SR 99: ALASKAN WAY VIADUCT & SEAWALL REPLACEMENT PROGRAM

Alternative Description and Construction Technical Memorandum

S. Holgate Street to S. King Street Viaduct Replacement Project

Environmental Assessment

June 2008

TABLE OF CONTENTS

LIST OF EXHIBITS

ACRONYMS

City	City of Seattle
EA	Environmental Assessment
HDPE	high-density polyethylene
I-5	Interstate 5
Project	SR 99: S. Holgate Street to S. King Street Viaduct Replacement Project
SIG	Seattle International Gateway
SR	State Route
T-46	Terminal 46
WOSCA	Washington-Oregon Shippers Cooperative Association
WSDOT	Washington State Department of Transportation

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Chapter 1 SUMMARY

1.1 Project Limits

The project limits for the SR 99: S. Holgate to S. King Street Viaduct Replacement Project (the Project) extend from S. Walker Street on the south to S. King Street on the north. See Exhibit 1-1.

1.2 Project Overview

The Project would replace the State Route (SR) 99 mainline from S. Walker Street (just south of S. Holgate Street) to the vicinity of S. King Street. This section of roadway would be replaced with an improved three-lane roadway, both northbound and southbound.

The improved roadway would transition from the existing at-grade roadway via retained fill ramps to an elevated structure to match the existing viaduct in the vicinity of S. King Street. The existing access ramps at S. King Street would be maintained, and new access ramps would be added. A new northbound off-ramp and a new southbound on-ramp from Alaskan Way S. just north of S. Royal Brougham Way would be built.

The Project would provide grade-separated access for freight and general purpose traffic traveling between the BNSF Seattle International Gateway (SIG) Railyard and the Port of Seattle container terminals along Seattle's waterfront. These east-west movements would be provided via a U-shaped undercrossing extending from the intersection of S. Atlantic Street/Colorado Avenue S. to the intersection of S. Atlantic Street and E. Marginal Way S. This new connection would improve vehicle access, particularly for freight, compared to existing conditions by providing a grade-separated route for east-west traffic when railroad cars on the tail track block the at-grade roadway. At-grade access connecting these two areas (on the east and west) would continue to be provided via S. Atlantic Street. The project would also improve the local street connections to SR 519. However, S. Royal Brougham Way would no longer provide east-west at-grade connections between First Avenue S. and Alaskan Way S. or E. Marginal Way S. as it does today.

A remote holding area for Seattle Ferry Terminal traffic would be added between S. Royal Brougham Way and S. King Street along the east side of SR 99.

1.3 Construction Approach

In the process of evaluating several construction sequencing and traffic control scenarios, Washington State Department of Transportation (WSDOT) determined that maintaining through traffic on SR 99 as much as possible throughout the construction period was of key importance. An approach that would minimize effects on First Avenue S. traffic and maintain access to and from area businesses and the stadiums was considered to be a design priority.

The construction approach analyzed in this Environmental Assessment (EA) was based on several assumptions and constraints, which are summarized as follows:

- A minimum of two lanes of SR 99 traffic in each direction will be maintained during peak traffic hours or a comparable detour will be provided, except for nights and weekends when full closures are allowed.
- Access to and from the North SIG Railyard and the Port of Seattle's Terminal 46 (T-46) will be maintained at all times.
- Railroad tracks and both the Whatcom and North SIG Railyards must remain in service, except for periodic closures of short duration (8 hours or less) to facilitate construction activities.
- The City's Fourth Avenue S. loop ramp from the Spokane Street Viaduct will be completed prior to Traffic Stage 2.

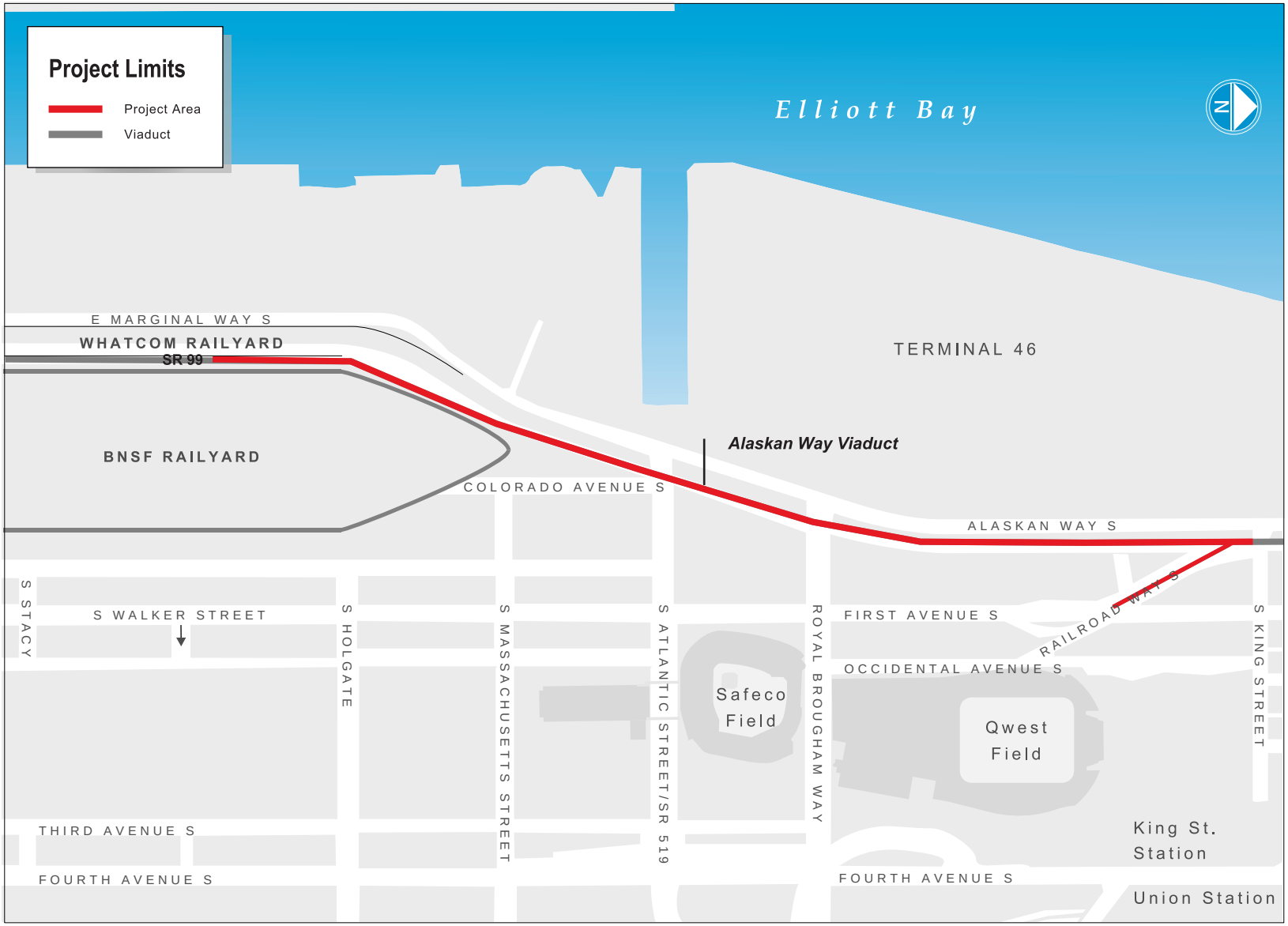
Project Limits
Project Area
Viaduct
Elliott Bay
N
E MARGINAL WAY S
WHATCOM RAILYARD
SR 99
TERMINAL 46
BNSF RAILYARD
Alaskan Way Viaduct
COLORADO AVENUE S
ALASKAN WAY S
S STACY
S WALKER STREET
S HOLGATE
S MASSACHUSETTS STREET
S ATLANTIC STREET/SR 519
ROYAL BROUGHAM WAY
FIRST AVENUE S
RAILROAD WAY S
S KING STREET
OCCIDENTAL AVENUE S
Safeco Field
Qwest Field
THIRD AVENUE S
FOURTH AVENUE S
FOURTH AVENUE S
King St. Station
Union Station

Exhibit 1-1

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Chapter 2 PROJECT DESCRIPTION

This chapter describes the Project.

2.1 Viaduct Replacement

Description of the Alignment

The Project would replace the existing stacked viaduct structure between S. Holgate Street and S. King Street as shown in Exhibit 2-1. At S. Walker Street, SR 99 would transition from an at-grade, side-by-side roadway to an aerial, side-by-side roadway crossing over S. Atlantic Street and the BNSF tail track. SR 99 would return to a side-by-side, at-grade roadway for a short distance north of S. Royal Brougham Way. SR 99 would then transition to a stacked, aerial structure that would match with the existing stacked viaduct at about S. King Street.

Access and Connections

New access ramps would connect Alaskan Way S., just south of S. King Street, to the proposed at-grade section located between the proposed elevated sections. These new ramps would improve access to downtown. The existing northbound on-ramp and southbound off-ramp at First Avenue S. near Railroad Way S. would be retained. S. Royal Brougham Way would be closed between First Avenue S. and Alaskan Way S.

New roadways and connections would be provided near S. Atlantic Street. These connections include:

- Providing grade-separated access for freight and general purpose traffic traveling between the SIG Railyard, SR 519, and the Port of Seattle. Access would be provided via a U-shaped undercrossing extending from the intersection of S. Atlantic Street/Colorado Avenue S. to the intersection of S. Atlantic Street and E. Marginal Way S. This new connection would improve vehicle access by providing a route for east-west traffic when railroad cars on the tail track block the at-grade roadway.
- Improving Colorado Avenue S. to enhance access to the new North SIG Railyard. Improvements include building two southbound and one northbound truck-only lanes on the west side of the street, and one general purpose lane in each direction on the east side of the street. Additionally, a parking lane would be provided along the east side of the street, south of the Bemis Building near First Avenue S. and S. Atlantic Street.

Proposed Action

- Providing southbound and northbound frontage roads located immediately west and east of SR 99, respectively. The frontage roads would split the southbound and northbound lanes of Alaskan Way S. from S. Atlantic Street to S. King Street. In addition, the northbound frontage road would also provide access from S. Atlantic Street to the remote holding area for the Seattle Ferry Terminal, and to Alaskan Way S.
- Reconfiguring the intersections where S. Atlantic Street meets Alaskan Way S., the new U-shaped undercrossing, Colorado Avenue S., the new frontage roads, and Utah Avenue S.

2.2 Other Features

Rail

The tail track would be relocated west of the new SR 99 roadway and would extend north from the railyard to the vicinity of S. King Street. This will help to maintain the connections between the Whatcom Railyard on the west side of SR 99 and the SIG Railyard on the east side of SR 99. Train assembly operations would be maintained on the relocated tail track.

Ferry Holding

A remote holding area for Seattle Ferry Terminal traffic would be added between S. Royal Brougham Way and S. King Street along the east side of SR 99.

Bicycle and Pedestrian Facilities

Existing bicycle and pedestrian access would be both maintained and improved as part of this Project. From S. Holgate Street to about S. Massachusetts Street, a bicycle/pedestrian shared-use path would be located to the west of SR 99. North of S. Atlantic Street, the bicycle/pedestrian path would continue west of the relocated tail track (in accordance with the City of Seattle Bicycle Master Plan), and proceed north to the vicinity of S. Dearborn Street. The bicycle and pedestrian facilities are shown on Exhibit 2-1.

The existing Waterfront Bicycle/Pedestrian Facility would connect with the future Mountains to Sound Greenway Trail at First Avenue S. and S. Atlantic Street and would connect to the south with the multi-use trail along E. Marginal Way S.

On-street bicycle facilities would be expanded as well. Surface streets in the project area would be widened to add bike lanes along both sides of E. Marginal Way S. and S. Royal Brougham Way, the west side of Alaskan Way S., and the east side of the proposed new northbound Alaskan Way S. frontage road running along the east side of SR 99 between S. Atlantic Street and Alaskan Way S.

Chapter 3 CONSTRUCTION TRAFFIC STAGES

As part of the development of construction sequencing for this Project, the Project was broken down into a series of traffic stages that represent significant changes to traffic flow and routes within the project corridor, such as detours or lane or roadway closures. Each traffic stage includes a set of construction activities that must be substantially completed before the next traffic stage and the subsequent construction activities can begin.

The construction period for this Project would consist of approximately 8 months of initial utility relocations followed by five traffic stages of roadway construction. Water, communication, and electrical lines would be moved during this time so that they are not in the path of the major construction activities. The overall Project's construction duration would be approximately 4 years 4 months, but the major construction would take place during Traffic Stages 1, 2, 3, and 4 and would last approximately 3 years 2 months.

3.1 Traffic Stage 1 (17 months)

SR 99

SR 99's traffic (three lanes northbound and three lanes southbound) would be unchanged on the Alaskan Way Viaduct for the first 9 months of Traffic Stage 1. However, during the last 6 months, southbound traffic would be reduced to two lanes roughly between Railroad Way S. and S. Holgate Street.

Local Streets

- Various local streets in the project area, such as Colorado Avenue S., S. Atlantic Street, S. Royal Brougham Way, and Alaskan Way S., would be intermittently disrupted with temporary lane or street closures necessary for utility relocations.
- Northbound and southbound traffic on Alaskan Way S. would be maintained between S. King Street and E. Marginal Way S. until construction of the undercrossing. At that time, traffic on Alaskan Way S. would need to be detoured onto S. Royal Brougham Way, First Avenue S., and S. Atlantic Street.
- S. Atlantic Street would carry a minimum of one lane of traffic in each direction.

Ferry Holding

There would be no remote ferry holding area in Traffic Stage 1. Informal queuing of overflow traffic bound for the Seattle Ferry Terminal would be accommodated under the Alaskan Way Viaduct, as it is today.

Whatcom Railyard and Lead Track

Relocation of the northern portion of the Whatcom Railyard's lead track would be required at the beginning of Traffic Stage 1. Relocating the lead track would be necessary to clear the work zone used to construct the north half of the southbound bridge and the west half of the undercrossing. During an 8-hour rail closure and a weekend closure of S. Atlantic Street, a portion of the existing tracks would be removed, the new rail moved into place, new turnout installed, and new crossings constructed for S. Atlantic Street. During this brief closure, both motorized and bicycle traffic would be detoured to S. Royal Brougham Way.

BNSF Tail Track

Later in Traffic Stage 1, after the west half of the undercrossing is constructed, a temporary Whatcom lead track would be constructed on the east side of Alaskan Way S. south of S. Atlantic Street. The Whatcom lead track would then connect to the proposed tail track that would be built on the west side of Alaskan Way S. north of S. Atlantic Street. The construction of the tail track would include construction of railroad bridges over the undercrossing and the existing, shallow 96-inch-diameter sewer in S. Royal Brougham Way.

Once the tail track and Whatcom lead track are completed, final connections would be made to the existing Whatcom Railyard tracks near S. Holgate Street and to the existing SIG Railyard south of S. Atlantic Street, replacing the existing turnout at the north end of the SIG Railyard with a new turnout. Final connections would require track shutdowns of up to 8 hours. Finally, with the new Whatcom tracks connected and in operation, the existing Whatcom lead track and tail track would be removed.

Union Pacific Track

The easternmost Union Pacific track in the Whatcom Railyard (UP Track 650) would be affected during construction of the southbound bridge between S. Walker and S. Atlantic Streets. This track would be out of service for approximately 3 years.

Bicycle and Pedestrian Facilities

During Traffic Stage 1 of construction, the sidewalk on the west side of Alaskan Way S. would be rerouted around construction activities between S. Atlantic Street and S. Royal Brougham Way to a combined bike/pedestrian

path on the east side of the street. The reroute would cross under the existing viaduct and run along a temporary path east of the viaduct between S. Royal Brougham Way and S. Atlantic Street. During construction of the undercrossing in Traffic Stage 1, Alaskan Way S. would be detoured to S. Royal Brougham Way, First Avenue S., and S. Atlantic Street. Bicyclists would have the option of sharing the roadway with vehicles or using the combined bike/pedestrian path.

3.2 Traffic Stage 2 (6 months)

SR 99

During Traffic Stage 2, the viaduct's three lanes of northbound traffic would remain unchanged. However, the southbound traffic would be diverted to the WSDOT-owned Washington-Oregon Shippers Cooperative Association (WOSCA) property to the east of SR 99 via the two-lane First Avenue S. off-ramp. The WOSCA site lies to the west of First Avenue S. between S. Royal Brougham Way and S. Dearborn Street. This detour route would rejoin SR 99 in the vicinity of S. Walker Street.

Local Streets

Alaskan Way S. traffic would be reduced to one lane northbound and two lanes southbound. The connection to E. Marginal Way S. would be maintained as it is today. S. Royal Brougham Way would be closed between First Avenue S. and Alaskan Way S.

Ferry Holding

During Traffic Stages 2 through 4, a temporary remote holding area for Seattle Ferry Terminal traffic would be located to the west of the viaduct south of S. King Street on Alaskan Way S.

Bicycle and Pedestrian Facilities

During Traffic Stages 2 through 4, a combined bike/pedestrian path would be provided on the west side of Alaskan Way S., close to the location of the existing sidewalk. The path currently located on the east side of Alaskan Way S. would be closed south of S. King Street and combined with the bike/pedestrian path on the west side of Alaskan Way S. A bike/pedestrian connection to S. Atlantic Street would be provided. As in Traffic Stage 1, bicyclists would need to use the combined bike/pedestrian path or share the roadway with vehicles.

3.3 Traffic Stage 3 (8 Months)

SR 99

During Traffic Stage 3, when the existing viaduct is demolished and the transition structures are completed, both northbound and southbound viaduct travel would need to be diverted off the existing viaduct. To maintain traffic flow on SR 99 and minimize traffic effects on First Avenue S., traffic would be diverted to the S. King Street ramps, the WOSCA property detour, and the new southbound SR 99 bridge with two lanes in each direction.

Two temporary ramps would be constructed in the middle of the WOSCA site connecting to the existing northbound and southbound First Avenue S. ramps. South of S. Royal Brougham Way, both southbound and northbound traffic would use the new southbound bridge. Exhibit 3-1 provides a visual display of this detour route.

Local Streets

Alaskan Way S. traffic would be reduced to one lane northbound and two lanes southbound with a connection to E. Marginal Way S. maintained by decking over the undercrossing. S. Royal Brougham Way would be permanently closed between First Avenue S. and Alaskan Way S.

3.4 Traffic Stage 4 (7 months)

SR 99

The viaduct's northbound and southbound traffic would be diverted to the new transition structures and the new southbound SR 99 bridge, with two lanes in each direction.

Local Streets

Alaskan Way S. would be reduced to one lane in each direction with a connection to E. Marginal Way S. maintained.

3.5 Traffic Stage 5 (6 months)

SR 99

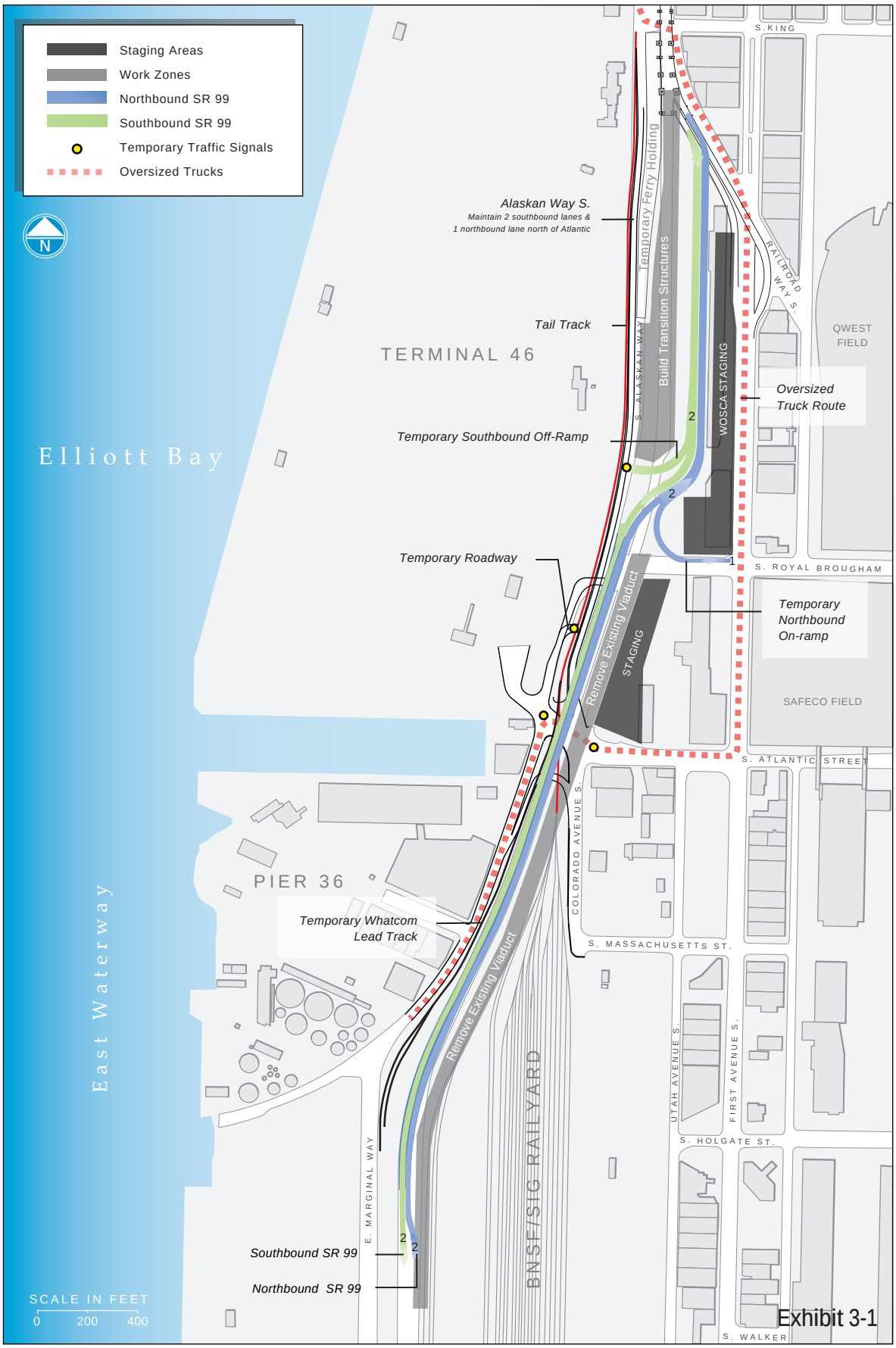
Northbound and southbound SR 99 traffic would travel on the new structures from S. Holgate Street to Railroad Way S. with three lanes in each direction.

Local Streets

Although there would be some minor localized lane or street closures or detours as needed for final paving and striping, the city streets would be open for general purpose, ferry, and nonmotorized traffic.

S. Holgate to S. King Construction

TRAFFIC STAGE 3 DETOUR



Ferry Holding

A new remote holding area for Seattle Ferry Terminal traffic would be located between S. Royal Brougham Way and S. King Street along the east side of SR 99.

Bicycle and Pedestrian Facilities

Some detours of short duration and distance for bicycles and pedestrians may be necessary before the final facilities are open for use.

Chapter 4 CONSTRUCTION

4.1 Construction Elements

4.1.1 Staging Areas and Work Zones

Staging areas are sites that are temporarily used for storage of materials or equipment, assembly, or other temporary, construction-related activities. Work zones are those areas where the construction is occurring. Work zones change as construction moves through different locations in the project area as the work proceeds.

Construction activities would be staged within the existing SR 99 and street rights-of-way, where possible. In addition, a portion of the WOSCA property east of the SR 99 alignment would be used as a staging area for construction equipment, supply lay-down areas, parking, and other miscellaneous contractor resources. This site lies to the west of First Avenue S. between S. Royal Brougham Way and S. Dearborn Street. Other staging areas would be created by the contractor within the project footprint where needed as work progresses.

Another site that would be a primary staging site in Traffic Stage 1, referred to as the Team Track site, is bounded by S. Atlantic Street, the BNSF tail track under the existing viaduct, S. Royal Brougham Way, and private properties on the east side. The site would be accessed from either S. Royal Brougham Way or S. Atlantic Street. During Traffic Stage 4, most of this site would be occupied by the built facility on the west side, and the east side could be used as a work zone for the construction of the northbound Alaskan Way S. frontage road.

The adjacent Trager Building and U-Park sites, located along S. Dearborn Street and Railroad Way S., would also be used for staging.

4.1.2 Construction Working Hours

Construction would typically take place 5 days per week, 10 hours per day, but may occur up to 24 hours per day, 7 days per week at times during the construction period. Some night or weekend work may be required for roadway crossings, tail track relocation, or other critical construction phases. Any night or weekend work would require a noise variance from the City, as described in the Noise and Vibration Technical Memorandum, available in Appendix G of the Project's EA.

4.1.3 Construction Haul Routes

Construction-related trucking is expected to use established truck routes, including S. Atlantic Street, E. Marginal Way S., S. Michigan Street, SR 99, and I-5. The delivery and removal of materials would primarily use I-5 or city arterials to and from the South of Downtown (SODO) area. Haul routes to and from the work zone would use First Avenue S., Fourth Avenue S., or E. Marginal Way S. Material hauled along these routes would include new construction materials as well as demolished structure materials, excavated soil, and spoils created by ground improvement activities.

4.1.4 Construction Equipment

Equipment expected to be used for construction includes:

- Trucks
- Cranes
- Pile-driving hammers
- Backhoes
- Excavators
- Drilling rigs
- Vibrator probes
- Compactors
- Loaders
- Forklifts and manlifts
- Jackhammers
- Pumps
- Grading and paving equipment
- Compressors
- Generators
- Welding equipment
- Dewatering tanks and associated equipment
- Temporary erosion and sediment control equipment

4.1.5 Utility Relocations

The relocation of utilities would be required, primarily in Traffic Stages 1 and 2. Very few temporary utility relocations would be required; most relocations would be permanent. The relocations of utilities in the project area would include:

- Water lines and mains
- Drainage facilities
- Wastewater facilities
- Electrical facilities

- Gas lines
- Communication duct bank and lines

For additional detail on utility relocations, refer to Chapter 5 of the Public Services and Utilities Technical Memorandum in Appendix G of the Project's EA.

4.2 Construction Methods

Construction of the bridges, street-level facilities, and retained cuts that would compose the new SR 99 roadway and ramps would require the following activities:

- Demolition and removal of materials
- Support wall construction
- Ground improvements
- Substructure installation
- Retained fill construction
- Retained cut construction

4.2.1 Removing the Alaskan Way Viaduct

Demolition and Material Removal

This Project would require demolishing and removing viaduct structural components south of the intersection of Railroad Way S. and Alaskan Way S. (Bent No. 121). In total, the viaduct demolition would remove approximately 40,000 cubic yards of reinforced concrete. Demolition and material removal is expected to take about 3 months.

The viaduct is composed of steel-reinforced concrete supported on pile foundations. The piles are composite, with the upper portion composed of reinforced concrete and the lower portion of timber. The viaduct would be demolished to approximately 2 feet below the existing ground surface. Pile caps interfering directly with proposed construction and generally below proposed retained fill would also be removed. Demolition would likely require removing the concrete portion of the piles (leaving the timber pile in place) in addition to the pile cap. Approximately 20 foundations would be removed in this manner. Equipment needed for demolishing and removing the viaduct would include backhoes, front loaders, and excavators with crunching/shearing and hammering attachments. Concrete saws and splitters along with cutting torches would also be used.

4.2.2 Building the Undercrossing

Secant Pile Wall Construction

The U-shaped undercrossing would be built with a retained cut, using an internally braced excavation support wall. The support wall would be constructed of secant piles. Secant pile walls are constructed of overlapping drilled concrete piles. The overlap is created by placing primary piles slightly less than two pile diameters apart; the close spacing ensures that secondary piles placed into the gaps will cut into the adjacent piles to join them. See Exhibit 4-1 for a graphic depiction of the secant pile wall construction steps.

The secant piles are placed using an oscillator. This large crane attachment uses oscillating motion to force a large-diameter steel casing down through the layers of soil and rock. A grab bucket clears out the spoil from inside the casing. After the casing reaches the planned pile depth, steel reinforcement is placed inside the excavated shaft. Then as the casing is withdrawn, concrete is tremied into the hole. A tremie is a pipe or hose that allows the concrete to be placed below water in the shaft excavation to its final location. As the water is displaced, it is pumped from the excavation and treated before disposal.

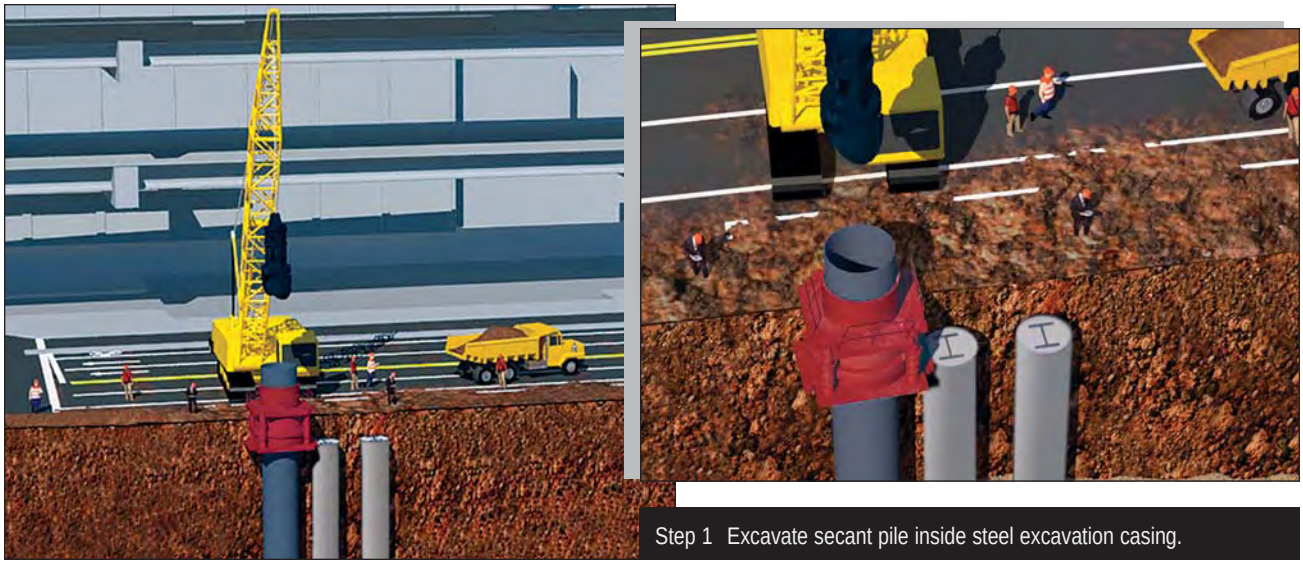
Construction of primary piles involves filling in the spaces between secondary piles by boring through the concrete in the secondary piles to key the primary piles between them. Usually only the primary piles are reinforced with reinforcing cages or steel wide-flange sections; however, in some cases, the secondary piles are also reinforced.

Ground Improvement

Ground improvements would be required to offset the risk of soil liquefaction and lateral spreading of soils throughout the project area in the event of an earthquake. These improvements would consist of a combination of deep soil mixing, jet grouting, earthquake drains, and stone columns or displacement piles. Refer to Exhibit 4-2 for examples of these ground improvement methods, which are described below.

Deep soil mixing would be required along the length of the Project to reduce lateral spreading of soils. Jet grouting would be used in place of deep soil mixing within the S. Atlantic Street right-of-way where existing utilities preclude access for deep soil mixing equipment. The remaining ground improvement methods—earthquake drains, stone columns, and displacement piles—would be used to reduce potential liquefaction-induced settlement beneath proposed structural earth fills and in the vicinity of bridge abutments and piers.

Exhbit 4-1. Secant Pile Wall Construction



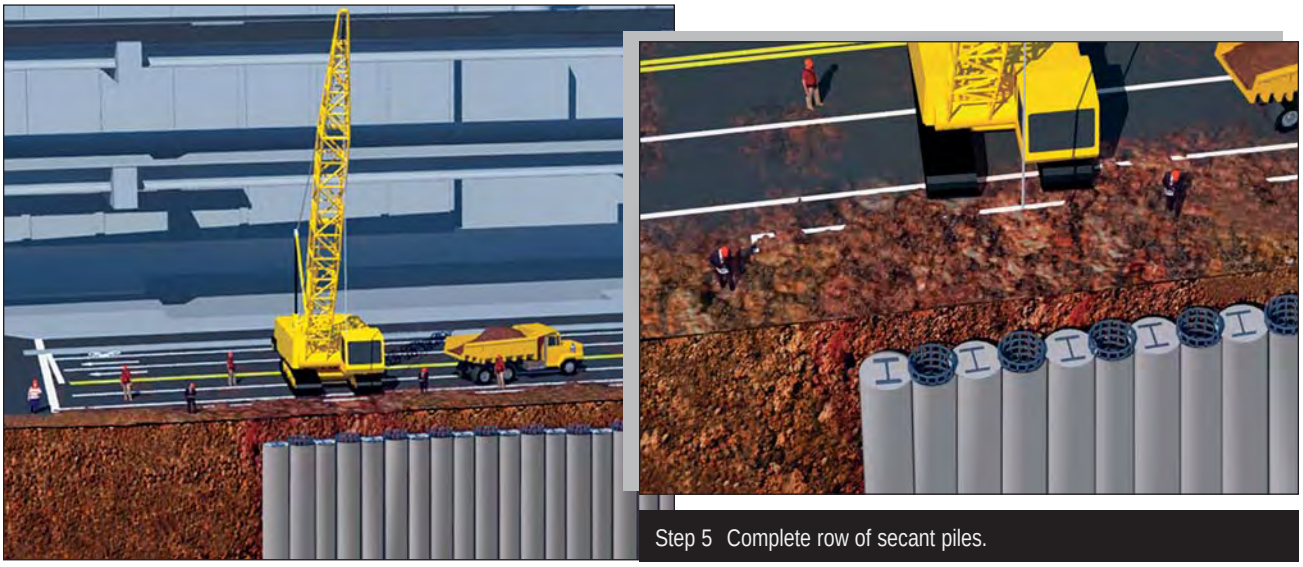
Step 1 Excavate secant pile inside steel excavation casing.

Step 2 Place wide flange reinforcement inside forming tube.
Pour concrete into forming tube.

Step 3 Excavate intermediate pile between existing secant piles.

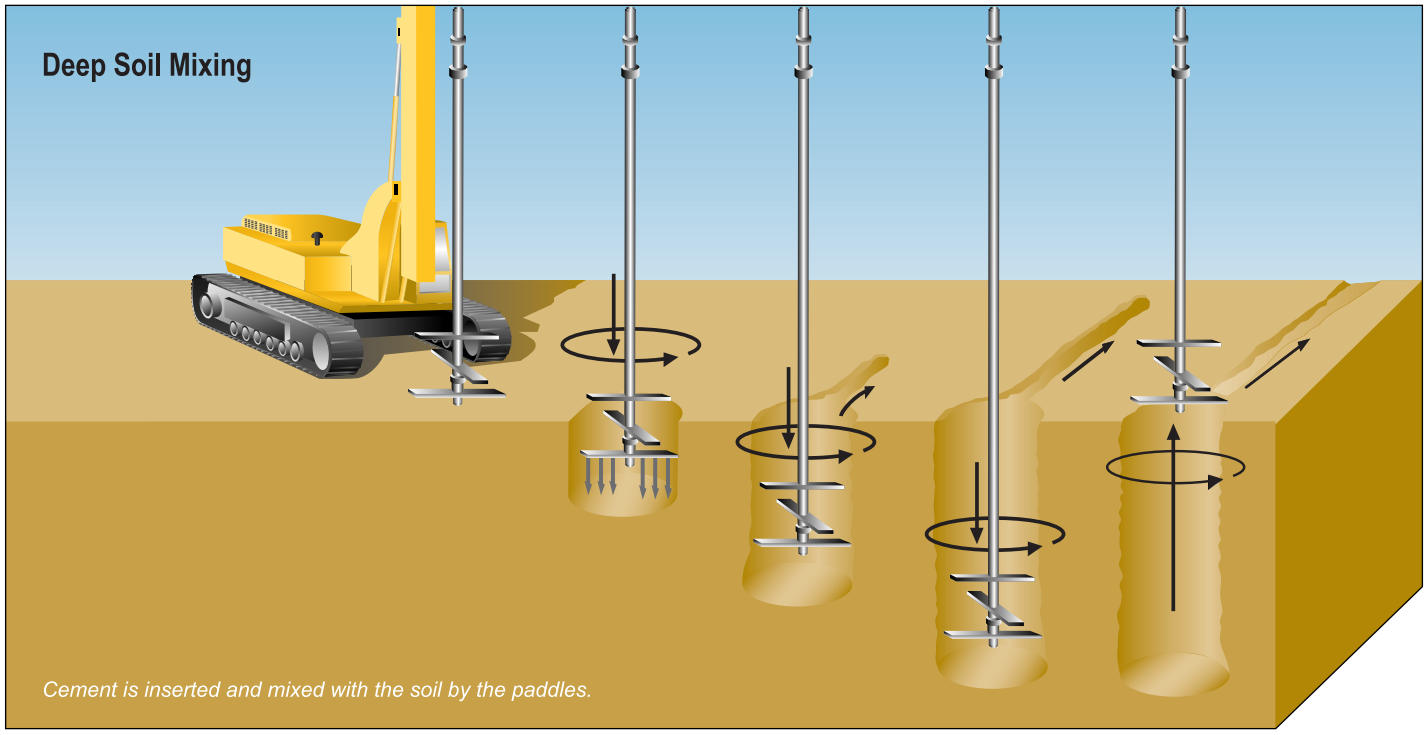
Exhbit 4-1. Secant Pile Wall Construction

Step 4 Place wide rebar cage reinforcement with forming tube. Pour concrete into steel tube — pull out casing.



Step 5 Complete row of secant piles.

Soil Improvement Methods



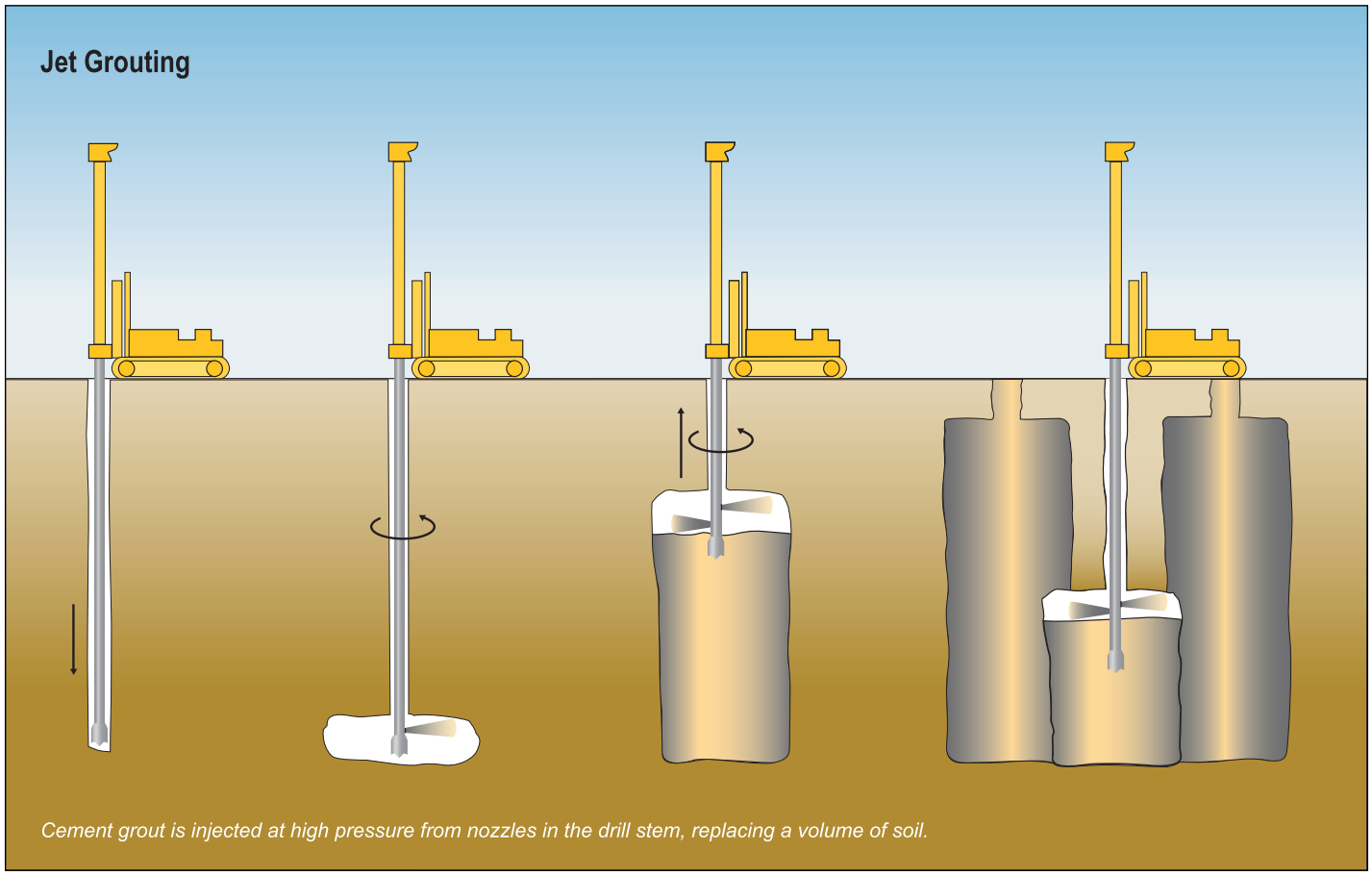


Exhibit 4-2

Soil Improvement Methods

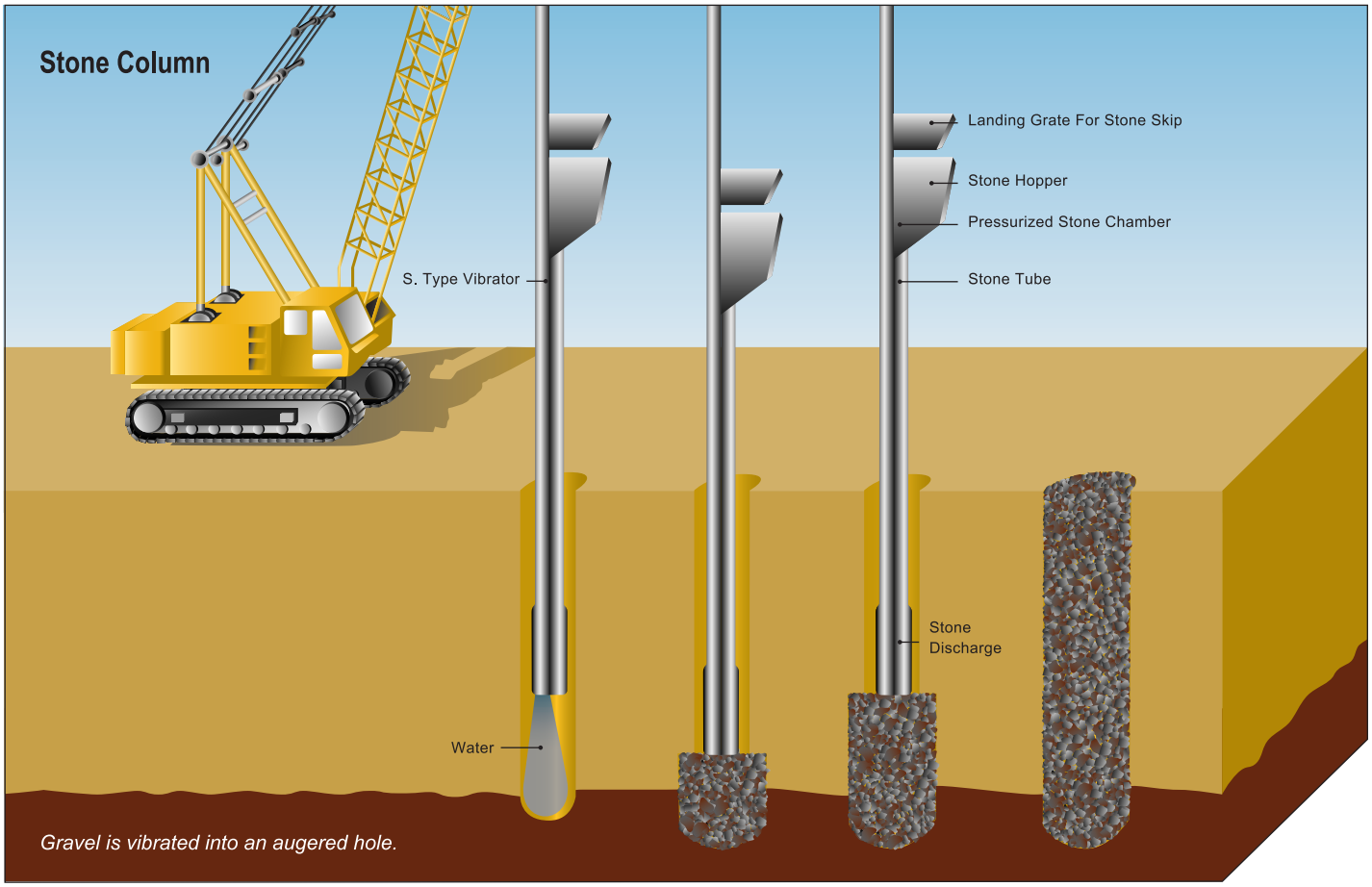


Exhibit 4-2

The construction staging for this Project allows for the deep soil mixing to be completed prior to bridge construction. This would give the deep soil mixing operation unlimited vertical clearance and would improve the construction efficiency. Ground improvements would be needed in an area approximately 50 feet wide below the proposed southbound SR 99 structure between the southern abutment and S. Atlantic Street. Within S. Atlantic Street, a portion of the 50-foot ground improvement area would intersect with utilities and would need to use jet grouting. North of S. Atlantic Street, the deep soil mixing would extend to the west and end at its northern terminus near S. Royal Brougham Way.

Earthquake drains are recommended in a 40-foot-wide band immediately east of the deep soil mixing zone to reduce the potential for liquefaction and reduce lateral pressures imposed on the deep soil mixing zone. Earthquake drains are generally plastic perforated pipe, installed vertically in the ground and spaced at intervals of about 4 to 5 feet apart. They are used to relieve soil pore pressure that builds in a seismic event. This reduces the risk of soil liquefaction. Stone columns also reduce seismic event pore pressures as well as stabilize retained fills against ground settlement.

Ground spoils would be produced by both deep soil mixing and jet grouting. Volumes of spoils would range from 30 to 50 percent of treated ground volume for deep soil mixing and from 50 to 100 percent of treated ground volume for jet grouting. Earthquake drains, stone columns, and displacement piles would produce minimal spoils.

Substructure Installation for Foundations

The proposed foundations for the permanent structures include drilled concrete shafts, cast-in-place concrete piles, and auger-cast piles. The foundations would support steel-reinforced concrete columns and bent caps for all structures except the temporary bridges. Temporary bridge columns and pier caps would be made of steel.

Cast-in-place concrete piles would be used for the southern portion of the bridges carrying SR 99 over S. Atlantic Street. Piles would have 2-foot diameters and would be driven to an average depth of 150 feet. The installation of the concrete piles would entail driving a closed-end, steel pipe pile and casting a concrete pile within the steel pile. The installation would be expected to produce ground vibrations during the pile driving operation, but would produce little or no spoils. A typical pile cap is expected to have a plan dimension of 30 feet by 50 feet and a height of 5 to 7 feet. Approximately 600 cubic yards of soil would be excavated for each pile cap.

The remainder of the mainline bridges, including the transition bridges, would be founded on drilled concrete shafts. The depth of competent soil and the relatively small footprint of drilled shafts make them ideal for this construction. Shafts would most likely be bored using a rotary-oscillator drill rig capable of boring through obstacles within the soil. Each drilled shaft would require the excavation of approximately 250 to 350 cubic yards of soil. A steel reinforcing cage is then placed into the shaft hole, and concrete is tremied to the bottom of the excavation until the hole is filled. The steel excavation casing is extracted as the concrete fills the hole.

Temporary bridges proposed for Traffic Stage 3 would be founded on auger-cast piles or micropiles. These pile types would not produce heavy ground vibrations and would protect the existing utilities from damage. The excavation required for one pile would be approximately 10 cubic yards, with additional excavation required for pile caps. Total excavation volume for both temporary bridges is estimated at approximately 650 cubic yards. The pile would be drilled using an auger drill or a rotary drill. A steel reinforcing cage or bar would then be cast into the hole.

Construction of the mainline substructures would be completed with the casting of the reinforced concrete columns and pier caps. This operation would require the erection of steel reinforcing cages and formwork to support the concrete while it cures. In addition to the formwork, construction machinery and workers would require extensive access around the proposed piers. These activities would need to be coordinated with railroad, port, and general traffic.

Retained Fill Construction

Structural earth walls are proposed for all the retained fills. A structural earth wall is restrained with straps that extend into the embankment, so that the wall does not require large footings to counter overturning forces. This allows the wall to be built in a footprint very close to that of the roadway it is supporting. This construction method works well for construction of facilities that are closely adjacent to the railroads or utilities.

Structural earth walls are built by placing and compacting progressive lifts of soil. Retaining straps made from plastic or steel are placed with the lifts at typically 2-foot vertical spacing. The successive layers of soil and retaining straps create a block of soil that acts as a solid wall. The wall's exterior face is typically wrapped with a metal or plastic mesh to prevent erosion; a system of reinforced concrete face panels may also be connected to the retaining straps. The face panels stop erosion and can be cast with architectural finishes.

Retained Cut Construction

Construction of the retained cut structures would consist of secant piles, ground improvements, excavation, concrete bottom slabs, and finally the interior concrete. The retained cuts would be built using an internally braced excavation support wall. The support wall would be constructed of secant piles.

Excavation of the cut would follow construction of the support wall. Excavation depth is expected to vary between 0 and 40 feet. The maximum depth allows for a concrete seal up to 15 feet thick to be placed at the base of the retained cut. The concrete would be placed with a tremie, and a concrete bottom slab would provide a water barrier to allow the interior of the cut to be dewatered. This is necessary because the existing ground water level is approximately 5 to 10 feet below existing ground surface. The cut would then be pumped empty, and the interior concrete construction and finishes would be completed in dry conditions.

4.3 Construction Activities by Traffic Stage

4.3.1 Traffic Stage 1 (17 months)

Traffic Stage 1 construction activities would include the following:

- Begin utility relocations.
  - Construct a new communications duct bank. The duct bank must be built and operational prior to the ground improvements and construction of the undercrossing later in Traffic Stage 1.
  - Move major electrical lines currently suspended on power poles in the Whatcom Railyard.
  - Remove and replace gas lines.
  - Relocate and replace existing water lines.
  - Relocate and replace combined sewer lines.
  - Construct storm drains as segments of the roadways are completed.
- Construct the temporary Whatcom lead and tail track.
- Modify the existing tail track at S. Atlantic Street, along with final connections to the existing Whatcom Railyard tracks and the existing SIG Railyard south of S. Atlantic Street.
- Construct the west half of the undercrossing, which would consist of drilled secant pile walls, followed by excavation and ground improvements. Ground improvements would be made using either jet grouting or deep soil mixing (refer to Section 4.2.2 above).

- Construct the temporary remote holding area for Seattle Ferry Terminal traffic west of the viaduct.
- Construct the west half of the southbound retained fill
- Construct the southbound WOSCA detour.

4.3.2 Traffic Stage 2 (6 months)

Traffic Stage 2 construction activities would include the following:

- Remove the east half of the existing southbound SR 99 between S. Holgate and S. Massachusetts Streets, and complete the construction of the east half of the southbound retained fill structure near S. Holgate Street.
- Construct the northbound WOSCA detour.

4.3.3 Traffic Stage 3 (8 months)

Traffic Stage 3 construction activities would include the following:

- Demolish the viaduct south of S. Dearborn Street. This would include the removal of the viaduct structure, footings, and piles to a depth of about 2 feet below grade. Pile caps would also be removed.
- Install gas lines.
- Construct the northbound and southbound transition structures, including the necessary ground improvements.
- Begin construction of the east half of the undercrossing.
- Move rail traffic from the temporary Whatcom lead track to the new track alignment.

4.3.4 Traffic Stage 4 (7 months)

Traffic Stage 4 construction activities would include the following:

- Construct the new northbound roadway alignment and associated ground improvements.
- Construct the retained fill roadways at the north and south approaches.
- Complete construction of the east half of the undercrossing and the south portion of the west half of the undercrossing.
- Remove temporary roadways and ramps built for the northbound and southbound WOSCA detours, to allow for the construction of the remaining roadways and new remote holding area for Seattle Ferry Terminal traffic on the east side of the viaduct.

- Complete construction of the final Whatcom lead track and connect to the new tail track with a new turnout. Once the new tail track is operational, the temporary Whatcom lead track would be removed and the east side of Alaskan Way S. would be completed.

4.3.5 Traffic Stage 5 (6 months)

The final stage, Traffic Stage 5, construction activities would include the following:

- Complete the final paving, signage, striping, and landscaping.
- Complete the remote ferry holding area along the east side of SR 99.

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Chapter 5 REFERENCES

PB. 2007. S. Holgate to S. King Street Viaduct Replacement Project: Construction Methods Technical Memorandum. December 2007.

PB. 2008. S. Holgate to S. King Street Viaduct Replacement Project: Construction Staging, Phasing and Traffic Control Strategy Report. March 2008.

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