construction. These pipes collect surface storm drainage and have multiple side sewer connections. The existing separated storm drain aligned in Broad Street would also be affected by the north portal construction. Coordination with SPU and King County would be required to determine how best to relocate these systems and maintain their services.

Natural Gas

PSE's natural gas facilities would be affected by the north portal construction. These facilities would be monitored as the design process proceeds and would be either relocated or protected in place.

Telecommunications

DoIT's existing system aligned along SR 99 and Sixth Avenue N. would be affected by the north portal construction. Coordination with DoIT would be required to determine how best to relocate this system. DoIT's system that crosses SR 99 at Thomas Street may also be affected.

The Broadstripe, Comcast, Global Crossing, Qwest, TW Telecom of Washington, King 5, and Verizon systems may be affected by the north portal construction. It may be possible to temporarily relocate systems to an aboveground location, thereby vacating the SR 99 corridor. Some providers may need to cross the SR 99 corridor in some locations during construction.

6.3.4 Viaduct Removal

All utilities attached to the existing Alaskan Way Viaduct or buried beneath the existing viaduct would be monitored as the design process proceeds and would be either relocated, replaced, or protected in place. Some of these relocations or replacements may require excavation. The same is true for the removal of viaduct columns and footings to an estimated depth of 5 feet below existing grade. Coordination with the owners of these utilities would be required to understand and mitigate the effects.

The surface features of existing utilities located beneath the viaduct may need to be adjusted to be flush with the new surface. Grade changes in this area are expected to be minimal, which would limit the effects on utilities.

Electrical Power

SCL's transmission lines 1 and 2 are attached to the existing viaduct and would need to be relocated before the viaduct is demolished. Coordination with SCL would be required. Relocation work for the 115-kV system would need to consider lead times required to obtain cable and specialty electrical equipment and SCL system outage windows during construction. SCL would need to be consulted to ascertain the latest clearance lead times. Once a preferred plan is selected, load flow, soil thermal conductivity, and cable-rating studies may be required to ensure that capacity requirements are met by any temporary or permanent modifications to the existing 115-kV system (POWER Engineers 2008).

Any electrical lines attached to the underside of the existing viaduct would require relocation before the viaduct is demolished.

Coordination with utility providers would be needed to minimize service disruptions before, during, and after construction.

Water

It is expected that existing fire hydrants, water valves, water mains, and water services would need to be relocated to accommodate the viaduct demolition and surface restoration construction activities.

Sanitary Sewer and Storm Drainage

Existing utilities beneath the existing viaduct would potentially be affected by the viaduct removal. Coordination with the owners of these utilities would be required to understand and mitigate the effects these utilities.

Natural Gas

The 12-inch-diameter high-pressure natural gas main crosses over multiple existing viaduct pile caps. These facilities would be monitored as the design process proceeds and would be either relocated or protected in place.

Steam

No direct effects on steam facilities are expected. However, coordination with Seattle Steam would be advisable to ensure that the steam lines would not be affected by construction activities.

Telecommunications

DoIT infrastructure is attached to the existing viaduct from S. Washington Street south through SODO and would need to be relocated before the viaduct is demolished. Coordination with DoIT would be required.

Broadstripe, 360networks, Comcast, ELI, Qwest, and XO Communications also have infrastructure attached to the existing viaduct that would need to be relocated before demolition. Coordination with these providers would occur before demolition.

6.3.5 Battery Street Tunnel Decommissioning

The Battery Street Tunnel would be closed after the bored tunnel is opened to traffic. The cross streets above the Battery Street Tunnel and the utilities would be maintained. The current proposal is to use crushed rubble recycled from the demolished viaduct to fill the tunnel approximately two-thirds full and then pump in a low-strength concrete slurry to solidify the rubble. The concrete slurry mix would be poured into the tunnel from openings in Battery Street above the tunnel in several locations along the tunnel alignment.

Before filling the Battery Street Tunnel, the project would remove materials associated with tunnel system components and other elements, such as asbestos transite conduit, lead-based paint, light fixtures, and light tubes containing heavy metals. The combined sewer piping would be maintained. The ends of the tunnel would be sealed with concrete, and barricades would be placed to prevent entry.

After the Battery Street Tunnel is closed, the utilities that are currently accessed from within the tunnel would have to be accessed through other means. One component of the decommissioning process would be to ensure that utilities are completely disconnected and separated from the serving utility and that customers relying on these utilities are provided with new service. No other effects on utilities are expected to result from the decommissioning of the Battery Street Tunnel.

6.4 Cut-and-Cover Tunnel Alternative Utilities Effects

This section describes potential construction effects on utilities resulting from the Cut-and-Cover Tunnel Alternative. Unlike the Bored Tunnel Alternative, the Cut-and-Cover Tunnel Alternative is not expected to result in settlement effects, which for the Bored Tunnel Alternative would extend upland from the waterfront along the alignment. On the other hand, the Cut-and-Cover Tunnel Alternative would result in more disruptive effects on underground utilities located on the central waterfront along its alignment.

The utility relocations identified in this section are based on planning-level estimates for the Cut-and-Cover Tunnel Alternative. These estimates would continue to be refined in close consultation with the utility providers as part of final design.

The temporary and permanent utility relocations associated with the Cut-and-Cover Tunnel Alternative could involve the following construction activities and direct effects: pavement demolition, excavation, backfilling, repaving, disruption of ground support systems, dust and noise monitoring, relocation impacts on other localized utilities, traffic disruptions, increased traffic delay, temporary service outages, and construction accidents. Other substantive effects would include utility crew support of construction activities and increased difficulty in accessing utilities for repairs. If not properly mitigated, these effects could potentially result in adverse conditions.

6.5 Elevated Structure Alternative Utilities Effects

This section describes potential construction effects on utilities resulting from the Elevated Structure Alternative.

The Elevated Structure Alternative is expected to involve construction activities and effects similar to those described for the Cut-and-Cover Tunnel Alternative: pavement demolition, excavation, backfilling, repaving, disruption of ground support systems, relocation impacts on other localized utilities, traffic disruptions, increased risk of schedule delays, and temporary service outages. However, due to less below-grade work for the Elevated Structure Alternative, this alternative is expected to result in fewer effects on utilities than either the Bored Tunnel Alternative or the Cut-and-Cover Tunnel Alternative.

6.6 Mitigation of Construction Effects Common to All Build Alternatives

This section discusses mitigation measures to help minimize potential construction effects on public services and utilities. The proposed mitigation measures are based on NEPA principles, WSDOT and City policies, mitigation proposed for similar projects, and coordination with affected agencies. These measures need to be refined, and additional or more specific mitigation measures will be developed as the planning and design process continues. These mitigation measures have been developed through ongoing coordination among the affected agencies and WSDOT. Ongoing coordination will be particularly important to mitigate the effects of concurrent construction effects in Section 6.2.

The proposed construction mitigation measures are based on the construction effects discussed in previous sections of this chapter. For a detailed description of the overall construction sequencing, including traffic detours and staging, see Appendix B, Alternatives Description and Construction Methods Discipline Report.

WSDOT will continue coordinating with the City and Port of Seattle police and fire departments, regional transportation agencies, and other related agencies during the final design of the selected alternative. The objectives of this coordination are to provide or develop reliable emergency access and alternative plans or routes for avoiding delays in response times and to ensure that general emergency management services are not compromised. Early notice of detours and lane restrictions will be provided to emergency and nonemergency public service providers.

The utilities design team will continue to coordinate with SFD and SPU regarding water line relocations that could affect the water supply for fire suppression, establish alternative supply lines before any breaks in service, and coordinate electrical and telephone disconnections and/or relocations that could affect fire and life safety systems. WSDOT will coordinate with construction personnel and, if necessary, with SPD and the Port of Seattle police department to ensure that adequate staffing is available during construction for traffic and pedestrian movement control and other necessary policing efforts.

6.6.1 Mitigation of Effects on Public Services

WSDOT will coordinate with public service provider throughout project design and construction to ensure that the project effects are understood in advance, planned for, and minimized.

Fire and Emergency Medical Services

Intelligent traffic signal controls at signalized intersections could be used as a partial mitigation measure for the effects on response times for fire and emergency medical services, particularly during construction. If intelligent traffic signals cannot adequately mitigate the effects on emergency response, additional staff, apparatus, and facilities may be necessary.

During the relocation of water lines and fire hydrants, WSDOT will coordinate in advance with the affected fire stations, SPU, and hospitals and provide schedule notifications to allow advanced planning and to reduce the effects associated with service interruptions.

Law Enforcement Services

The need for additional police support services could be addressed by providing additional permanent or temporary law enforcement officers and/or stations.

School Buses

The Seattle School District has established rerouting plans for use when the existing viaduct is unusable. These rerouting plans are expected to be implemented when SR 99 is closed.

Solid Waste Collection, Disposal, and Recycling

Construction waste and debris could be disposed of at a number of disposal facilities in the Puget Sound region. A portion of the debris, including clean wood waste, metals, gypsum, and other materials, could be recycled at facilities such as Seattle's recycling and disposal stations. The area transfer stations and regional landfills have sufficient capacity to accommodate the construction waste and debris generated from the construction activities associated with any of the build alternatives. It is important to note that the disposal of construction waste and debris is unresolved at this time. Pending the selection of the alternative to be built and more refined engineering, a detailed analysis will need to be performed.

Waste processing haulers and facilities will be informed that additional loads would be delivered during construction. Additional haul trucks, operators, barges, or train cars may be required.

Disaster Preparedness

The project team will continue coordinating with the Seattle and Port of Seattle police and fire departments, regional transportation agencies, and other appropriate agencies during the final design of the selected alternative. The objectives of this coordination are to provide or develop reliable emergency access and alternative plans or routes for avoiding delays in response times and to ensure that general emergency management services are not compromised. Early notice of detours and lane restrictions will be provided to the providers of emergency and nonemergency public services.

In August 2010, WSDOT began work to install a system designed to automatically close the viaduct in the event of a moderate to severe earthquake in the greater Seattle area. The new system will consist of nine traffic gates strategically placed on the viaduct and controlled by an earthquake detection system. When the earthquake monitoring system detects significant ground movement, it will simultaneously lower all nine traffic gates and safely close the viaduct in 2 minutes (WSDOT 2010). The project was completed in 2011.

6.6.2 Mitigation of Effects on Utilities

WSDOT will coordinate with utility owners on utility relocation plans that identify impacts and potential temporary and final locations. Designers and contractors will be required to develop construction sequence plans and coordinate schedules for utility work to minimize service disruptions and provide ample advance notice when service disruptions are unavoidable, consistent with utility owner policies. Relocation plans and service disruptions will be reviewed and approved by the affected utility providers before construction begins.

As the final design proceeds, specific mitigation measures for effects on utilities will be developed during the ongoing coordination process between WSDOT, SPU, SCL, and other providers. Some of the potential mitigation measures for effects on utilities are the following:

- Assemble a multidisciplinary task force to monitor settlement during construction (Bored Tunnel Alternative only).
- Ensure that all utilities are accessible during construction.
- Expose critical utilities before beginning construction in the vicinity.
- Coordinate utility relocation plans with utility owners and customers to minimize the impacts of service disruptions.
- Require contractors to comply with utility owner notice requirements for planned outages.
- Coordinate with utility owners to ensure that owner contingency plans for management of any potential utility service disruptions during construction are accommodated.
- Coordinate construction-related mitigation with other construction projects in the vicinity to minimize utility and traffic disruptions.
- Provide backup on-site electrical generation, as needed, to minimize extended outages to customers as determined by SCL on a case-by-case basis.

In addition to this list of potential mitigation measures, Washington State law and standard specifications require adherence to additional measures during construction:

- If inadvertent damage to utilities occurs during construction, the appropriate utility provider would be contacted immediately to restore service. Contractors would also be required to take immediate measures to ensure public safety and protect property.
- Traffic revision equipment and personnel would be provided as required during utility relocations.

- Construction activities in the street right-of-way would be conducted during off-peak hours, whenever possible, to lessen traffic effects.
- All utilities determined to need protection in place would require protective measure, which could include pipe and conduit support systems, trench sheeting, and shoring during construction.
- Construction techniques to avoid or minimize vibration effects on utilities would be used where needed. Such techniques may include using drilled shafts in lieu of driven piles.
- A safety watch would be provided through coordination with SCL. The safety watch would minimize the interruption of power to customers and speed up power restoration in the event of accidental interruption of power caused by project construction. Critical utilities, such as transmission lines, may need to be exposed and remain exposed during construction to lessen the chance of damage that could result in unplanned outages.

Utility owner standards (along with other guidelines listed in Section 2.2) would be used for utilities that would need to be relocated. Existing piping, conduits, buried cable, and buried utilities that encroach on areas required for construction would be removed and relocated, within the existing right-of-way, wherever feasible. In some instances, relocation may not be feasible within the existing right-of-way and would require additional effort to reroute and to coordinate with adjacent property owners.

The lead agencies will work with utility providers to coordinate the planned schedule, sequencing, and areas of outages. These issues will need to be coordinated as part of the final design.

Hazardous materials may be encountered during construction. Asbestos-cement pipe may be encountered in water line construction, in some SCL transite conduits, and in insulation around steam lines. See Appendix Q, Hazardous Materials Discipline Report, for additional information regarding the mitigation of hazardous materials encountered during construction.

Appendix I, Historic, Cultural, and Archaeological Resources Discipline Report, discusses potential archaeological resources and mitigation within that discipline's study area. The mitigation measures identified in Appendix I would be implemented for utility construction that may occur before roadway construction to ensure that archaeological resources are either avoided or addressed appropriately during utility construction.

Depending on the type of structure or earthwork, specific construction methods may need to be used to minimize the transport of hazardous material or contaminated media. To prevent migration of contaminants in shallow groundwater, controlled-density fill or trench dams may be installed at intervals along utility runs where contamination is suspected. See Appendix Q, Hazardous Materials Discipline Report, for further information.

6.7 Bored Tunnel Alternative Mitigation Measures

To minimize ground settlement associated with the Bored Tunnel Alternative, the tunneling would be undertaken with the use of advanced tunneling technology. The ground improvement methods discussed in this section would be used before or during the tunneling activities to protect existing structures on the surface and underground utilities from potential ground subsidence and to strengthen the ground mass so that it can better accommodate the tunnel construction. Ground improvement activities could result in damage to utilities; therefore, care would be taken during ground improvement to avoid damage, and repairs would need to be performed if damage occurs.

Ground improvement measures would likely be performed along the tunnel alignment to stabilize soft soils and mitigate potential ground loss. More extensive ground improvements would be needed for the construction of the south portal and the tunnel, where the predominant existing soils are fill material. The area between S. King Street and Marion Street is more vulnerable to ground settlement than the north portal area because of the soil types in this area and the relatively shallow depth of the tunnel. However, certain locations in the north portal area may also need ground improvements.

The minimization of ground settlement risks posed by tunnel work, such as sinkholes in streets or damage to utility conveyance facilities, is a primary design goal of tunnel construction. Ground improvements, such as those described in this section, would also be used as advance mitigation before the tunnel boring to prevent damage to utilities due to ground settlement or ground movement during boring. Before the ground improvement begins, care would be taken to ensure that grout would not be able to enter utility pipes, trenches, vaults, areaways, and basements.

Although extensive planning and design measures are being undertaken to prevent subsidence, some unanticipated settlement could occur. If settlement occurs, emergency measures would be necessary to repair any damage or minimize further settlement. These measures could require lane and/or sidewalk closures or access to basements of adjacent buildings to inject grout. Refer to Appendix P, Earth Discipline Report, for a more detailed discussion of ground improvements and potential effects.

In addition to ground improvements, mitigation measures could include inspections before and after construction to identify damage due to settlement. If settlement-induced damage requires emergency repairs to utilities, coordination with the public and transit agencies should occur to mitigate the effects of any delays caused by the repairs. See Appendix B, Alternatives Description and Construction Methods Discipline Report, for greater detail on ground improvement methods that may be used.

6.7.1 Permeation Grouting

Permeation grouting is a ground improvement process in which a grout fluid is injected into the pore spaces of the soil to displace the air and/or water occupying the natural pore spaces. The fluid can be either a cement grout or a chemical grout, depending on the construction work requirements and restrictions, the soil permeability, the availability of material, and the availability of specialized equipment and skilled labor. Use of permeation grouting is limited to granular soils with a sufficiently high permeability to allow the fluid to penetrate the soil pore spaces.

6.7.2 Compaction Grouting

Compaction grouting is a process that injects a highly viscous grout into the soil mass. It does not penetrate the pores as with permeation grouting, but instead forms a grouted "bulb" within the soil mass, displacing the natural soil and consolidating and condensing it in the process. Because the grout does not penetrate the soil mass, a single bulb results in a limited volume and area of soil improvement. However, with this technique, multiple bulbs can be placed adjacent to one another to achieve the desired results of ground improvement. It is especially useful in loose, granular soils that compact easily and quickly.

Compaction grouting would involve the injection of grout above the tunnel crown as the TBM advances forward longitudinally. The grout densifies the soil profile overlying the crown of the tunnel, and it replaces some of the lost ground, thereby preventing potential settlement (or sinkholes) from propagating upward to the surface.

6.7.3 Compensation Grouting

Compensation grouting would be performed to mitigate ground loss during tunneling beneath the structures where settlement is expected or detected during construction of the bored tunnel. Compensation grouting is a particular type of ground improvement in which grout is injected into the ground beneath the foundations of existing structures, and grout bulbs are formed beneath the foundations. The grout displaces the soil, and in the process, it has the potential to uplift a foundation to recover displacement from ground movements associated with tunneling beneath the structure. Where use is indicated injection pipes would normally be installed prior to tunneling. Grout would be injected to "precondition" the soil as to insure rapid response when ground loss is actually experienced during and subsequent to tunneling. If no movement is detected, no additional grout is placed. If movement is detected, the preinstalled pipes are used to inject sufficient grout to maintain the vertical position of the foundation before construction. Injection would continue as long as vertical movement is detected.

6.7.4 Ground Freezing

Artificial ground freezing is a process by which heat is extracted from a water-saturated soil mass, temporarily converting the interstitial pore water to ice, resulting in a consolidated soil mass as long as it remains frozen. The heat extraction is accomplished by installing freeze pipes into the soil mass and then circulating a refrigerant fluid to extract the heat. Under normal conditions, a saline solution with a freezing point below that of pure water is used. Liquid nitrogen can be used for saline groundwater conditions, when groundwater is moving under a slight hydraulic gradient or where a "quick freeze" is desired. This expedites the freezing process but substantially increases the cost. The freeze can be maintained as long as the temporary foundation support is required.

Although ground freezing has not been ruled out as a ground improvement method, it is not among the most likely methods to be used. If it is used, it would be used in very limited areas.

6.7.5 Underpinning

Underpinning is a traditional structural modification process by which the foundations of an existing structure are temporarily (sometimes permanently) structurally supported by alternative support elements. The objective is to maintain the structural integrity and vertical position of the existing structure while excavating for a new structure.

Typical underpinning methods include temporary timber cribbing beneath existing foundations, ground improvement with grout or ground freezing beneath the existing foundations, or new structural elements such as pin piles (or micropiling) beneath the existing foundations.

Care would be taken to maintain access to utilities before, during, and after construction activities.

6.8 Cut-and-Cover Tunnel Alternative Mitigation Measures

Mitigation measures for the Cut-and-Cover Tunnel Alternative would include the construction of temporary pedestrian walkways between some of the central waterfront piers for pedestrian access along the waterfront side of the construction zone. These temporary structures would provide pedestrian access between Piers 54 and 55 and between Piers 56 and 57. A temporary structure providing pedestrian access to Colman Dock at Piers 50 and 52 would be maintained throughout construction. Utilities may need to be temporarily located on these walkways. Utility providers would need to be informed of the locations and sizes of the pedestrian walkways in case the walkways need to be used as temporary utility supports. The temporary structures and any attached temporary utilities would be removed before construction is completed.

Temporary service lines from the east water main would likely be extended across the tunnel construction zone to existing water meters. Combined sewer overflow and storm drainage outfalls would need to be maintained across the construction zone. During construction, these temporary lines may need to be supported in place for extended periods of time.

6.9 Elevated Structure Alternative Mitigation Measures

No construction mitigation measures are proposed exclusively for the Elevated Structure Alternative.

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Chapter 7 TOLLING

As currently defined, none of the alternatives under consideration to replace the Alaskan Way Viaduct includes tolls. However, it is possible that the Washington State Legislature will determine that a portion of the overall project cost will need to be funded through 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 travel to or through downtown Seattle from points beyond the north and south portals of the tunnel. The analysis did not assume that transit or carpools would pay a toll.

This report evaluates the potential effects of tolling on each of the build alternatives. Tolls would be applied to vehicles entering the portion of the replacement facility between Denny Way and Seneca Street, in either direction. The toll rate used (for the analysis in this Final EIS) would be higher at more congested times of day and lower at less congested times of day, with an average of $2.44 in each direction.

7.2 Effects of Tolling on Public Services Common to All Alternatives

Potential effects on public services as a result of implementing tolling would be due to changes in transportation conditions, which may affect response times and travel times. Effects on public services as a result of changes in traffic patterns could include delays of emergency and nonemergency service providers, reduced access to public services due to traffic congestion, changes in the transportation system, and reduced availability of parking in some areas. For a detailed comparison of tolled and non-tolled conditions for each build alternative in terms of roadway LOS, refer to Appendix C, Transportation Discipline Report.

Effects on public services as a result of changes in traffic patterns could include some delays for fire, police, and emergency service vehicles; postal carriers; solid waste and recycling carriers; and school buses. In other locations, benefits to public services could include reduced levels of congestion and improved access.

7.3 Effects of Tolling on Utilities Common to All Alternatives

All of the build alternatives would require additional electrical and telecommunications infrastructure to operate the toll collection and enforcement devices. This infrastructure would likely be within the WSDOT limited-access area and would be WSDOT's responsibility to maintain. Therefore, no effects on utility providers are expected to result from the tolled alternatives beyond the effects identified for their non-tolled counterparts.

7.4 Mitigation of Tolling Effects on Public Services Common to All Alternatives

As with the non-tolled alternatives, coordination with public service providers would be needed to ensure continued provision of services.

7.5 Mitigation of Tolling Effects on Utilities Common to All Alternatives

Tolling is not expected to result in additional effects on utilities beyond what is identified for the non-tolled alternatives. Therefore, no additional mitigation is proposed.

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