
Bored Tunnel Alternative
Southbound SR 99
Northbound SR 99
Egress
Egress
Egress
Vent
Surface
Lowered Roadway
Cut-&-Cover Tunnel
Bored Tunnel
Elevated Roadway
Aerial
Elliott Bay
Olympic Sculpture
SEATTLE CENTER
Decommission Battery Street Tunnel
Broad Street Removed
Southbound On
Southbound Off
SR 99
Tunnel Operations Building
Northbound Off
Northbound On
Bored Tunnel
Demolish Viaduct
S. Holgate to S. King Street Project
TERMINAL 46
PIER 48
COLMAN DOCK
Southbound On
Northbound On
Street Improvements
Railroad
Southbound Off
Northbound Off
Tunnel Operations Building
SAFECO FIELD
QWEST FIELD
King St. Station
Union Station
QUEEN ANNE AVENUE
FIRST AVENUE N
WARREN AVENUE N
SECOND AV
THIRD AVE
FOURTH AV
FIFTH AVENUE N
TAYLOR AVENUE N
SIXTH AVENUE N
AURORA AVENUE
DEXTER AV
NINTH AVE N
WESTLAKE AVE N
TERRY AVE N
BOREN AVENUE N
FAIRVIEW AVENUE N
MINOR AVENUE N
PONTIUS AVENUE N
YALE AVENUE N
DENNY WAY
JOHN STREET
THOMAS STREET
HARRISON STREET
REPUBLICAN STREET
MERCER
VALLEY STREET
ALASKAN WAY
WESTERN AVENUE
ELLIOTT AVENUE
BROAD STREET
BELL STREET
BLANCHARD STREET
LENORA STREET
VIRGINIA ST
STEWART STREET
PINE STREET
PIKE STREET
PIKE PLACE
OLIVE WAY
WESTLAKE AVENUE
UNION STREET
UNIVERSITY STREET
SENECA STREET
SPRING STREET
MADISON STREET
MARION STREET
COLUMBIA STREET
CHERRY STREET
JAMES STREET
JEFFERSON STREET
YESLER WAY
S WASHINGTON STREET
S MAIN STREET
S JACKSON STREET
S KING STREET
OCCIDENTAL AVENUE S
FIRST AVENUE S
FOURTH AVENUE S
FIFTH AVENUE S
S ATLANTIC STREET/SR 519
S ROYAL BROUGHAM WAY
0
1,000
2,000
SCALE IN FEET

Exhibit 3-1

CHAPTER 3 - ALTERNATIVES DESCRIPTION

What is in Chapter 3?

This chapter describes the alternatives evaluated in this Final EIS. It includes a description of the No Build Alternative, and the build alternatives with and without tolls. It describes how the alternatives would be built and that the Bored Tunnel Alternative has been identified as the preferred alternative.

ALTERNATIVES

1 What alternatives are evaluated in this Final EIS?
This Final EIS analyzes the Bored Tunnel, Cut-and-Cover Tunnel, and Elevated Structure Alternatives. Each alternative is evaluated with and without tolls. In addition, the Viaduct Closed (No Build Alternative) is evaluated as required by National Environmental Protection Act (NEPA) regulations to provide baseline information about conditions in the project area if none of the build alternatives were selected for construction.

2 What is the Preferred Alternative?
The lead agencies identified the Bored Tunnel Alternative as the preferred alternative in the 2010 Supplemental Draft Environmental Impact Statement (EIS). The Tolled Bored Tunnel Alternative analyzed in this Final EIS is now identified as the preferred alternative. However, because Washington State Department of Transportation (WSDOT) would need authorization from the Washington State Legislature to implement tolling on the bored tunnel, a discussion of the Bored Tunnel Alternative without tolling is also included in this Final EIS.

3 What is the Viaduct Closed (No Build Alternative)?
The Viaduct Closed Alternative describes what would happen if none of the proposed alternatives were developed. By describing conditions without a project, the build alternatives can be compared to the Viaduct Closed Alternative to show the project's effects. In a typical NEPA document, the Viaduct Closed Alternative describes future conditions if none of the build alternatives were built by the design year (2030 for this project). For this project, however, WSDOT has decided that the viaduct must be closed if it is not replaced.

The project area is susceptible to earthquakes that could happen at any time. A small earthquake could make the existing viaduct unsafe, requiring immediate closure. A stronger earthquake could cause the structure to collapse, with potentially catastrophic effects. Even without an earthquake, the viaduct is gradually deteriorating from constant exposure to moist marine air, rain, and vibration from traffic. Multiple studies have found that retrofitting or rebuilding the existing viaduct is not a reasonable alternative.[1, 2, 3, 4] Because of the facility's continued deterioration, even without an earthquake, the roadway will need to be closed at some point in the future.

Although WSDOT cannot predict the exact year when it would be closed, engineers have determined through the studies referenced above that the existing viaduct would be closed well before 2030. Therefore, traffic projections for the existing structure in 2030 are not useful and are not used in this document.

Earthquakes are unpredictable, and the rate at which the structure is deteriorating is not constant. Therefore, for this Final EIS, the Viaduct Closed Alternative describes the consequences of suddenly losing State Route 99 (SR 99) along the central waterfront. These consequences would last until transportation and other agencies could implement a new, permanent solution and businesses and people could adapt. This condition would be comparable to when the viaduct was suddenly closed for days following the Nisqually earthquake in 2001. Congestion spread through the area and lasted throughout the day. These effects spread to other highways in the region as travelers tried to avoid I-5 and downtown Seattle.

The Viaduct Closed Alternative is evaluated using 2030 transportation conditions so that it can be compared to the build alternatives, each of which are analyzed using a 2030 horizon year. The 2030 Viaduct Closed Alternative assesses traffic conditions if the viaduct were closed between the First Avenue S. ramps and the Battery Street Tunnel.

While we can predict the short-term effects of suddenly closing the viaduct, the long-term effects are harder to predict. Our traffic projections for 2030 are based on adopted local and regional land use and transportation plans, which include SR 99. Simply closing SR 99 and expecting all other assumptions about future development patterns to remain unchanged creates a conservative scenario where transportation demand far exceeds the capacity of I-5 and streets through downtown Seattle.

Additional information on 2030 Viaduct Closed (No Build Alternative)

The *Transportation Discipline Report*, *Appendix C*, explains how the 2030 Viaduct Closed (No Build Alternative) was modeled and how transportation and land use could be affected. Traffic data for modeled conditions for the 2030 Viaduct Closed Alternative are provided for most of the traffic conditions that were measured, such as vehicle miles of travel, vehicle hours of delay, and traffic volumes. These measures allow for relative comparisons between the Viaduct Closed and build alternatives. However, traffic conditions without the viaduct would be extremely congested, resulting in variable and unstable conditions. Traffic models are not designed for extremely congested conditions; therefore, predictions of detailed congestion measures such as travel speeds, travel times, and delays are not appropriate.

In this chapter, information for the 2030 Viaduct Closed shows what would happen if the lead agencies did not replace the existing viaduct and it were closed with little or no warning. To understand what would happen if the viaduct is replaced, the effects were compared among the build alternatives to explain tradeoffs.

1 TY Lin, International 2005.

2 KPFF Consulting Engineers 2008.

3 American Society of Civil Engineers Review Committee 2006.

4 Parsons Brinckerhoff 2007.

Bored Tunnel South Portal

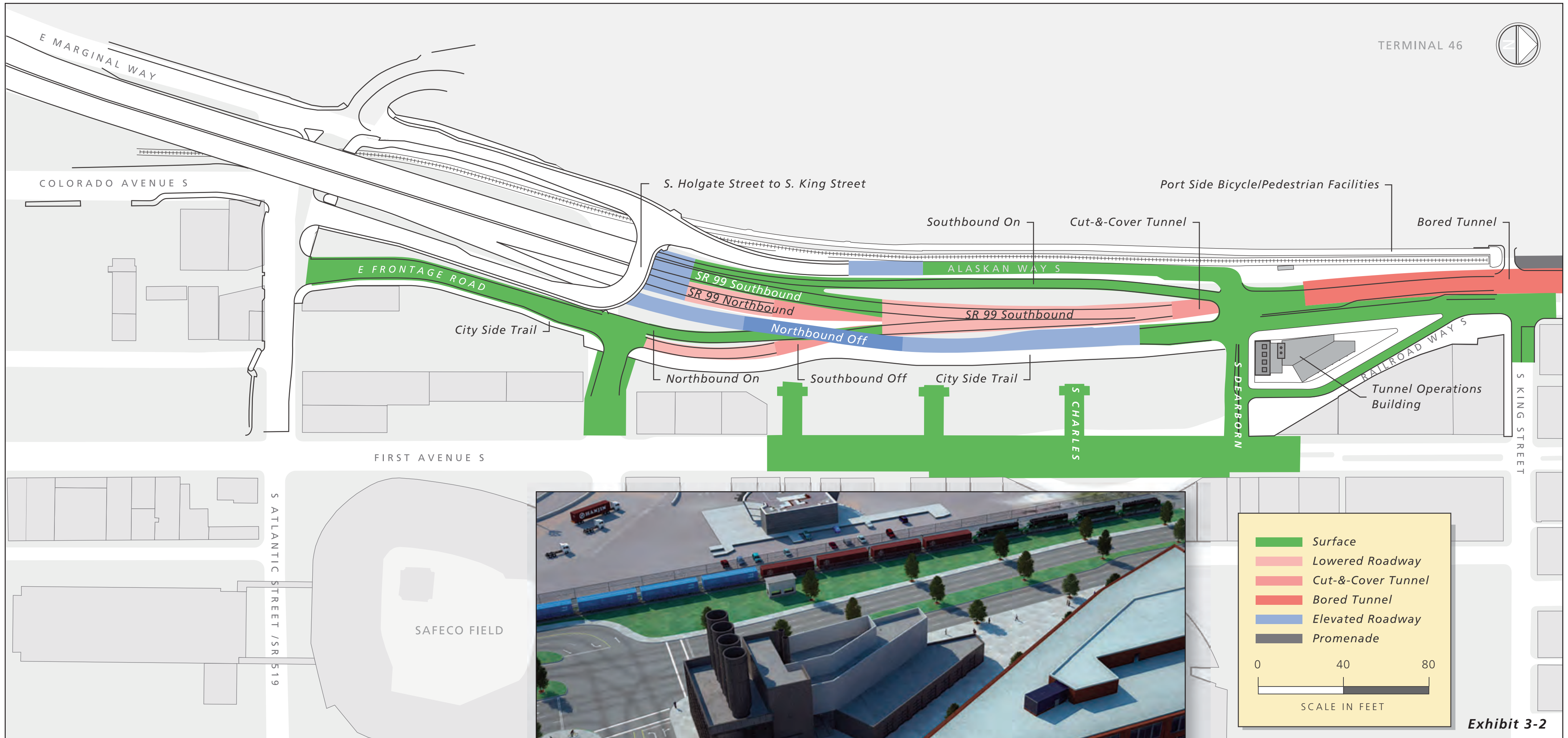


Exhibit 3-2

Tunnel Operations Building

What transportation improvements were assumed for the 2030 Viaduct Closed?

The transportation analysis conducted for the 2030 Viaduct Closed and build alternatives assumed that the following projects would be in place by 2030:

- S. Holgate Street to S. King Street Viaduct Replacement Project
- SR 519 Intermodal Access Project, Phase 2
- S. Spokane Street Viaduct Widening Project
- Mercer East Project from Dexter Avenue N. to I-5
- Third Avenue Transit Exclusivity
- Sound Transit Phase 1 and 2, including Sounder Commuter Rail, ST Express Bus, First Hill Streetcar, South Link, University Link, North Link, and East Link Light Rail
- Existing transit services and new services proposed in agencies' 6-year plans
- King County Transit Now

Appendix B, Alternatives Description and Construction Methods

Additional details about the alternatives and their construction methods are contained in *Appendix B*.

4 How would the Bored Tunnel Alternative replace SR 99 and the viaduct?

The Bored Tunnel Alternative would replace SR 99 between S. Royal Brougham Way and Roy Street as shown in Exhibit 3-1.

South Portal Area

Full northbound and southbound access to and from SR 99 would be provided in the south portal area between S. Royal Brougham Way and S. King Street. The northbound on-ramp to and southbound off-ramp from SR 99 would be reached from S. Royal Brougham Way at its intersection with the East Frontage Road, as shown in Exhibit 3-2. The southbound on-ramp to and northbound off-ramp from SR 99 would feed directly into a reconfigured Alaskan Way S. The northbound off-ramp would have a general-purpose lane and a peak hour transit-only lane to accommodate transit coming from the south and West Seattle.

The reconfigured Alaskan Way S. would have three lanes in each direction up to S. King Street. A new street, S. Dearborn Street, would be constructed from Railroad Way S. to Alaskan Way S., and would include a new signalized intersection at Alaskan Way S. This intersection would provide access to and from East Marginal Way S., which would run along the west side of SR 99. A tunnel operations building would be constructed in the block bounded by S. Dearborn Street, Railroad Way S., and Alaskan Way S.

Central Waterfront Area

Access to and from the bored tunnel would be provided via ramp connections at the south portal north of S. Royal Brougham Way and the north portal near Harrison and Republican Streets. Unlike the existing viaduct, ramps to and from Columbia and Seneca Streets and Elliott and Western Avenues would not be provided. This alternative would remove the viaduct along the Seattle waterfront and would decommission the Battery Street Tunnel after the bored tunnel is constructed.

The bored tunnel would have two lanes in each direction. Southbound lanes would be located on the top portion of the tunnel, and the northbound lanes would be located on the bottom. Travel lanes would be 11 feet wide, with a 2-foot-wide shoulder on one side and an 8-foot-wide shoulder on the other side. The 56-foot (outside diameter), single-bore tunnel being proposed for this project is at the technological limit for the industry. The stacked roadway configuration within this diameter has horizontal width limitations when combined with the necessary two lanes, vertical clearance, emergency access points, tunnel systems and traffic barriers. Any additional horizontal and/or vertical clearance requirements would likely have a direct impact on the tunnel bore's diameter, exceeding current tunneling technology and acceptable levels of risk. All deviations proposed to date for this project have been approved by WSDOT and the Federal Highway Administration (FHWA) and any future deviations proposed as final design proceeds will be reviewed in detail by these agencies prior to approval with the goal of assuring that the roadway is built to be the safest facility possible.

The bored tunnel will be constantly ventilated and lit. Radio and cell phone signals will be retransmitted to provide uninterrupted service.

Bored Tunnel North Portal

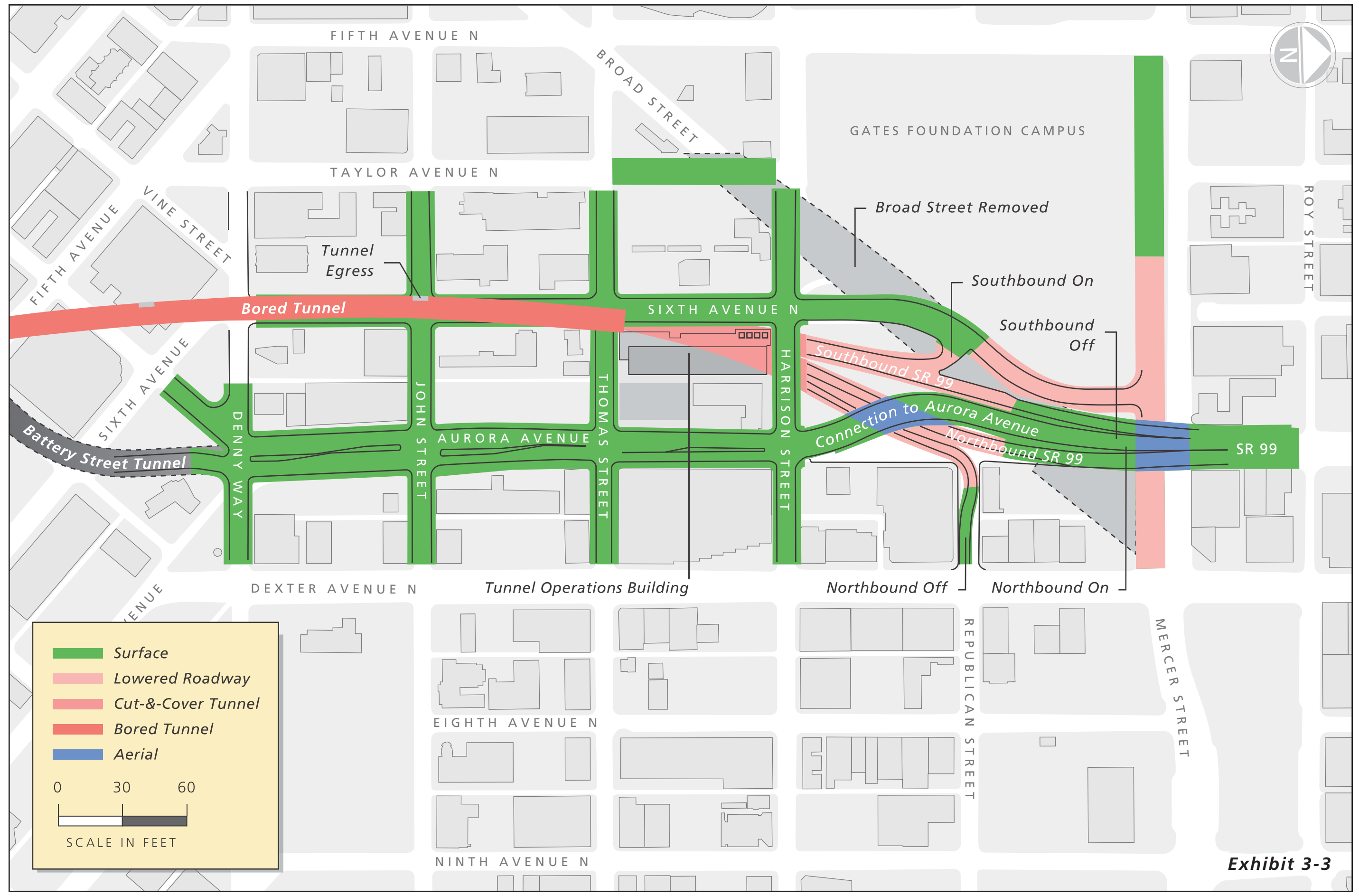


Exhibit 3-3

The bored tunnel would be designed to provide emergency access, evacuation routes, ventilation, and fire suppression systems in accordance with National Fire Protection Association (NFPA) standards and other codes and regulations. Conditions in the tunnel will be monitored constantly by television and traffic sensors. Emergency tunnel exits would be provided throughout the tunnel. In an emergency, travelers would move along the shoulders to reach a doorway into a secure waiting area, called a refuge area. The refuge areas will be located behind 2-hour-rated fire doors, and they would be equipped with sprinklers and separate ventilation and air supply from the roadway tunnel area. The refuge areas would be negatively pressurized to prevent air from the roadway tunnel area from entering the refuge area when the fire door is open. Staircases inside the refuge area would provide access to a walkway that would run the length of the tunnel and would be located between the roadway levels. Signs would point travelers to the nearest exit, where they would either wait for assistance or walk out of the tunnel. Refuge areas would contain emergency telephones. People who are unable to use the stairs to exit the tunnel could wait in the enclosed, protected refuge areas for assisted rescue. Refuge areas will be designed to meet Americans with Disabilities Act (ADA) requirements. The design will meet NFPA 502 standards for road tunnels, and as such meets the key ADA accessibility guidelines for emergency egress.

North Portal Area

Full northbound and southbound access to and from SR 99 would be provided near Harrison and Republican

What are design deviations?

Designers and engineers are faced with many complex tradeoffs when designing highways and streets. A good design balances cost, safety, mobility, social and environmental impacts, and the needs of a wide variety of roadway users. Highway design standards established through years of practice and research form the basis by which roadway designers achieve this balance. Designers are trained to use accepted design standards throughout the project development process. It must be recognized, however, that to achieve the balance described above, it is not always possible to meet design standards. Designers encounter a wide variety of site-specific conditions and constraints. For many situations, there is sufficient flexibility within the design standards to achieve a balanced design and still meet minimum values. However, when this is not possible, a design deviation may be considered.

Streets, as shown in Exhibit 3-3. The existing on- and off-ramps provided at Denny Way would be closed. New ramps at Republican Street would provide northbound access from SR 99 and southbound access to SR 99. 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. at Republican Street on the west side of SR 99. Access to SR 99 would continue to be available at Roy Street as it is today.

Surface streets would be rebuilt and improved in the north portal area. Aurora Avenue would be built to grade level between Denny Way and Harrison Street. John, Thomas, and Harrison Streets would be connected as cross streets with signalized intersections on Aurora Avenue at Denny Way and John, Thomas, and Harrison Streets. The rebuilt section of Aurora Avenue would connect to SR 99 via the ramps at Harrison Street. The roadway would have two general-purpose lanes in each direction, turn pockets, and right-side transit lanes.

Mercer Street would become a two-way street and would be widened from Dexter Avenue N. to Fifth Avenue N. The rebuilt Mercer Street would have three lanes in each direction with left-hand turn pockets. Broad Street would be filled and closed between Ninth Avenue N. and Taylor Avenue N. A tunnel operations building would be constructed between Thomas and Harrison Streets on the east side of Sixth Avenue N.

A new roadway would be built to extend Sixth Avenue N. in a curved formation between Harrison and Mercer Streets, as shown in Exhibit 3-3. The new roadway would have a signalized intersection at the southbound on-ramp.

How would tolls be applied to the Bored Tunnel Alternative?

WSDOT needs authorization from the Washington State Legislature to impose tolls on the bored tunnel. If the legislature grants this authority, WSDOT, Seattle Department of Transportation (SDOT), and other agencies will work to optimize the bored tunnel's toll configuration in order to minimize diversion to city streets while maintaining efficient traffic flow on SR 99 and generating revenue. This optimization process will include recommendations for toll rates, but the final determination of toll rates would be made by the State Transportation Commission. For the sake of analysis, this Final EIS assumes the toll rates shown on Exhibit 3-4, which would be highest during periods of high travel demand (peak commute hours) and lowest during evening and nighttime hours. Because northbound travel demand is typically higher in the morning and southbound in the evening, toll rates would be set correspondingly.

Exhibit 3-4
Assumed Toll Rates by Time of Day

Time of Day	Northbound	Southbound
Morning Commute	$4.00	$3.00
Mid-day	$2.25	$2.25
Evening Commute	$4.00	$5.00
Evening	$1.25	$1.25
Nighttime	$1.00	$1.00

Note: Toll rates are for 2015 based on toll scenario C, which was developed by WSDOT to test revenue generation. Final toll rates would be set by the Washington Transportation Commission.

Tolls would be charged to drivers entering the bored tunnel from either direction. However, tolls would not be charged to drivers using SR 99 to access downtown from the south via the new ramps at Alaskan Way S. or from the north via the new ramps at Harrison Street.

5 How would the Cut-and-Cover Tunnel Alternative replace SR 99 and the viaduct?

The Cut-and-Cover Tunnel Alternative would replace SR 99 from S. Royal Brougham Way to Aloha Street, as shown in Exhibit 3-5.

South Portal Area

In the south portal area, the cut-and-cover tunnel lane configurations and access points are nearly identical to the bored tunnel. Like the Bored Tunnel Alternative, full northbound and southbound access to and from SR 99 would be provided in the south portal area between S. Royal Brougham Way and S. King Street.

Like the Bored Tunnel Alternative, the southbound on-ramp to and northbound off-ramp from SR 99 would feed directly into a reconfigured Alaskan Way S. The northbound off-ramp would have a general-purpose lane and a peak hour transit-only lane to accommodate transit coming from the south and West Seattle. The reconfigured Alaskan Way S. would have three lanes in each direction up to S. King Street. A new street, S. Dearborn Street, would be constructed from Railroad Way S. to Alaskan Way S., which would include a new signalized intersection at Alaskan Way S. This intersection would provide access to and from East Marginal Way S., which would run along the west side of SR 99. A tunnel operations building would be constructed in the block bounded by S. Dearborn Street, Railroad Way S., and Alaskan Way S.

Central Waterfront Area

The Cut-and-Cover Tunnel Alternative would replace SR 99 with a six-lane cut-and-cover tunnel (three lanes in each direction) from approximately Railroad Way S. to Pine Street. The outer wall of the tunnel would serve as the new seawall from S. Washington Street to Union Street. A tunnel operations building would be constructed in the block bounded by Pine Street, SR 99, and the Alaskan Way surface street. Between Pine Street and Virginia Street, a new aerial structure would be built, and SR 99 would connect to the Battery Street Tunnel by traveling under Elliott and Western Avenues, where the existing Elliott Avenue on-ramp and Western Avenue off-ramp would be replaced. Because SR 99 would cross under Elliott and Western Avenues, Bell Street could be connected across Western Avenue.

Above the aerial structure from Pine to Virginia Streets, a lid would provide new open space and a pedestrian linkage between Victor Steinbrueck Park and Pike Place Market to the waterfront.

Alaskan Way would be replaced east of the existing roadway with at least two lanes in each direction and two waterfront streetcar tracks running in the center travel lanes. The center lane would have alternating turn pockets

Comparing Features of the Build Alternatives

Unlike the Cut-and-Cover Tunnel and Elevated Structure Alternatives, the Bored Tunnel Alternative does not require construction along Seattle's central waterfront, because the bored tunnel alignment runs inland between Yesler Way and the north portal. Consequently, several components included in the Cut-and-Cover Tunnel and Elevated Structure Alternatives are not included in the Bored Tunnel Alternative, most notably seawall replacement, the new Alaskan Way surface street, the waterfront streetcar replacement, and the roadway connection between the waterfront and Elliott and Western Avenues. These projects and others are referred to as "Program Elements" for the Bored Tunnel Alternative and are discussed in Chapter 2 of this *Final EIS*.

Cut-&-Cover Tunnel Alternative

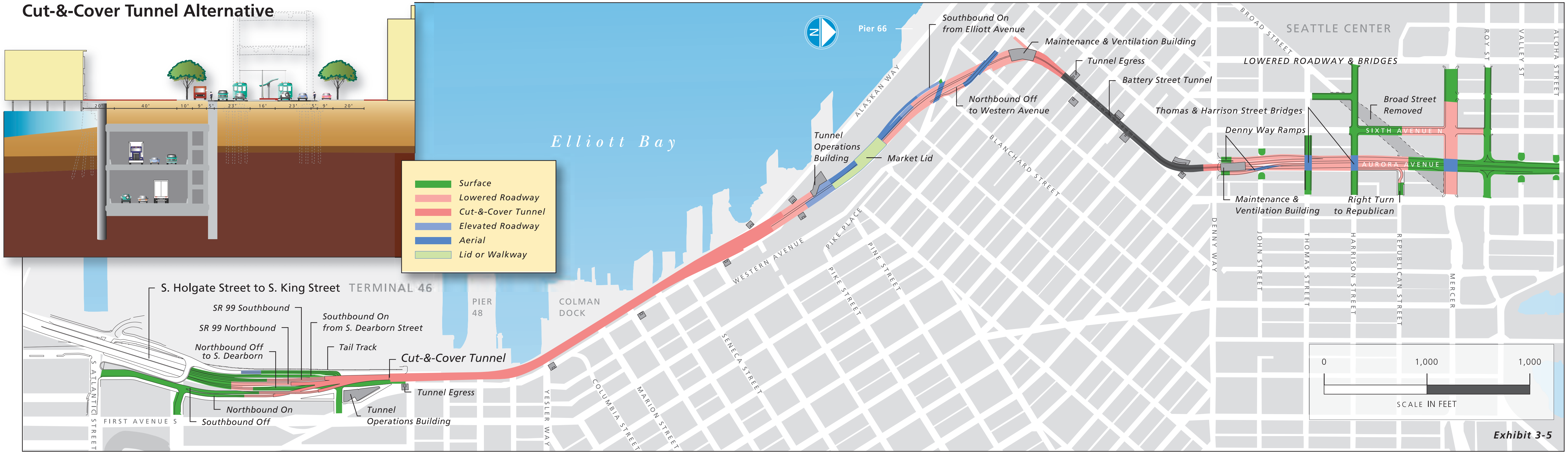


Exhibit 3-5

and streetcar stops. Between Railroad Way S. and Yesler Way, Alaskan Way would have three lanes in each direction. Alaskan Way would be lined with expanded open space, a wide waterfront promenade, broad sidewalks on both sides of the surface street, bicycle lanes, and parking including ADA-compliant spaces. Between Union Street and Broad Street the existing seawall would be replaced.

Like the Bored Tunnel Alternative, ramps to and from Columbia and Seneca Streets would not be provided. Unlike the Bored Tunnel Alternative, ramps to and from Elliott and Western Avenues would be provided. The existing pedestrian bridge at Marion Street from First Avenue to Colman Dock would be removed and replaced with a new ADA-compliant structure.

With the Cut-and-Cover Tunnel Alternative, the Battery Street Tunnel would be retrofitted for improved seismic safety. The existing tunnel safety systems and facilities would be updated with a fire suppression system, ventilation, and new emergency egress structures near Second, Third, Fourth, and Sixth Avenues. The south portal of the Battery Street Tunnel would be widened to accommodate the connection from the new SR 99 roadway. Tunnel maintenance and ventilation buildings would be built at each end of the Battery Street Tunnel to house ventilation, electrical, mechanical, and communications systems.

North of the Battery Street Tunnel

North of the Battery Street Tunnel, SR 99 would be improved and widened up to Aloha Street, as shown in Exhibit 3-6. Access on to SR 99 would be provided at Denny Way and Roy Street, and access off of SR 99 would be provided at Denny Way, Republican Street, and Roy Street. Two new bridges would be built on Thomas and Harrison Streets, spanning SR 99. Broad Street would be closed between Fifth and Ninth Avenues N., allowing the street grid to be connected. Sixth Avenue would be extended between Harrison and Mercer Streets. Mercer Street would continue to cross under SR 99 as it does today, but it would be widened and converted into a two-way street with three lanes in each direction and a center turn lane.

How would tolls be applied to the Cut-and-Cover Tunnel Alternative?

Like the Bored Tunnel Alternative, WSDOT needs authorization from the Washington State Legislature to impose tolls on the Cut-and-Cover Tunnel Alternative, and the specific configuration of these tolls would be determined through coordination between the city, state, and other parties. For analysis, this Final EIS assumes that the same rates described for the Bored Tunnel Alternative would apply to the Cut-and-Cover Tunnel Alternative (see Exhibit 3-4).

Similar to the bored tunnel, tolls would be charged to drivers entering the cut-and-cover tunnel from either direction. However, tolls would not be charged to drivers

Cut-&-Cover Tunnel North Area

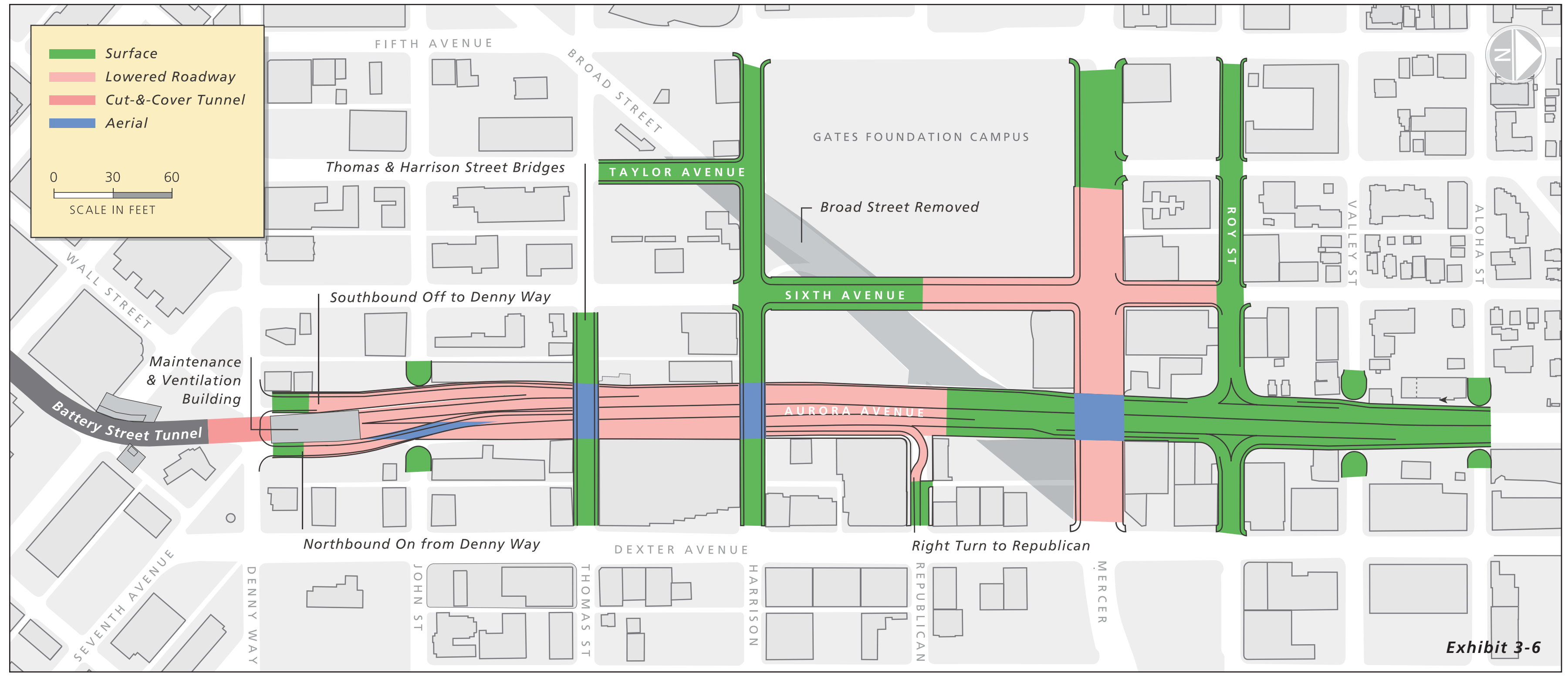


Exhibit 3-6

using SR 99 to access downtown from the south via the new ramps to Alaskan Way S. or from the north via the existing ramps at Denny Way.

6 How would the Elevated Structure Alternative replace SR 99 and the viaduct?

The Elevated Structure Alternative would replace SR 99 from S. Royal Brougham Way to Aloha Street, as shown in Exhibit 3-7.

South Area

In the south area, the Elevated Structure Alternative's lane configurations and access points are nearly identical to the Bored Tunnel and Cut-and-Cover Tunnel Alternative. Like the other build alternatives, full northbound and southbound access to and from SR 99 would be provided in the south area between S. Royal Brougham Way and S. King Street.

Like the other build alternatives, the southbound on-ramp to and northbound off-ramp from SR 99 would feed directly into a reconfigured Alaskan Way S. The northbound off-ramp would have a general-purpose lane and a peak hour transit-only lane to accommodate transit coming from the south or West Seattle. The reconfigured Alaskan Way S. would have three lanes in each direction up to S. King Street. A new street, S. Dearborn Street, would be constructed from Railroad Way S. to Alaskan Way S., which would include a new signalized intersection at Alaskan Way S. This intersection would provide access to and from East Marginal Way S., which would run along the west side of SR 99.

Central Waterfront Area

The Elevated Structure Alternative would be eight lanes wide from S. King Street to S. Main Street where it would transition to a stacked aerial structure. For the most part, the new aerial structure would have three lanes in each direction, and it would have wider lanes and shoulders than the existing viaduct. Between S. King Street and the ramps at Columbia and Seneca Streets, SR 99 would have four lanes in each direction. The existing ramps at Columbia and Seneca Streets would be rebuilt. The SR 99 structure would pass over Elliott and Western Avenues between Pine Street and the Battery Street Tunnel. The ramps to Elliott and Western Avenues would be rebuilt similar to the existing ramps.

The Alaskan Way surface street would be replaced with at least two lanes in each direction. Northbound lanes would travel under the new viaduct, and southbound lanes would travel west of the new viaduct. The waterfront streetcar would be replaced with two streetcar tracks that would share a travel lane with vehicles. Alaskan Way would be lined with bicycle lanes, sidewalks on both sides, and parking including ADA-compliant spaces. Between Railroad Way S. and Yesler Way, Alaskan Way would have three lanes in each direction.

The existing pedestrian bridge at Marion Street from First Avenue to Colman Dock would be removed and replaced with a new ADA-compliant structure.

As with the Cut-and-Cover Tunnel Alternative, the Elevated Structure Alternative would retrofit the Battery Street Tunnel for improved seismic safety, upgrade tunnel safety systems and facilities, and install new emergency egress structures near Second, Third, Fourth, and Sixth Avenues. The south portal of the Battery Street Tunnel would be widened to accommodate the connection from the new SR 99 roadway. Tunnel maintenance and ventilation buildings would be built at each end of the Battery Street Tunnel to house ventilation, electrical, mechanical, and communications systems.

The seawall would be replaced from about S. Washington Street up to Broad Street.

North of the Battery Street Tunnel

Improvements from the Battery Street Tunnel north would be the same as what was described for the Cut-and-Cover Tunnel Alternative.

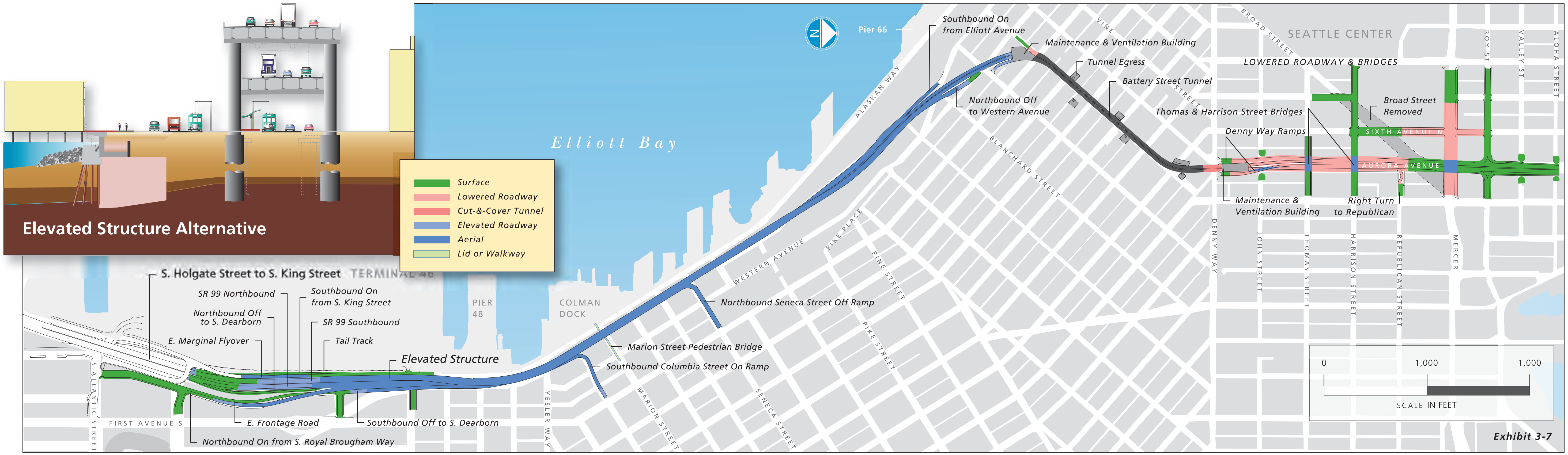


Exhibit 3-7

How would tolls be applied to the Elevated Structure Alternative?
Like other build alternatives, WSDOT needs authorization from the Washington State Legislature to impose tolls on the elevated structure and the specific configuration of these tolls would be determined through coordination between the city, state, and other parties. For analysis, this Final EIS assumes that the same rates described for the Bored Tunnel Alternative would apply to the Elevated Structure Alternative (see Exhibit 3-4).

Tolls would be charged to drivers using the new elevated structure for trips through the city, including drivers using the Elliott Avenue on-ramp and Western Avenue off-ramp. Similar to the other build alternatives, tolls would not be charged to drivers using SR 99 to access downtown from the south via the new ramps to Alaskan Way S., Columbia Street, and Seneca Street or from the north via the existing ramps at Denny Way.

CONSTRUCTION

7 What must happen before construction can begin?

Construction cannot begin until a Record of Decision (ROD) is issued selecting a build alternative and required permits are obtained. The FHWA will sign the ROD no earlier than 30 days after this Final EIS is published. As the project progresses after the ROD, the lead agencies will work to obtain permits, finish right-of-way acquisitions, and procure needed equipment.

8 What construction shifts are proposed?

Construction for all activities could occur up to 24 hours per day, 7 days per week. Proposed construction shifts are likely to vary depending on the location and type of construction activity.

For the preferred Bored Tunnel Alternative, tunnel boring and work at the Washington-Oregon Shippers Cooperative Association (WOSCA) staging area in the south portal area would likely occur in three shifts per day, 6 days a week. Tunnel boring machine (TBM) maintenance activities would be performed 1 day a week when tunnel boring is not occurring. In the north portal area, construction would likely occur 6 days a week with two shifts per day. Viaduct demolition is expected to occur 5 or 6 days a week with two shifts a day. The difference in the number of shifts proposed is due to the varying construction activities.

For the Cut-and-Cover Tunnel Alternative, construction durations assume two 8-hour shifts per day. Construction would occur 5 days a week in the south portal area and 6 days a week along the central waterfront. However, work could occur up to 24 hours per day, 7 days per week if necessary. North of the Battery Street Tunnel, construction would likely occur 6 days a week with two shifts a day. Viaduct demolition is expected to occur 5 or 6 days a week with two shifts a day when SR 99 and Alaskan Way are closed to all traffic.

For the Elevated Structure Alternative, construction would likely occur 6 days a week with two shifts a day. Demolition of the upper level of the viaduct is expected to occur 5 or 6 days a week with two shifts a day when SR 99 is closed to all traffic. The lower level of the viaduct would be demolished after the new upper level is constructed.

9 Where would construction staging occur?
Space for potential on-site construction staging is limited, so some staging areas are proposed outside of the immediate project area. Construction staging areas for the proposed build alternatives are shown on Exhibit 3-8 and described below:

- **Terminal 106 –** This site may be used as a construction staging, materials fabrication, and laydown area. Materials would be fabricated more than 200 feet from the shoreline.

- **Terminal 25 –** This site may be used for contractor parking, construction staging, materials fabrication and concrete debris processing, which would occur more than 200 feet from the shoreline.

- **WOSCA Property –** This property would be used as the primary staging site in the south project area for all alternatives. The WOSCA property is located west of First Avenue S. and extends from S. Royal Brougham Way to Railroad Way S. Part of the site would be used for a traffic detour and for construction offices. The site may be used for a concrete batch plant, if needed. The Elevated Structure Alternative may fabricate materials on this site. The Bored Tunnel and Cut-and-Cover Tunnel Alternatives would use this site for supporting tunnel construction. For the Bored Tunnel Alternative, this site would be used to assemble and launch the TBM, hold and transport spoils, serve as a launch site for installing interior tunnel structures, and house a temporary electrical substation to support the TBM.

- **Pier 48 –** This property is located along Alaskan Way S. between S. Jackson and S. Washington Streets and is owned by the State of Washington. The property may be used for contractor parking and staging activities, such as material laydown.

- **Terminal 46 and Pier 46 –** The northwest corner of Terminal 46 would be used as a primary staging area for materials laydown and storage. Pier 46, at the northern edge of Terminal 46, may be used to accommodate excavated materials that would be transported by barge for off-site disposal. The site may be modified to include conveyor and hoppers to transfer materials to a barge. No in-water work would be required. Container activity on the rest of Terminal 46 would not be affected.

- **Interstate 90 (I-90) high-occupancy vehicle (HOV) Ramp Site –** This site is under the HOV ramps between the E-3 Busway and Sixth Avenue would be used primarily for storage.

- **Alaskan Way S., S. King to S. Jackson Street Site –** This site would be used as a construction work area.

- **Railroad Way S. Right-of-Way –** During much of the construction period, the right-of-way along Railroad Way S. under the First Avenue S. ramps would be used to accommodate construction activities in the south project area. During the last year of construction, the area would be used to demolish the existing ramps.

- **Alaskan Way S., S. Royal Brougham Way to S. King Street –** This construction staging and work area would eventually become the location of the new permanent ramps and SR 99 facility.

- **First Avenue S. Bridge Site –** This site would be used primarily for storage.

- **Fischer Site (Fourth Avenue S., formerly an SR 519 project staging site) –** This site would be used

primarily for storage but could also be used for fabricating materials.

- **I-90 Ramp Site –** This site would be used primarily for storage.

- **Broad Street Right-of-Way –** Once Broad Street is closed, this area may be used for construction staging and storage.

- **City of Seattle Right-of-Way North of King Street –** Portions of the right-of-way along the Alaskan Way S. and the existing viaduct would be used for various construction activities such as secant pile wall construction, soil improvements, and viaduct demolition.

- **BNSF/Lenora Street Construction Zone –** This strip of right-of-way between approximately Pine Street and Bell Street, would be used for materials storage, viaduct demolition, and resurfacing Alaskan Way.

- **Battery Street Staging Areas –** The Seattle City Light parking lot just south of the Battery Street Tunnel and two other small parking lots on Battery Street would be used for construction staging for the Battery Street Tunnel or for materials storage.

- **North End Construction Staging Area –** This area would be used for construction staging, and closing and backfilling of Broad Street. For the Bored Tunnel Alternative, the TBM would be retrieved in this area.

- **North End Staging Area for Mercer improvements –** This site would be used for materials storage and construction office space.

Except for Terminal 106, Terminal 25, Terminal 46, and Pier 46, which are owned by the Port of Seattle, all of the potential staging areas are already owned by WSDOT, have been acquired in advance from willing sellers, or are other public rights-of-way. WSDOT and the Port of Seattle are in the process of developing agreements for the potential use of the Port of Seattle properties.

10 What construction haul routes are proposed?

During construction, City-designated truck routes would be used for transporting construction materials, oversized equipment, and spoils into and out of the construction zones for each of the build alternatives.

In the south project area, the primary construction access to the WOSCA site would be from S. Atlantic Street. Construction vehicles would enter the work area using a temporary construction road that would cross the southbound off-ramp of SR 99 north of Royal Brougham Way S. A temporary traffic signal would be installed at this intersection. Trucks leaving the construction area would merge with traffic on the southbound off-ramp from SR 99 and turn eastbound on S. Atlantic Street. Trucks accessing the WOSCA or T-46/Pier 46 construction staging areas could also use Edgar Martinez Drive S. (the eastern extension of S. Atlantic Street) to access I-5 and I-90. To maintain traffic operations on the temporary SR 99 off-ramp and along the S. Atlantic Street corridor between East Marginal Way S. and I-90, the number of construction trucks entering and exiting the WOSCA staging area would be restricted during weekday peak hours and stadium events. Trucks with over-legal loads could use First Avenue S. to Railroad Way S. to Alaskan Way S.

For the Bored Tunnel Alternative, spoils from tunnel boring would be transported using a conveyor system and hoppers to Terminal 46 and Pier 46 to be loaded on barges and transported to Mats Mats Quarry near Port Ludlow, Washington. Spoils excavated from other areas of the Bored Tunnel Alternative and for the Cut-and-Cover Tunnel or Elevated Structure Alternatives may be transported by trucks to Terminal 46 and Pier 46 to be loaded on barges or hauled on designated truck routes to locations south of the project area. Proposed southbound truck travel routes would be located on Alaskan Way, East and West Marginal Way S., and in some cases, west across the West Seattle Bridge to West Marginal Way SW.

In the north, potential haul routes being considered for each of the alternatives are:

- I-5 to Fairview Avenue N. to Denny Way to Sixth Avenue N. to the north end construction staging area

- I-5 to Mercer Street to the construction staging area

Until Broad Street is closed, another potential haul route from the north area would be to use Broad Street to Alaskan Way, and then south to Terminal 46. SR 99 could also be used as a potential haul route to and from locations north of the north end construction staging area.

11 What construction equipment and activities are common to the alternatives?

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

Types of equipment that crews would use during construction include, but are not limited to cranes, bulldozers, loaders, excavators, extended-arm trackhoes with concrete-pulverizing attachment (concrete munchers), dump trucks, forklifts, grading and paving equipment, drilling rigs, generators, and welding equipment.

For viaduct demolition activities, crews would most likely use crunching/shearing attachments, concrete saws, concrete splitters, and cutting torches. For soil improvements, work crews would need specialty equipment such as drilling rigs for tunnel wall work, drilling rigs with mixing augers, and slurry processing equipment.

Construction for the Bored Tunnel Alternative would require an earth pressure balance TBM, as well as hoppers, conveyor belts, and barges to transport tunnel spoils.

Appendix C, Transportation Discipline Report

Appendix C, Chapter 4 includes a map of City of Seattle designated major truck routes. A number of streets could be used. The potential haul routes will be further defined by the contractor during final design.

Barges may also be used to transport materials for either the Cut-and-Cover Tunnel or Elevated Structure Alternatives. The Cut-and-Cover Tunnel and Elevated Structure Alternatives would also need special equipment for dewatering processes, such as settlement and pretreatment storage tanks.

The following activities would take place for each of the alternatives:

- Relocate utilities
- Improve soils
- Remove existing viaduct

Relocate Utilities
Utilities in the project area include electric power, communication, water, sanitary, storm sewers, steam, and SDOT's traffic signal system. All underground utility relocations involve similar construction activities. Construction activities associated with underground utility relocations include pavement demolition, excavation, repaving, ground support systems, and groundwater control.

All utilities would be reviewed and approved on a case-by-case basis before they are relocated. In the south project area, major utility relocations will have taken place as part of the separate S. Holgate Street to S. King Street Viaduct Replacement Project, prior to construction for this project.

Utilities attached to the viaduct would be relocated before the viaduct is demolished. These utilities would be relocated underground, which would require excavation under the existing viaduct.

For the Bored Tunnel Alternative, construction of both the south and north portals would require excavation. Utilities within the footprint of both the retained cut and the cut-and-cover sections would need to be relocated, replaced, or protected.

For the Cut-and-Cover Tunnel Alternative, utilities would need to be relocated, replaced, or protected along the tunnel alignment, depending on the depth of the tunnel. Other relocations may occur during the initial stages of construction, and again in the final stage before the surface streets are restored.

For the Elevated Structure Alternative, utilities that do not conflict with the construction of the elevated structure or seawall replacement will remain in operation and be protected in place. The only utilities that would be located on the elevated structure would be those utility services needed for the operational roadway.

Improve Soils
In the south project area, most of the existing soils are soft fill material that could liquefy in an earthquake. Each of the alternatives would need soil improvements in the south project area under proposed aerial structures and retained fills to adequately support them. Soil improvements and stabilizing measures could use the following methods:

- **Compaction grouting –** This is a process that injects grout into soil to form a grouted "bulb" that displaces and consolidates the soil.
- **Compensation grouting –** This is a type of grouting that would use a controlled grout injection process that distributes grout into the ground from either drilled access shafts near the buildings or from the ground surface through small-diameter injection pipes. The pipes could be installed along the perimeter of the buildings and angled to reach the target areas under buildings, filling voids in the soil as shown in Exhibit 3-9.
- **Jet Grouting –** This is a process by which cement grout is injected into weak soils and then mixed to strengthen and stabilize the soil.
- **Ground freezing –** This is a process by which heat is extracted from a water-saturated soil mass, temporarily converting the water to ice, resulting in a consolidated soil mass as long as it remains frozen.
- **Underpinning –** This is a stabilizing measure that involves a building foundation support system to temporarily support vulnerable structures during construction.

For the Bored Tunnel and Cut-and-Cover Tunnel Alternatives, soil improvements and stabilizing measures are needed near the south portal to protect other existing structures and utilities from settlement. Compensation grouting is likely the soil improvement method that would be used in this area. Compensation grouting would also likely be used along the bored tunnel alignment to

Compensation Grouting

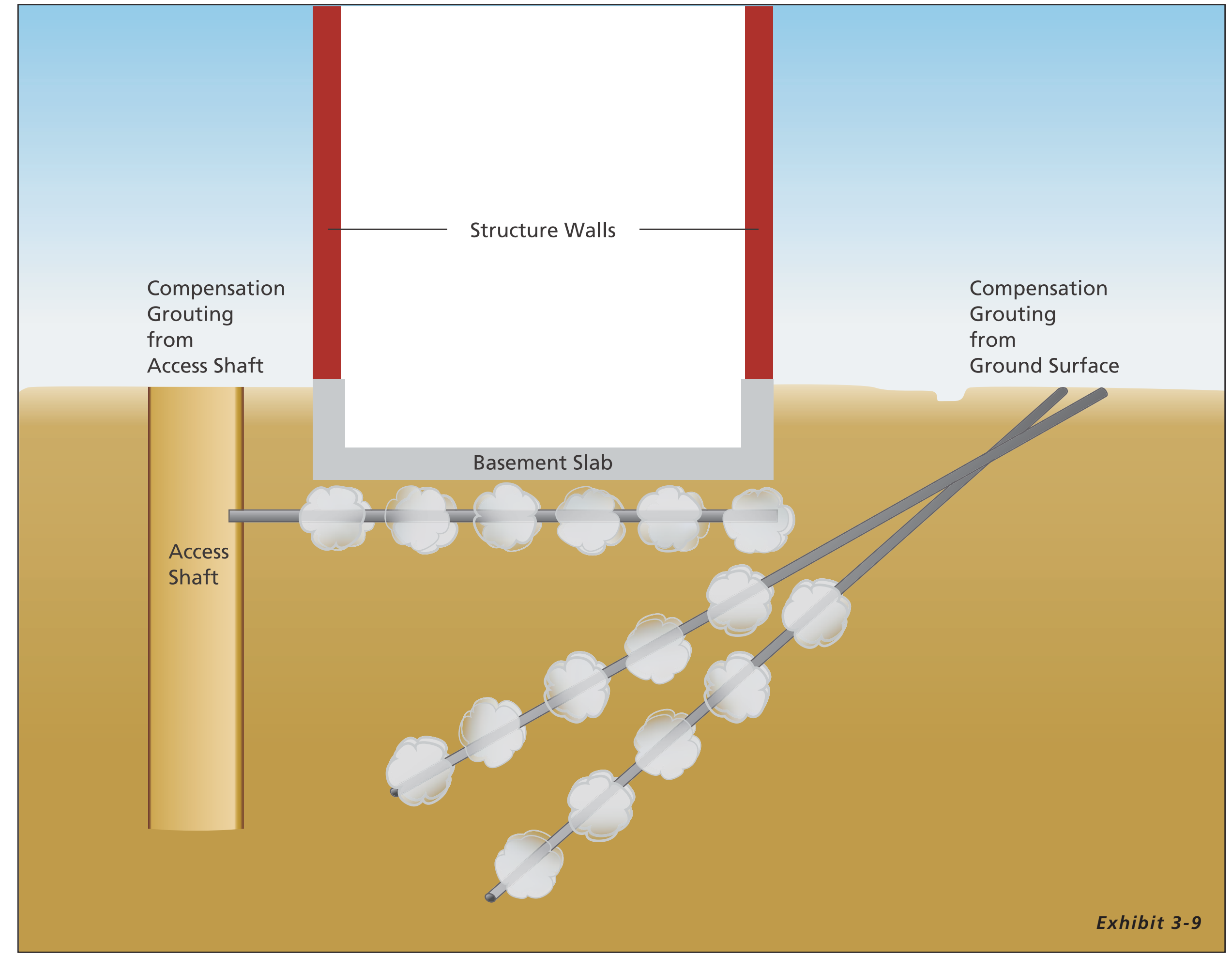


Exhibit 3-9

Appendix K, Public Services and Utilities Discipline Report

Appendix K provides greater detail regarding utility relocations and the construction effects on utilities.

What is grout?

Grout is a cement-like mixture used for filling spaces.

stabilize soft soils around the tunnel and mitigate potential ground loss.

Remove Existing Viaduct
All of the build alternatives would remove the existing viaduct from just south of S. King Street to the Battery Street Tunnel. Viaduct demolition would generate approximately 107,000 cubic yards of material, primarily broken concrete and reinforcing steel that would need to be hauled away and disposed of. Material would be hauled away in trucks, railcars, or barges to a predetermined disposal site. With the Bored Tunnel Alternative, some of the concrete may be used to fill the Battery Street Tunnel.

For the Bored Tunnel Alternative, demolition of the viaduct is anticipated to begin in January 2016 when the bored tunnel opens to traffic. Demolition would take approximately 9 months with two construction teams working at the same time in different locations. The construction teams would work on demolishing segments two blocks at a time, with each segment taking no more than 4 weeks.

For the Cut-and Cover-Tunnel Alternative, viaduct demolition would occur when the SR 99 corridor is closed to all traffic. The viaduct is anticipated to be torn down beginning in January 2016 and take about 6 months.

For the Elevated Structure Alternative, demolition of the viaduct between Pike Street and the Battery Street Tunnel would occur during a 6-month period beginning in late 2014. Traffic would be routed onto the Broad Street detour through this area. Demolition of the upper level of the viaduct between S. King Street and Pike Street would take approximately 3 months in early 2017 when SR 99 is closed to all traffic. Approximately 2 years later, when the new upper level is complete, the lower level of the viaduct would be demolished during about a 6-month period.

12 How would construction of the S. Holgate Street to S. King Street Viaduct Replacement Project relate to this project?

The section of the S. Holgate Street to S. King Street Viaduct Replacement Project from approximately S. Royal Brougham Way to S. King Street is within the same geographic area as this project (Alaskan Way Viaduct Replacement Project). This transition section would be constructed either as part of the S. Holgate Street to S. King Street project, or as part of this project. The two potential scenarios are:

1 If a ROD is issued for this project by late summer 2011 as planned, then the transition section would be constructed as part of this project. This project would then be responsible for connecting SR 99 from approximately S. Royal Brougham Way to the south portal of the Bored Tunnel or Cut-and-Cover Tunnel Alternatives, or to the new aerial facility with the Elevated Structure Alternative.

2 If no decision is made on this project, or if the Viaduct Closed Alternative is selected for this project, then the transition section would be constructed as part of the S. Holgate Street to S. King Street Viaduct Replacement Project. Under this scenario, the transition section would be built to connect to the existing viaduct structure near S. King Street.

Construction in the transition section could occur for both the S. Holgate Street to S. King Street Viaduct Replacement Project and this project from fall 2011 through early 2014. If no decision is made on how to replace the viaduct along the central waterfront, the S. Holgate Street to S. King Street Viaduct Replacement Project would be built to reconnect to the existing viaduct structure near S. King Street with the new ramps to Alaskan Way. However, a ROD on replacing the central waterfront portion of the viaduct is expected in late summer 2011. The Alaskan Way Viaduct Replacement Project would then be responsible for connecting SR 99 from about S. Royal Brougham Way to the south portal of the Bored Tunnel or Cut-and-Cover Tunnel Alternatives, or to the new aerial facility with the Elevated Structure Alternative.

The S. Holgate Street to S. King Street Viaduct Replacement Project is constructing the WOSCA detour. Southbound traffic on the SR 99 mainline will begin to use the WOSCA detour beginning about December 2011, and northbound traffic will begin using the detour beginning about May 2012. This project will also remove the viaduct structure from S. Holgate Street up to about S. King Street in mid-2012.

The WOSCA detour would continue to be used for construction of the Bored Tunnel, Cut-and Cover Tunnel, or Elevated Structure Alternatives.

13 How would the Bored Tunnel Alternative be constructed?

Bored Tunnel Alternative construction activities would begin around August 2011 and would last for 5.4 years (65 months). Construction activities are described in eight stages. Expected activities, sequencing, and durations are shown on Exhibit 3-10. These activities, sequences, and durations may change as the design is finalized with the contractor. SR 99 would remain open to traffic throughout the majority of the construction period. Lane closures would be required on some city streets throughout construction. The Bored Tunnel Alternative would completely close SR 99 only for a few weeks to connect SR 99 to the new bored tunnel.

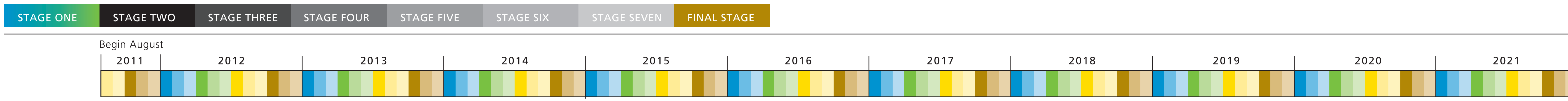
The Bored Tunnel Alternative would relocate utilities, improve soils, and remove the existing viaduct, which are construction activities common to all alternatives identified in Question 11 of this chapter.

South Portal Construction
Utility relocations and soil improvements would take place as needed in the south project area. As construction begins, the WOSCA site would be prepared to support many of the construction activities for the bored tunnel, including construction material and excavated soil storage

What is the WOSCA Detour?

All of the build alternatives propose to use the WOSCA detour. This detour would route both directions of SR 99 traffic off of the existing viaduct between S. Royal Brougham Way and Railroad Way S. near Qwest Field. The detour would have two lanes in each direction with a temporary southbound off-ramp at S. Atlantic Street and northbound on-ramp at S. Royal Brougham Way. Construction detours and restrictions are further described in **Chapter 6, Question 1** and the WOSCA detour is shown in Exhibit 6-3.

Construction Activities Chart



In Months

Bored Tunnel

4 | 5 | 7 | 3 | 16 | 9 | 9 | 12 — 5 years 5 months

STAGE 1 –
- **Relocate Utilities** – occurs periodically throughout all construction stages
- Begin compensation grouting from south portal up to Madison Street

STAGE 2 –
- Prepare WOSCA staging site
- Install shoring systems and excavation at south portal
- Continue compensation grouting up to Madison Street

STAGE 3 –
- Prepare WOSCA staging site
- Install shoring systems and excavation at south portal
- Complete compensation grouting up to Madison Street
- Construct support walls for the north portal and Tunnel Boring Machine (TBM) retrieval pit
- Excavate and construct secant pile walls in the north portal area

STAGE 4 –
- Install shoring systems and excavation at south portal
- Construct cut-&-cover tunnel sections at the south and north portals
- Construct north portal tunnel operations building
- Complete support wall and TBM retrieval pit at north portal
- Excavate and construct secant pile walls in the north portal area
- Widen Mercer from Fifth to Ninth Avenue N
- Construct new SR 99 overcrossing at Mercer

STAGE 5 –
- Construct south portal tunnel operations building
- Assemble TBM and begin boring
- Soil improvements may occur along the the alignment throughout tunnel boring
- Install interior tunnel structures and systems
- Complete construction of cut-&-cover section at the south portal
- Continue constructing north portal tunnel operations building
- Continue construction of cut-&-cover tunnel at north portal
- Construct Harrison ramps

STAGE 6 –
- Continue installing interior tunnel structures and systems
- Continue constructing both tunnel operations buildings
- Complete Harrison ramps
- Continue cut-&-cover section, excavation, and secant pile walls at north portal
- Disassemble and remove TBM
- Complete widening of Mercer
- Complete construction of SR 99 overcrossing at Mercer

STAGE 7 –
- Complete interior tunnel structures and systems
- Complete both tunnel operations buildings
- Complete cut-&-cover section, excavation, and secant pile walls at north portal
- Construct Republican ramps and Sixth Avenue N.
- Connect bored tunnel and Harrison Street ramps to SR 99
- Disassemble and remove TBM

FINAL STAGE –
- Demolish the viaduct from S. King to Battery Street
- Decommission Battery Street Tunnel
- Remove WOSCA Detour
- Restore surface streets and complete landscaping and lighting at both portals

Cut-&-Cover Tunnel

30 | 9 | 15 | 27 | 12 | 12 — 8 years 9 months

STAGE 1 –
- **Relocate Utilities** – occurs periodically throughout all construction stages
- Construct temporary over-water bridge between Pier 48 and Colman Dock
- Relocate ferry holding
- Begin seawall construction from S. Jackson to Pike
- Relocate Seattle Fire Station
- Build retaining wall from Stewart to Blanchard

S. Holgate to S. King Street Project –
- S. Holgate to S. King construction – *Complete early 2014*

STAGE 2 –
- Complete seawall construction from S. Jackson to Pike
- Start building the tunnel
- Construct retaining wall from Stewart to Blanchard

STAGE 3 –
- Continue tunnel construction
- Remove and replace southbound SR 99 from Pike to Battery Street Tunnel
- Begin construction of Partially Lowered Aurora

STAGE 4 –
- Remove viaduct from S. King to Pike
- Complete southbound tunnel
- Continue SR 99 construction from Pike to Battery Street Tunnel
- Complete Battery Street Tunnel improvements
- Continue north end construction and construct the Mercer and Roy bridges

STAGE 5 –
- Complete northbound tunnel
- Continue seawall construction from Pike to Broad
- Complete the northbound SR 99 from Pike to the Battery Street Tunnel

FINAL STAGE –
- Complete the seawall from Pike to Broad
- Restore Alaskan Way and complete landscaping & lighting
- Complete relocating utilities

Elevated Structure

30 | 9 | 27 | 3 | 24 | 21 | 3 | 3 — 10 years

STAGE 1 –
- **Relocate Utilities** – occurs periodically throughout all construction stages
- Construct temporary over-water bridge between Pier 48 and Colman Dock
- Relocate ferry holding
- Begin seawall construction from S. Jackson to Pike
- Relocate Seattle Fire Station
- Build retaining wall from Stewart to Blanchard

S. Holgate to S. King Street Project –
- S. Holgate to S. King construction – *Complete early 2014*

STAGE 2 –
- Construct Broad Street Detour
- Build new viaduct columns
- Construct retaining wall from Stewart to Blanchard

STAGE 3 –
- Complete seawall construction from S. Jackson to Pike Rebuild seawall from Pike to Broad
- Widen lower viaduct deck from S. King to Pike
- Remove and construct southbound SR 99 from Pike to the Battery Street Tunnel
- Begin constructing improvements to Battery Street Tunnel
- Begin constructing partially Lowered Aurora

STAGE 4 –
- Demolish upper viaduct from S. King to Pike
- Remove north-bound SR 99 from Pike to Battery Street Tunnel
- Complete partially lowered Aurora

STAGE 5 –
- Construct upper viaduct from S. King to Pike
- Build northbound SR 99 from Pike to the Battery Street Tunnel
- Complete Battery Steet Tunnel Improvements
- Build bridges at Thomas and Harrison

STAGE 6 –
- Demolish and rebuild lower level viaduct from S. King to Pike

STAGE 7 –
Connect structure to S. Holgate to S. King

FINAL STAGE –
- Restore Alaskan Way and complete landscaping and lighting
- Complete relocating utilities

Exhibit 3-10

and TBM maintenance. Construction offices would be located on the WOSCA property. If needed, a concrete batch plant may also be placed on the site.

The following activities would take place near the south portal area:

- Strengthen and support the existing viaduct
- Construct the tunnel's south portal
- Build the temporary electrical substation to power the TBM
- Support tunnel boring activities and remove tunnel spoils
- Connect the tunnel portal to SR 99 and restore surface streets

Strengthen and Support the Existing Viaduct

During south portal construction, the existing viaduct would be protected so that it remains safe for traffic. WSDOT and the design-build contractor would determine what measures are needed to strengthen the existing viaduct while construction and tunnel boring activities are underway. Possible methods that may be used are discussed below.

Between the First Avenue S. ramps and Columbia Street, plastic sheets that are reinforced with carbon fibers may be wrapped around the structure to strengthen the beams that support the roadway deck. Steel rods may also be used to strengthen the concrete beams.

Soil improvement methods and stabilization measures may also be used to support the existing viaduct from S. Washington Street to just north of Yesler Way, where the TBM would cross under the structure. Before the tunnel boring begins, columns of jet grout could be injected into soils to prevent the existing viaduct foundations from settling when the TBM bores under the structure. Jet grouting is a process by which cement grout is injected into weak soils and then mixed to strengthen and stabilize the soil as shown in Exhibit 3-11. In addition, hydraulic jacks could be installed on each column. If the column foundations at a location settle differently, the jacks could be raised or lowered to keep the beams that support the roadway deck level.

Construct the Tunnel's South Portal

Construction at the south portal would begin by building secant pile walls to support excavation for the tunnel portal. A deep cut would be excavated in the north end of the WOSCA property, where the TBM would be launched. The perimeter of secant piles would be constructed approximately between S. Royal Brougham Way and S. Main Street. This will reduce the risk of settlement and help to isolate the TBM from soil and groundwater as the tunnel begins boring underground. Two large concrete boxes would be built at either end of this stretch of secant piles. The concrete boxes would frame the TBM launch area to provide safer conditions for construction workers who perform inspections after the initial startup of the machine and for crews being trained to work on the project.

Once the walls are installed, the excavation would begin on the WOSCA property and Alaskan Way, at varying depths from approximately 12 feet to a maximum of 90 feet. Temporary tiebacks (and/or internal bracing struts) would also be installed for additional support. From about S. Main Street to about S. Washington Street, drilled shafts would be installed only along the east side of the tunnel to mitigate potential settlement of the existing viaduct.

Approximately 285,000 cubic yards of material would be generated from proposed excavations in the south portal area. All of this material would likely require off-site disposal. Demolition, foundation installation, and soil improvement activities would also generate some additional spoils, but the quantities are not yet known.

Within the excavation area for the south portal, a base would be built to support the assembly and launching of the TBM. The base would be a concrete and steel cradle that would include an approximately 9-foot-thick reinforced concrete slab.

Jet Grouting

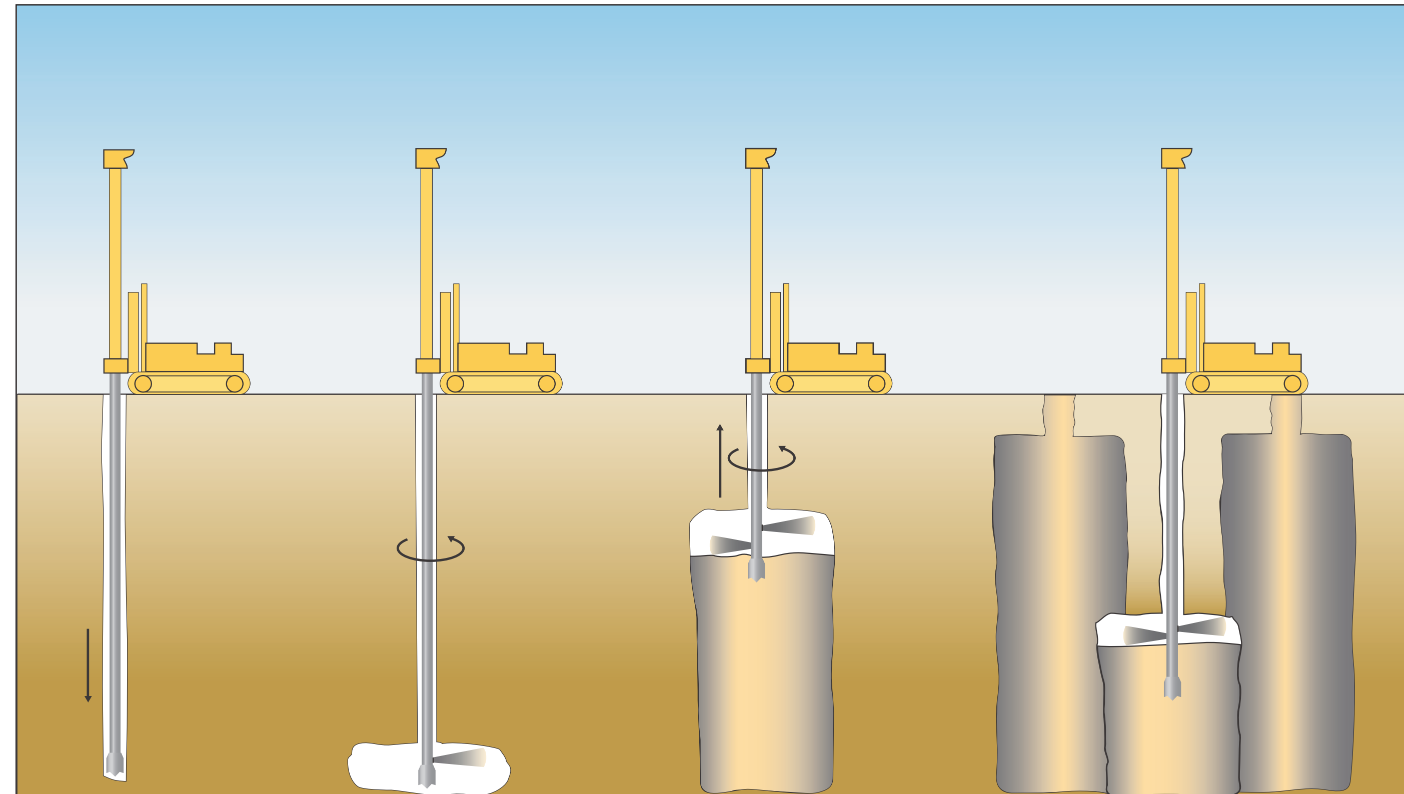


ILLUSTRATION COURTESY OF HAYWARD BAKER, INC.

Exhibit 3-11

Dewatering may be required throughout construction, particularly at the south portal area, to control groundwater flow into the excavated areas that are below the water table. Ground settlement that may result from dewatering activities would be mitigated with reinjection wells near the excavation area, supplied by water from the dewatering operation. If water quality monitoring indicated that the water required treatment, it would be treated prior to being discharged. Excess water would be treated and disposed of in the sanitary sewer under King County Wastewater Discharge Permit or Authorization conditions if necessary.

A tunnel operations building would be constructed near the south portal on the block bounded by S. Dearborn Street, Railroad Way S., and Alaskan Way S.

What are secant pile walls?

A secant pile wall is a type of retaining wall that is built by placing two concrete drilled shafts apart from each other. Then another shaft is placed between the first two shafts. This forms a continuous wall of interlocking shafts, called a secant pile wall.

Secant Pile Wall

Build the Temporary TBM Electrical Substation
The TBM would require its own electrical substation to provide power during construction of the bored tunnel. The TBM substation would be built on the WOSCA property. It would be about 75 feet by 125 feet and no more than two stories tall.

Support Tunnel Boring Activities and Remove Spoils
The south portal area would support tunnel boring activities. It would serve as the launching point for the TBM and the location where excavated material from the bored tunnel would be processed, stockpiled, and transferred into trucks, railcars, or barges for off-site disposal. It would also serve as an assembly site for constructing the tunnel's interior structures.

One building on the northeast corner of Terminal 46 would need to be demolished to accommodate the conveyor system and the handling of excavated materials.

Connect the Tunnel Portal to SR 99 and Restore Surface Streets
Once tunnel boring activities are completed, the on- and off-ramps to SR 99 would be built. A closure of several weeks would be required to connect SR 99 to the new bored tunnel and ramps.

The surrounding surface streets, such as First Avenue S. and Alaskan Way S., would be restored, which could include paving, restriping, and lighting. The East Frontage Road and new surface streets would be constructed between S. Royal Brougham Way and S. King Street, connecting First Avenue S. and Alaskan Way S. Landscaping, trails, and sidewalk improvements would be incorporated into surface roadways.

Bored Tunnel Construction
Bored tunnel construction would include the following activities:

- Procure, assemble, and launch the TBM
- Drive the TBM and remove soil and spoils
- Construct the internal tunnel structure and roadway

Bored Tunnel Potential Settlement Mitigation Locations

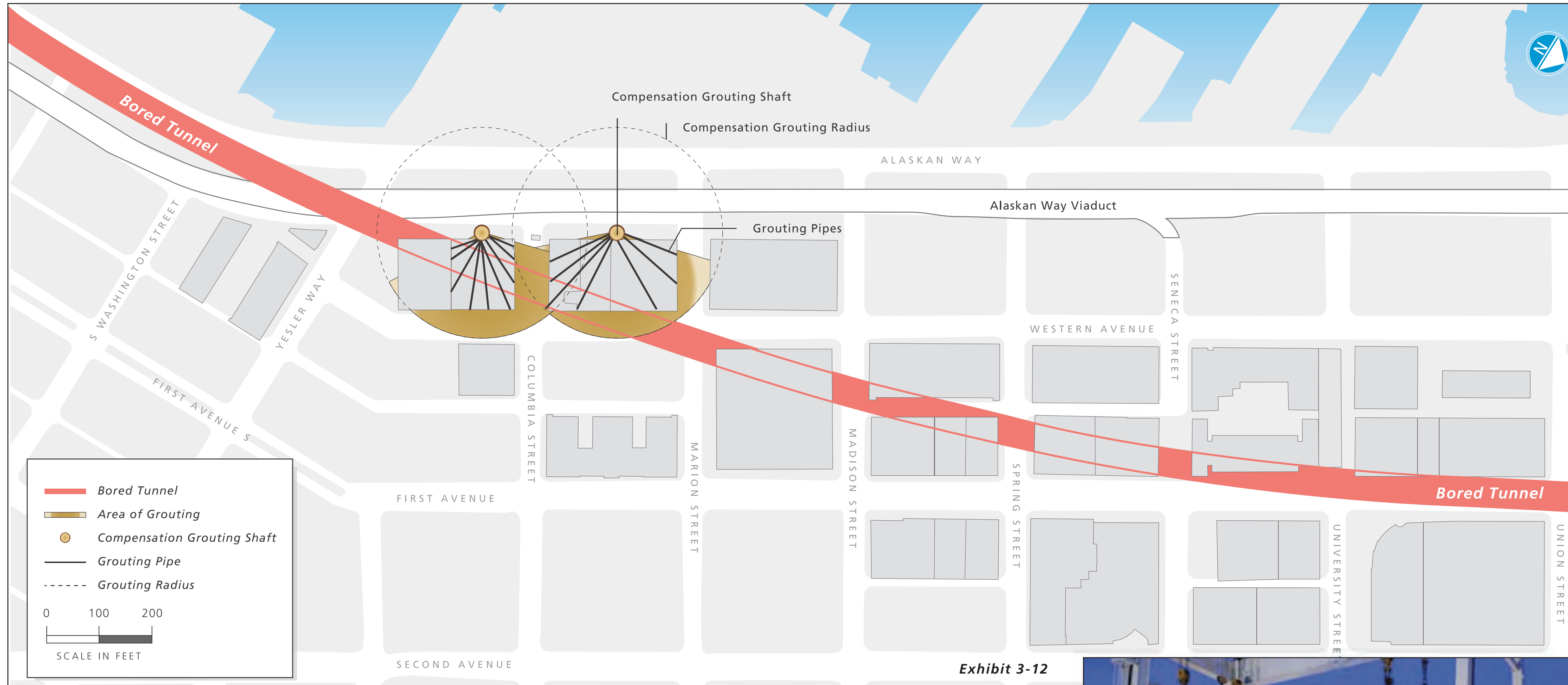


Exhibit 3-12

- Remove the TBM
- Install internal tunnel systems

Procure, Assemble, and Launch the TBM
The type of TBM designed for the Bored Tunnel Alternative would be an earth pressure balance machine. This machine maintains pressure at the face by retaining excavated soil in a chamber behind the cutterhead and balancing the rate of advance of the TBM with the rate of discharge of the excavated material. The TBM would be designed and procured during the first year and a half of construction. The TBM would then be assembled on the WOSCA site, which would take approximately 3 months. The TBM with trailing gear would likely measure at least 400 feet in length and approximately 56 feet in diameter.

The TBM would begin boring the tunnel just south of Railroad Way S.

Drive the TBM and Remove Soils and Spoils
Driving the TBM through the proposed tunnel alignment is estimated to take approximately a year and a half, assuming an average rate of advancement of approximately 30 feet per day. This would produce an average of approximately 2,600 cubic yards of material per day, which would fill approximately six trucks per hour.

While the TBM is advancing, approximately 900,000 cubic yards of soil would be excavated and an additional estimated 49,000 cubic yards of spoils may be generated by soil improvements. Along the south portion of the tunnel alignment, soil improvements would strengthen existing

Tunnel Boring Machine Being Assembled SOURCE: WWW.HERRENKNECKT.COM

What are spoils?

Spoils consist of soil along with other debris that is removed during a construction activity.

soil to better accommodate tunnel construction and protect structures and utilities from settlement. Improvements are needed in two locations along the bored tunnel alignment between Yesler Way and Madison Street, as shown in Exhibit 3-12, where soil types are more vulnerable to settlement and the tunnel would be at a relatively shallow depth. To avoid potential archaeological deposits, no soil improvements are planned along the bored tunnel alignment between S. Main and S. Washington Streets. Near the north portal, between John and Thomas Streets, soil improvements may also be considered. Soil improvement activities and stabilizing measures would occur throughout most of the construction period.

Along with the soil improvements and stabilizing measures described previously, an extensive and continuous monitoring process would be used during construction of the bored tunnel to provide early warning when soils settle beyond specific thresholds. These processes have been used in Europe under historic buildings and have been found to control settlement to within 22 millimeters,[5] about ¾ inch. Advance measures would be taken to prevent settlement, but unanticipated settlement could occur along the bored tunnel. If settlement does occur, emergency measures would be required to repair damage or to minimize further settlement. Emergency measures could require injecting grout from the ground surface to stabilize soils in adjacent areas or from within the tunnel. Soil stabilization measures could require closing traffic lanes, sidewalks, or access to basements of adjacent buildings.

With an earth pressure balance TBM, the excavated spoils would consist of mud with a toothpaste-like consistency. Soils would likely be removed from the tunnel using a conveyor system and hoppers. The material would then be conveyed to Terminal 46 and loaded onto a barge. Barged materials would be disposed of at the Mats Mats quarry in Jefferson County, Washington. Some material may be stockpiled and removed by truck.

Construct Internal Tunnel Structure and Roadway

The tunnel would be lined with precast concrete segments as it is excavated and has an internal diameter of approximately 52 feet. The internal walls and roadway decks may be constructed with a combination of precast components fabricated off site and cast-in-place concrete for specialized tunnel components. Precast components fabricated off site would be trucked to the WOSCA construction staging site using designated haul routes. Two levels of roadway deck would be installed in the tunnel to support two lanes of traffic in each direction.

Remove TBM

Tunnel boring would end near Thomas Street in the north end construction staging area. A retrieval pit would be excavated between Thomas and Harrison Streets so that the TBM could be disassembled and removed.

Install Internal Tunnel Systems

After the internal structures have been completely installed, components relating to mechanical, electrical, and control/instrumentation systems would be installed throughout the bored tunnel and portals. Once the bored tunnel construction is completed, the structures to connect the tunnel to existing SR 99 and the surrounding surface streets would be completed.

North Portal Construction

The following activities would take place near the north portal area:

- Construct the north tunnel portal
- Connect the north tunnel portal to SR 99
- Construct and restore surface streets

Construct the North Tunnel Portal

North portal construction would begin by building retaining walls along the eastern and western boundaries of the new SR 99 alignment between Thomas and Harrison Streets where the TBM would be removed. The interior structures housing the northbound and southbound roadway decks and connections to the tunnel ventilation structures would be built within this excavation. The tunnel operations building would be constructed adjacent to the north portal along the east side of Sixth Avenue between Thomas and Harrison Streets. The bored tunnel transitions to a cut-and-cover section north of Thomas Street, which would transition to a retained cut and finally an at-grade surface roadway at Roy Street. Based on the current level of design, an estimated 233,000 cubic yards of spoils would be generated from proposed excavations in the north portal area.

Connect the North Tunnel Portal to SR 99

At the north portal, a northbound on-ramp and southbound off-ramp would be constructed at the intersection of Harrison Street and Aurora Avenue. A northbound off-ramp would be constructed at Republican Street. A southbound on-ramp would be constructed from the new Sixth Avenue N.

Construct and Restore Surface Streets

Aurora Avenue would be filled and restored to grade between the Battery Street Tunnel and John Street. John, Thomas, and Harrison Streets would be connected across Aurora Avenue. Signalized intersections would be built at Denny Way and John, Thomas, and Harrison Streets.

Sixth Avenue N. would be extended north to connect with Mercer Street. Broad Street would be closed between Dexter and Taylor Avenues N. about 3 years into construction, then backfilled and replaced by the newly connected street grid. Landscaping and sidewalk improvements would be incorporated into the reconstruction of surface roadways and intersections.

Mercer Street would be widened to become a two-way street with three lanes in each direction with left-hand turn pockets. Two lanes would be closed from Dexter Avenue N. to Fifth Avenue N. for about 1.5 years while Mercer Street is widened and a new SR 99 bridge is built over the roadway. This activity would occur approximately 1.5 years into construction of the Bored Tunnel Alternative.

Chapter 6, Construction Effects

Refer to **Chapter 6** where construction closures, restrictions, and detours are discussed.

5 Littlejohn 2009.

What would happen to the Battery Street Tunnel?
The Battery Street Tunnel would be decommissioned and closed after the bored tunnel is open to traffic. As part of the Battery Street Tunnel decommissioning process, the tunnel may require remediation to remove soot containing high levels of lead and to remove asbestos within the tunnel. Decommissioning would also include disconnecting power, water, and drainage lines. The necessary utilities that run through the tunnel would be relocated, and materials such as lighting fixtures would be removed. Then the tunnel would be filled with suitable material (such as the concrete rubble from viaduct demolition), and all street access vents and both portals would be sealed. The rubble would be solidified with a concrete mix. The Battery Street Tunnel portals would be sealed with concrete and barricaded.

14 How would the Cut-and-Cover Tunnel Alternative be constructed?
Construction activities for the Cut-and-Cover Tunnel Alternative would begin around August 2011 and last for about 8.75 years (105 months). Construction activities are described in six stages. Expected activities, sequencing, and durations are shown on Exhibit 3-10. The Cut-and-Cover Tunnel Alternative would completely close SR 99 for 27 months. In addition, southbound SR 99 would be closed for 15 months prior to, and northbound SR 99 would be closed for 12 months after the complete closure. Lane closures would also be required on some city streets throughout construction.

The Cut-and-Cover Tunnel Alternative would relocate utilities, improve soils, and remove the existing viaduct, which are construction activities common to all alternatives identified in Question 11 of this chapter.

As construction begins, the WOSCA site would be prepared to support many of the construction activities for the cut-and-cover tunnel, including storage of construction materials and excavated soils. Construction offices would be located on the WOSCA property. If needed, a concrete batch plant may also be placed on the site.

The following construction activities would take place:

- Build the temporary Colman Dock ferry access bridge
- Rebuild the seawall
- Excavate and construct east tunnel wall
- Dewater, remove tunnel spoils, and construct portals
- Construct section from Pine Street to Battery Street Tunnel
- Upgrade the Battery Street Tunnel
- Construct SR 99 north of the Battery Street Tunnel and restore surface streets

Build the Temporary Colman Dock Ferry Access Bridge
A temporary ferry access bridge between Pier 48 and Colman Dock would be constructed to maintain vehicle access throughout construction. As shown in Exhibit 3-13, the temporary ferry access bridge would be approximately 300 feet long and would require in-water pile-supported foundations with above-water crossbeams in several locations. A barge and crane, a support barge, and pile-driving equipment would likely be used to do this work.

Rebuild the Seawall
Between S. King Street and S. Washington Street, soil improvements and new face paneling would replace the failing bulkhead at Pier 48. From S. Washington Street to where the tunnel ends near Pike Street, the western wall of the tunnel would replace the existing seawall. The western wall of the tunnel would most likely be a secant pile wall built behind the existing seawall. A secant pile wall is a wall of interlocking drilled shafts. The wall would be constructed of 4- or 5-foot-diameter drilled shafts that would extend about 90 feet below the street's surface. The shafts would overlap to form a continuous wall from S. Washington Street up past where the tunnel ends near Pike Street. It would take about 18 months to build the secant pile wall from S. King Street to Pike Street, which would occur at the beginning of construction. Multiple crews would be working at the same time. Construction steps for the secant pile wall are described below.

Temporary Ferry Access Bridge

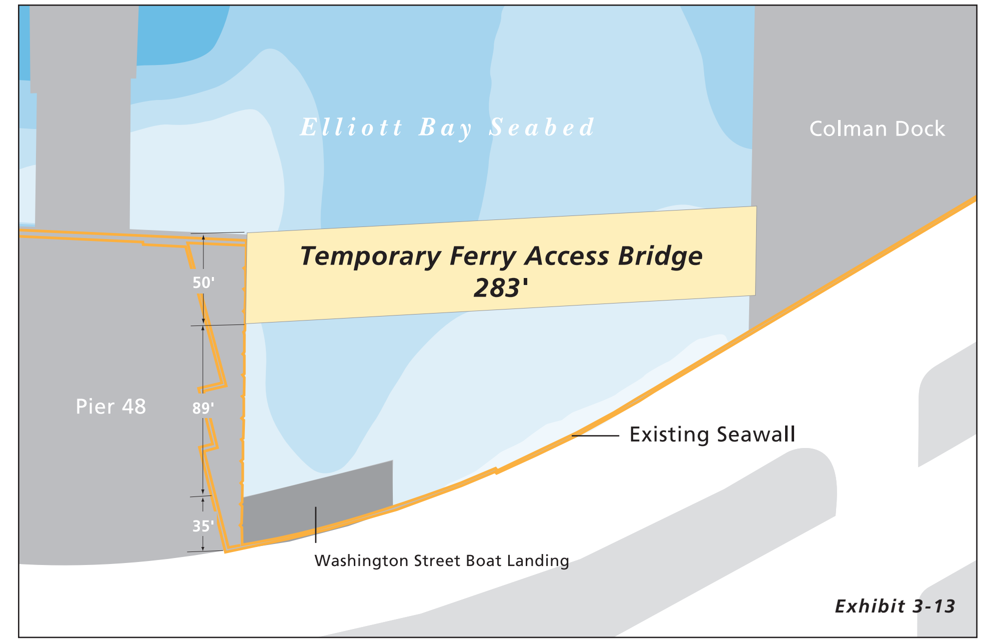


Exhibit 3-13

Step 1, Remove Sidewalk (above seawall) – In areas where the seawall would be rebuilt, crews would remove the existing sidewalk that extends out over the seawall. This activity is expected to take about 2 to 3 days for a 100-foot section of sidewalk. The sidewalk would be removed using concrete saws and cranes. Pedestrian access directly in front of the work zone would be rerouted.

Step 2, Install Protective Wall – Once the sidewalk is removed, crews may remove riprap adjacent to the seawall. During this activity, cranes and excavators would be parked on the landward side of the seawall. Once the riprap is removed, a sheet pile wall, silt curtain, or equivalent protective measure would be installed in front of the existing seawall to prevent construction debris from reaching Elliott Bay. If a sheet pile wall were installed, it would most likely be installed using vibration, rather than impact methods, to limit effects to surrounding aquatic life. These activities would take about 2 to 3 weeks at each 100-foot section.

Step 3, Remove Soil – Crews would excavate down to the seawall's relieving platform, which is about 15 feet below the Alaskan Way surface street. The excavated area would be about 15 feet deep and 40 feet wide. Backhoes and cranes would be used to dig and remove debris, and the material would most likely be removed from the site in trucks. Each 100-foot section would take 2 to 3 days to excavate.

Step 4, Build Secant Pile Wall – Crews would build the secant pile wall from S. King Street to Pike Street, which would be approximately 2,800 feet long. This wall would be constructed by building drilled shafts that overlap to form a secant pile wall. In general, the drilled shafts for this section would be built by drilling soil out of the shafts to the desired size (in this case, the shafts would have a circumference of about 4 to 5 feet and extend as far as 90 feet down to reach competent soil), installing rebar, and filling the hole with the concrete that forms the new drilled shaft.

Approximately 1,500 4- or 5-foot diameter shafts would be required for the secant pile wall. The number of shafts required would depend on the final project design. Engineers expect that it would take about 1 day to build each drilled shaft, although it is possible that up to two shafts could be built each day. Based on these production rates, it would take about 1 month to construct a 100-foot section of the secant pile wall (or a total of 29 drilled shafts). Each shaft needs 3 to 5 days for the concrete to cure before the overlapping shaft is installed, so if a construction crew were building a 100-foot section, they would build about 15 shafts along the entire 100 feet, and then they would come back and build the overlapping shafts to complete the section.

The seawall and SR 99 become separate structures north of Pike Street. For most of the areas between Pike and Broad Streets, the seawall would be replaced by strengthening the soil and replacing the existing seawall with a new face panel and L-wall support structure, as shown in Exhibit 3-14. Near Pier 66, between Blanchard and Battery Streets, only soil improvements are needed, because other improvements have already been made to this section of the seawall.

Excavate and Construct East Tunnel Wall
For the cut-and-cover tunnel, a slurry wall would be constructed to form the eastern tunnel wall. The wall would be about 3 feet wide and 90 feet deep along the entire length of the proposed tunnel. Construction of the eastern wall would most likely lag behind the secant pile wall construction by about 2 to 3 months so that the operations do not conflict. Both walls would be completed about the same time, because the secant pile wall extends farther north as a separate structure from Pike Street to Broad Street.

In general, slurry walls are constructed as described below:

- Concrete guide walls would be constructed on each side of the proposed 3-foot-wide slurry wall. The guide walls are usually constructed in a trench 3 to 5 feet deep.

- Slurry wall excavation would proceed in the trench between the guide walls. Excavated material would be replaced with a slurry mixture, which keeps the walls of the hole from caving in as excavation progresses. The excavation and slurry injection would continue down to the desired depth of the wall (from 75 to 90 feet in the central waterfront).

- Once the area is excavated, rebar (or steel beams) would be lowered into the hole through the slurry mixture.

- The hole would be filled with concrete. As the concrete fills the hole, the slurry material would be pumped out and stored for reuse. Slurry wall construction would continue until the wall is the desired length.

Dewater, Excavate Tunnel, and Construct Portals
Tunnel construction would require dewatering in advance of excavation to keep construction areas dry and to control the stability of the excavation. Water pumped out of the tunnel construction zone would either be reinjected back into the ground or discharged into the combined sewer system. If water quality monitoring indicated that the water required treatment, it would be treated prior to being discharged.

Construction of the tunnel and its portals would require extensive excavation of soil. Approximately 200,000 cubic yards of material would be excavated in the south area, and 1,235,000 cubic yards of material would be excavated along the central waterfront. Soil would be tested for contamination before being transported to an appropriate disposal facility by truck, rail, or barge.

Construction at both portals of the cut-and-cover tunnel would include building structural retaining walls. At the south portal, a tunnel ventilation and maintenance building would be constructed on the block bounded by

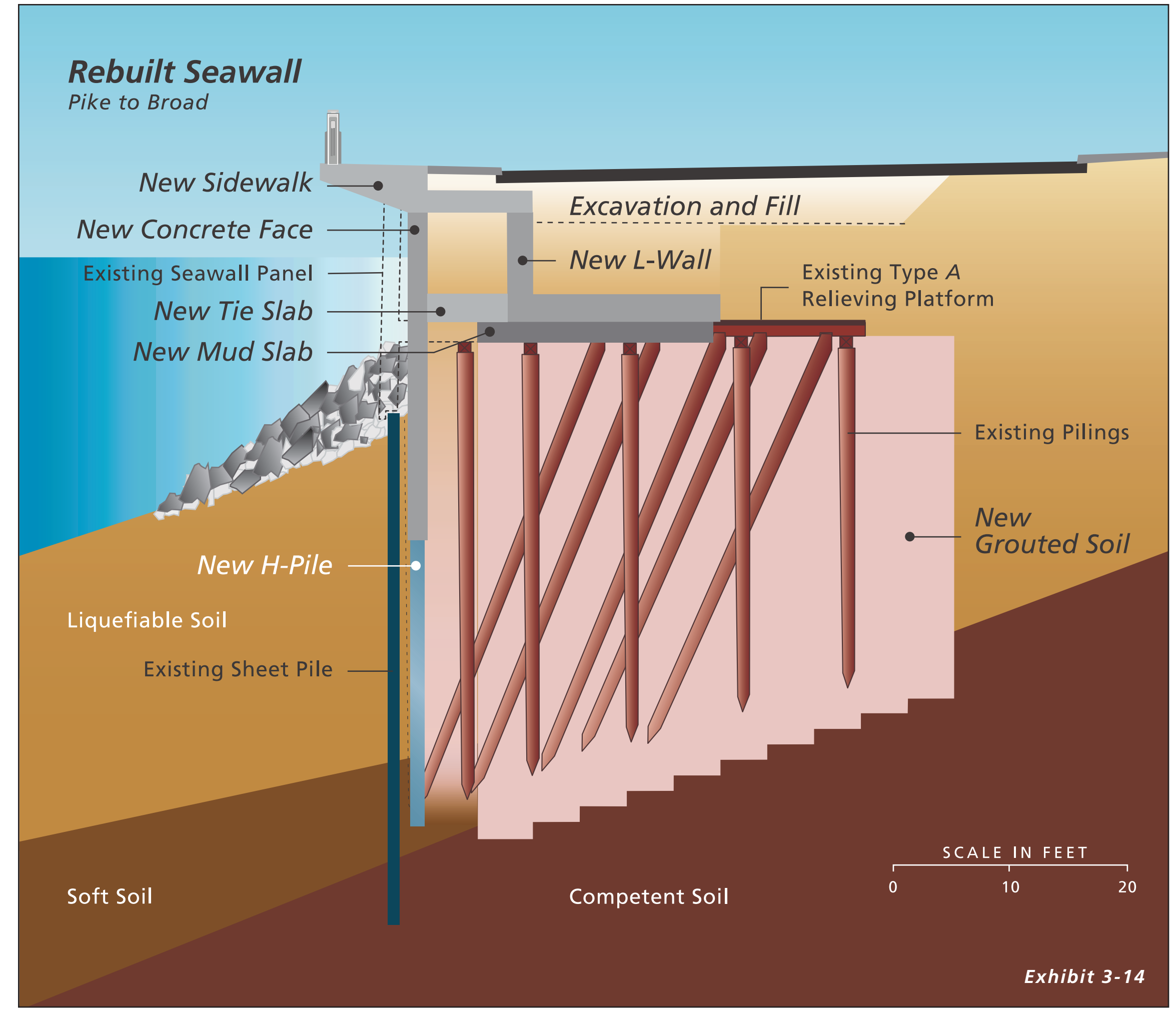


Exhibit 3-14

What is a slurry wall?

A slurry wall is a reinforced concrete wall constructed in an excavated trench. During excavation, a sealing mixture called slurry (made of bentonite and water) is used to support the excavated trench. Bentonite is clay that expands to help seal off groundwater flow and support the trench during excavation.

S. Dearborn Street, Railroad Way S., and Alaskan Way S. The ventilation and maintenance building at the north portal would be constructed between Alaskan Way S. and SR 99, just south of Pine Street. Maintenance and ventilation buildings would also be located at each end of Battery Street Tunnel.

Construct Section from Pine Street to Battery Street Tunnel
From about Pine Street north, a new above-grade roadway would connect the new waterfront tunnel to the Battery Street Tunnel, as well as to the Western and Elliott Avenue ramps. A concrete lid would be constructed over the southbound tunnel lanes at Pike Street and connect up to Victor Steinbrueck Park. Between approximately Pine and Virginia Streets, a new aerial structure would build new foundations made of drilled shafts. After crossing over the BNSF rail tracks, a cut section would be excavated under Elliott and Western Avenues and connect to the Battery Street Tunnel.

Upgrade the Battery Street Tunnel
The Cut-and-Cover Tunnel Alternative would improve the Battery Street Tunnel to meet current safety requirements for fire and seismic events, and the tunnel floor would be lowered to increase the vertical clearance in the tunnel to 16.5 feet. Construction activities would take place while SR 99 is completely closed to traffic and include:

- Upgrading the facility to meet seismic safety standards.
- Constructing air intakes on the south and north ends of the existing tunnel.
- Constructing up to four emergency exits (two on each side of the tunnel). These emergency exits are expected to be located near the intersections of Second Avenue and Battery Street and Fourth Avenue and Battery Street.
- Constructing tunnel maintenance and ventilation buildings at each end of the Battery Street Tunnel to house ventilation, electrical, mechanical, and communications systems.
- Replacing and upgrading the lighting system in the tunnel.
- Lowering the existing tunnel floor to increase the vertical clearance to 16.5 feet. The tunnel would be lowered by excavating soil in the existing tunnel and replacing the existing roadway in the tunnel.

Construct SR 99 North of the Battery Street Tunnel and Restore Surface Streets
North of the Battery Street Tunnel, the Cut-and-Cover Tunnel Alternative would include the following construction activities:

- Lowering the roadway profile of SR 99/Aurora Avenue by as much as 45 feet between Denny Way and Republican Street. The northbound lanes of SR 99 (or the east half) would be about 20 feet lower than the southbound lanes to accommodate the northbound on-ramp from Denny Way.
- Widening Mercer Street between Fifth and Dexter Avenues N. to accommodate two-way traffic.
- Connecting the street grid with new bridges over SR 99 at Thomas and Harrison Streets.
- Rebuilding the Denny Way northbound on- and southbound off-ramps.
- Building cul-de-sacs at John, Valley, and Aloha Streets.
- Closing and filling Broad Street from Fifth to Ninth Avenues N.

It would take approximately 36 months to build the improvements north of the Battery Street Tunnel. Construction crews would first relocate utilities and begin building the west half, or southbound lanes, of SR 99. A temporary retaining wall would be built in the middle of SR 99 to support the east half, or northbound lanes, of the roadway while the southbound lanes are under construction. Construction activities for the west half are:

- Building retaining walls from the north portal of the Battery Street Tunnel up to Harrison Street.
- Demolishing the southbound lanes of SR 99.
- Excavating the west half of SR 99 for the new lowered roadway; this could include dewatering if groundwater is encountered.

Once excavated, the new roadway bed would be built and connected to the southbound off-ramp to Denny Way. It would take about 18 months to build the southbound lanes before the roadway is opened to traffic.

Once the west half is completed, then the east half, or northbound lanes, of SR 99 would be constructed. Construction activities would be similar to those described for the west half, except the retaining wall would be deeper for the east side. In addition, a wall would be built between the northbound and southbound lanes from Denny Way to Republican Street. It would take about 12 months to build the northbound lanes.

Broad Street would be closed and backfilled from approximately Fifth Avenue N. to Ninth Avenue N., allowing the street grade to be reconnected. Mercer Street would be widened to seven lanes (three lanes each way, with a center turn lane). Bridges would be built at Thomas and Harrison Streets; and portions of Sixth and Taylor Avenues N. and Harrison, Thomas, and Roy Streets would be restored and constructed. The northbound on-ramp from Denny Way would be built, and utilities would be installed in their final locations.

15 How would the Elevated Structure Alternative be constructed?
Construction activities for the Elevated Structure Alternative would begin around August 2011 and would

last for about 10 years (120 months). Construction activities are described in eight stages. Expected activities, sequencing, and durations are shown on Exhibit 3-10. The Elevated Structure Alternative would completely close SR 99 for about 3 months in 2017 and again for about 3 months in 2021. Lane closures would also be required on some city streets throughout construction.

The Elevated Structure Alternative would relocate utilities, improve soils, and remove the existing viaduct, which are construction activities common to all alternatives identified in Question 11 of this chapter.

As construction begins, the WOSCA site would be prepared to support many of the construction activities for replacing the viaduct, including storage of construction materials and excavated soils. Construction offices would be located on the WOSCA property. If needed, a concrete batch plant may also be placed on the site.

The following construction activities would take place:

- Build the temporary Colman Dock ferry access bridge
- Replace the seawall
- Construct Broad Street detour
- Construct new aerial structure
- Upgrade the Battery Street Tunnel
- Construct SR 99 north of the Battery Street Tunnel and restore surface streets

Build the Temporary Colman Dock Ferry Access Bridge
The Elevated Structure Alternative would construct the same temporary ferry access bridge as described for the Cut-and-Cover Tunnel Alternative and shown in Exhibit 3-13.

Replace the Seawall
The Elevated Structure Alternative proposes to replace the seawall from S. Washington Street to just north of Broad Street. The seawall would be replaced by strengthening the soil and replacing the existing seawall with a new face panel and L-wall support structure (shown in Exhibit 3-14). Near Pier 66, between Blanchard and Battery Streets, only soil improvements are needed, because other improvements have already been made to this section of the seawall. This is the same seawall design proposed north of Pike Street for the Cut-and-Cover Tunnel Alternative.

Construct Broad Street Detour
The temporary aerial trestle would be built over the railroad tracks at Broad Street from approximately the intersection of Alaskan Way and Vine Street up to the intersection of Broad Street and Western Avenue. The temporary trestle would be constructed using steel beams and precast concrete segments.

Construct New Aerial Structure
The Elevated Structure Alternative would construct a new viaduct in the central section from S. King Street to the Battery Street Tunnel. The aerial structure would be constructed by building new foundations made of drilled shafts. Driven piles and pile caps may be used in place of drilled shafts where greater structural support is needed. The superstructure would be completely replaced by precast components as much as possible.

Upgrade the Battery Street Tunnel
The Elevated Structure Alternative would have the same construction activities for improving the Battery Street Tunnel as described for the Cut-and-Cover Tunnel Alternative.

Construct SR 99 North of the Battery Street Tunnel and Restore Surface Streets
The Elevated Structure Alternative would have the same construction activities north of the Battery Street Tunnel as described for the Cut-and-Cover Tunnel Alternative.

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