Discipline Report

Water Quality

Prepared by:

KPFF Consulting Engineers

Shannon and Wilson, Inc.

April 2005

Seattle Department of Transportation
Agreement No. T01-34

Draft EIS

Magnolia Bridge Replacement

City of Seattle

Contents

Contents ... i

Purpose and Need ... 1

Purpose ... 1

Need ... 1

Structural Deficiencies ... 1
System Linkage ... 1
Traffic Capacity ... 4
Modal Interrelationships ... 4
Transportation Demand ... 4
Legislation ... 5

Description of Alternatives ... 7

No-Build Alternative ... 7

Alternative A ... 8

Alternative C ... 8

Alternative D ... 8

Methods ... 17

Applicable Regulations and Policies ... 17

Federal ... 17
State of Washington ... 17
City of Seattle ... 18

Surface Water Methods ... 18

Groundwater Methods ... 19

Affected Environment ... 21

Historic Environment ... 21

Existing Built Environment ... 22

Topography ... 22
Climate ... 22
Drainage Basins and Watersheds ... 22
Drainage Pathways ... 25
Surface Water Resources ... 30
Elliott Bay Water Quality ... 30
Elliott Bay Sediment Quality ... 33

Sediment Dynamics 35
Structural Nearshore Limiting Factors 35
Aquatic ESA Status 36
Public Water Supply and Wastewater Systems 36
Groundwater 36
Aquifer Systems 37
Shallow Unconfined Aquifer System 37
Upland Aquifer System 38
Deep Artesian Aquifer System 38
Groundwater Rights 39
Public Drinking Water Wells 39
Sole Source Aquifers 39
Wellhead Protection Areas 39
Critical Aquifer Recharge Areas 39
Studies and Coordination 41
Studies 41
Data Sources 41
Impacts 43
Surface Water Impacts 43
Operational Impacts 43
No-Build Alternative 43
Alternatives A, C, and D 43
Pollutant Loading Estimate 44
Existing Outfall Capacity 45
Shoreline Impacts 46
No-Build Alternative 47
Alternative A 47
Alternative C 47
Alternative D 47
Secondary and Cumulative Impacts 51
Groundwater 51
Operational Impacts 51
No-Build Alternative 51
Alternatives A, C, and D 51
Secondary and Cumulative Impacts 51
Mitigation Measures 53
Surface Water 53
Stormwater Management Requirements 53
Operational Mitigation 54
No-Build Alternative 54
Alternatives A, C and D 54
Shoreline Mitigation 55

Alternative A 55
Groundwater 55
Operational Mitigation 55
No-Build Alternative 55
Alternatives A, C and D 55
Construction Impacts 57
Surface Water 57
Impacts 57
No-Build Alternative 57
Alternatives A, C and D 57
Mitigation 59
Groundwater 59
Impacts 59
No-Build Alternative 59
Alternatives A, C, and D 59
Mitigation 60
Summary of Findings 61
Affected Environment 61
Surface Water 61
Groundwater 61
Impacts 62
Operational Impacts 62
Surface Water 62
Groundwater 64
Shoreline Impacts 64
Secondary and Cumulative Impacts 64
Construction Impacts 64
Surface Water 64
Groundwater 64
Mitigation Measures 65
Operational Mitigation 65
Surface Water 65
Groundwater 65
Shoreline Mitigation 65
Construction Mitigation 66
Surface Water 66
Groundwater 66

References 67

Appendix A..1

Depth to Shallow Groundwater Figures 1

Appendix B..9

Water Quality Elements Checklist Summary 9

List of Figures

Figure 1 Vicinity Map..2
Figure 2 Study Area 3
Figure 3 Typical Sections – No-Build Alternative 9
Figure 4 Typical Sections – Build Alternatives 10
Figure 5 No-Build Alternative 11
Figure 6 Alternative A - Intersection...12
Figure 7 Alternative A - Ramps 13
Figure 8 Alternative C...14
Figure 9 Alternative D - Intersection...15
Figure 10 Alternative D - Ramps...16
Figure 11 Project Vicinity in Historic Smith Cove Estuary...........................21
Figure 12 Project Vicinity in Nearshore Subwatershed, WRIA 9 23
Figure 13 Existing Bridge Drains...25
Figure 14 Existing Stormwater / Combined Facilities..................................27
Figure 15 Surrounding Parks/Greenspaces...29
Figure 16 King County Ambient Monitoring Stations...................................32
Figure 17 Sampling Stations in Elliott Bay 34
Figure 18 Shoreline Zone and Alternative Locations 49

Purpose and Need

Purpose

The purpose of this project is to replace the existing Magnolia Bridge structure, approaches, and related arterial connections with facilities that maintain convenient and reliable vehicular and non-motorized access between the Magnolia community and the rest of the City of Seattle. The bridge provides an important link to the Magnolia community in Seattle (see Figure 1 and Figure 2). Since the existing bridge also provides the only public vehicular access to the land between North Bay, also referred to as Terminal 91, Smith Cove Park, Elliott Bay Marina, and U.S. Navy property, the project purpose also includes maintenance of access to these areas.

Need

Structural Deficiencies

The City of Seattle has identified the Magnolia Bridge as an important bridge that should remain standing following a "design" seismic event (an earthquake with a peak ground acceleration of 0.3g that is anticipated to happen every 475 years and may measure 7.5 on the Richter Scale). Even with the repairs completed following the February 2001 earthquake, the existing bridge is susceptible to severe damage and collapse from an earthquake that is less severe than the "design" seismic event.

The original bridge was constructed in 1929 and has been modified, strengthened, and repaired several times. The west end of the bridge was damaged by a landslide in 1997, requiring repair and replacement of existing bridge columns and bracing, the construction of six additional supports, and a retaining wall north of the bridge to stabilize the bluff from further landslides. Repairs after the 2001 earthquake included replacement of column bracing at 27 of the 81 bridge supports. A partial seismic retrofit of the single-span bridge structure over 15th Avenue West was completed in 2001. The other spans were not upgraded.

Inspections of the bridge conclude that the concrete structure is showing signs of deterioration. The concrete is cracking and spalling at many locations, apparently related to corrosion of the reinforcing steel. The bridge requires constant maintenance in order to maintain its load capacity, but there does not appear to be any immediate load capacity problem. The existing foundations have insufficient capacity to handle the lateral load and uplift forces that would be generated by a "design" seismic event. The existing foundations do not extend below the soils that could liquefy during a "design" seismic event. If the soils were to liquefy, the foundations would loose their vertical load carrying ability and the structure would collapse.

System Linkage

There are three roadway connections from the Magnolia community, of over 20,000 residents, to the rest of Seattle. As the southernmost of the three connections, the Magnolia Bridge is the most direct route for much of south and west Magnolia to downtown Seattle and the regional freeway system.

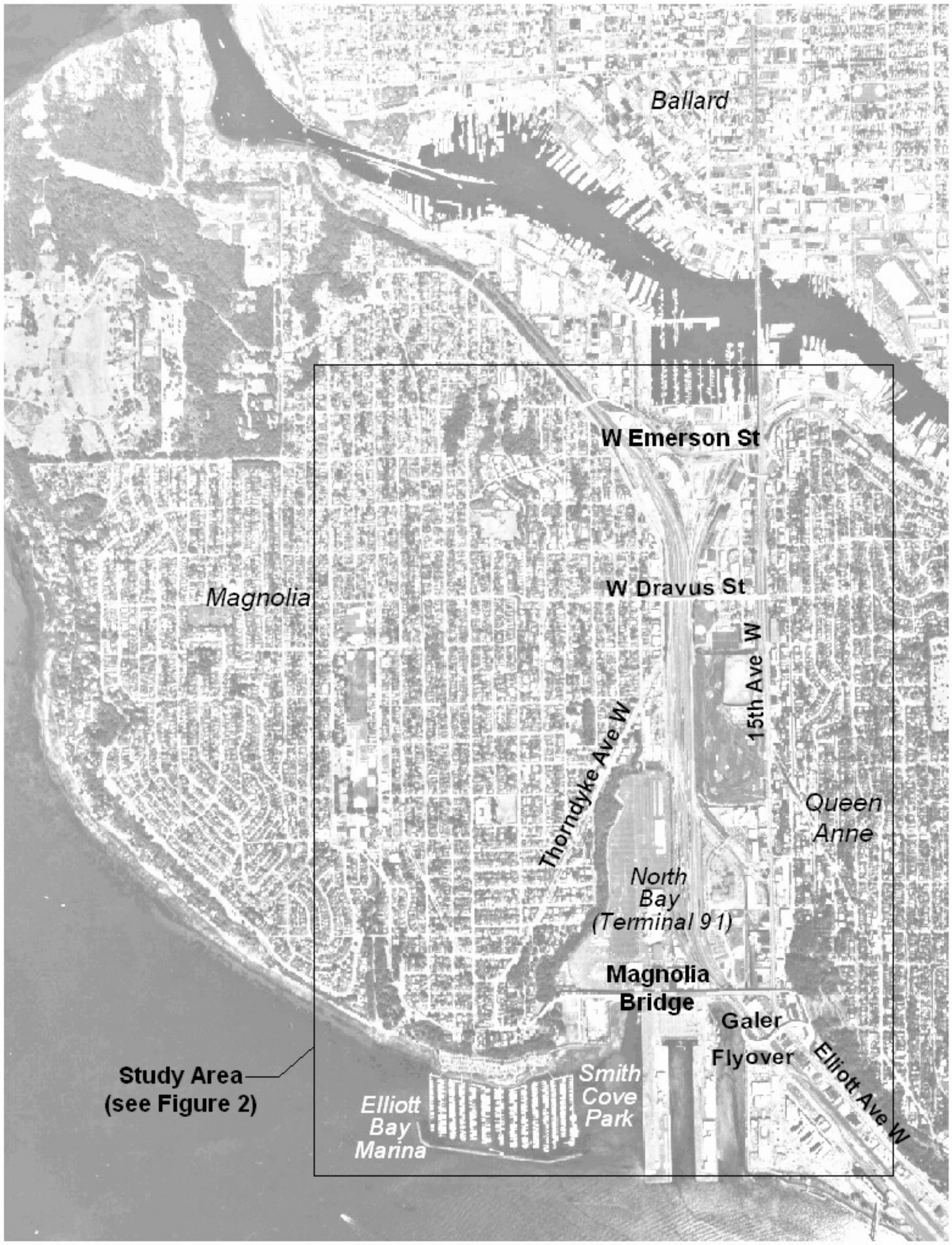


Figure 1
Vicinity Map

In meetings with the public and the Seattle Fire Department, the importance of this route for emergency services has been emphasized. The loss of use of this bridge in 1997 and again in 2001 demonstrated to the City that the remaining two bridges do not provide acceptable operation. During the bridge closure following the February 2001 earthquake, the City addressed community concerns about reduced emergency response time to medical facilities outside of Magnolia by 24-hour stationing of paramedics at Fire Station 41 (2416 34th Avenue West).

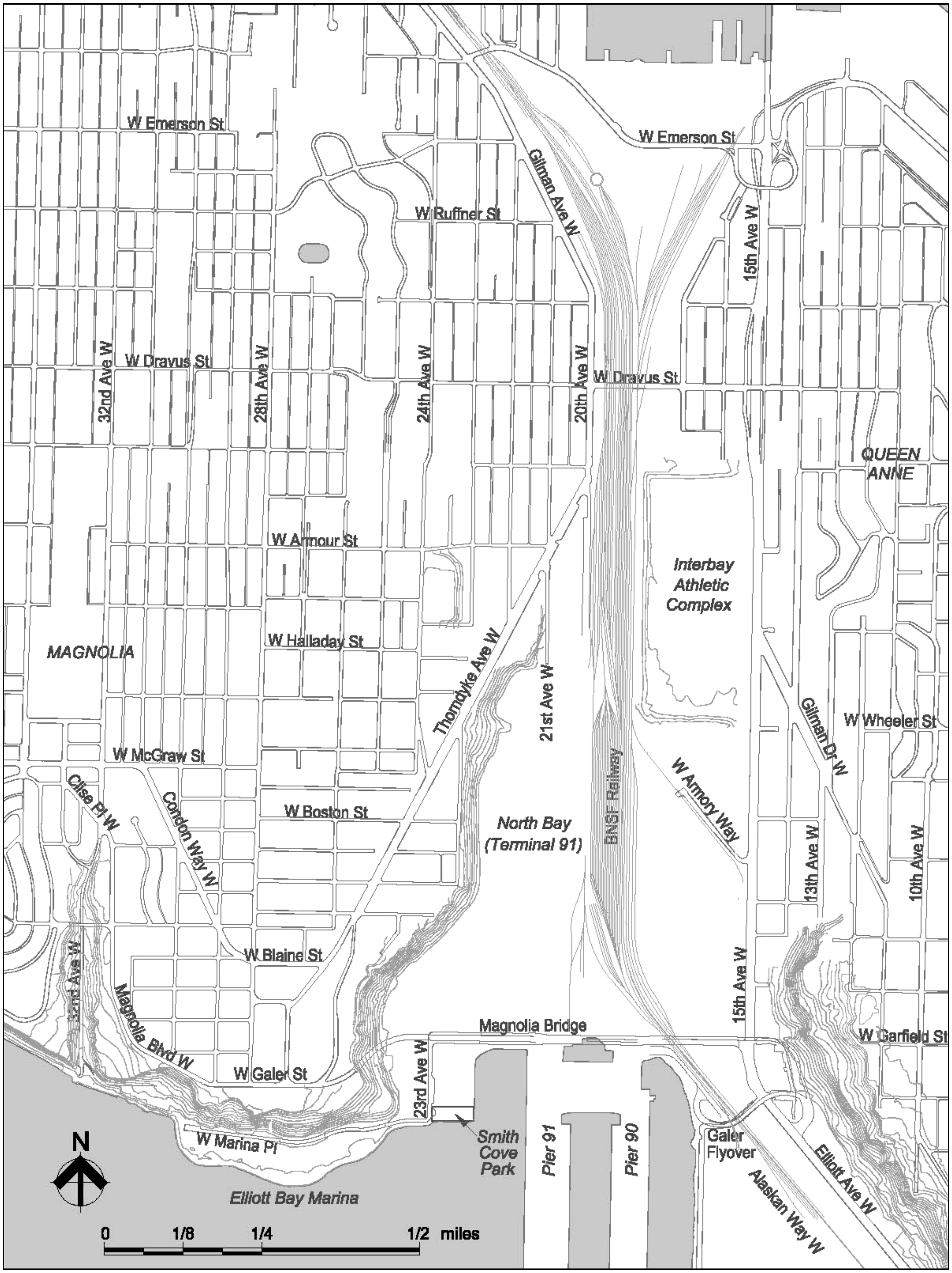


Figure 2
Study Area

Traffic Capacity

The three Magnolia community connections to the 15th Avenue West corridor are adequate for the present volume of traffic. Each of the three connections carries about 30 to 35 percent of the 60,100 daily vehicle trips (2001 counts) in and out of the Magnolia community. Loss of the use of the Magnolia Bridge for several months after the February 2001 earthquake, and in 1997 following the landslide at the west end of the bridge, resulted in lengthy 15 to 30 minute delays and increased trip lengths for many of the users of the Magnolia Bridge. These users were required to use one of the two remaining bridges at West Dravus Street and West Emerson Street. Travel patterns in the Magnolia community changed substantially resulting in negative impacts on local neighborhood streets. The increase of traffic through the West Dravus Street and West Emerson Street connections also resulted in congestion and delay for the regular users of these routes. Losing the use of any one of these three bridges would result in redirected traffic volumes that would overwhelm the capacity of the remaining two bridges.

Modal Interrelationships

The Magnolia Bridge carries three of the four local transit routes serving Magnolia and downtown Seattle destinations. The topography of the east side of Magnolia, East Hill, would make access to the 15th Avenue West corridor via the West Dravus Street Bridge a circuitous route for transit. Use of the West Emerson Street connection to 15th Avenue West would add significant distance and travel time for most trips between Magnolia and downtown Seattle.

The Magnolia Bridge has pedestrian facilities connecting the Magnolia neighborhood to Smith Cove Park and Elliott Bay Marina as well as to 15th Avenue West/Elliott Avenue West. These facilities need to be maintained. The Elliott Bay multi-use trail connects Magnolia with downtown Seattle through Myrtle Edwards Park. The trail passes under the Magnolia Bridge along the west side of the BNSF rail yard, but there are no direct connections to the bridge.

Bicycle facilities on the Magnolia Bridge need to be maintained or improved. Even with the steep (about 6.3 percent) grade, bicyclists use the Magnolia Bridge in both directions. There are no bike lanes on the bridge, so bicyclists use the traffic lanes and sidewalks. Once bicyclists cross the bridge, they must either travel with motor vehicles on Elliott Avenue West or find a way back to the Elliott Bay Trail using local east-west streets such as the Galer Flyover.

Transportation Demand

The existing Magnolia Bridge provides automobile access for Port of Seattle North Bay (Terminal 91) to and from the Elliott Avenue West/15th Avenue West. Truck access between Terminal 91 and Elliott Avenue West/15th Avenue West is accommodated via the Galer Flyover. Future planned expansion of the Amgen facility on Alaskan Way West and redevelopment of underutilized portions of North Bay and other areas of Interbay will increase demand for traffic access to the Elliott Avenue West/15th Avenue West corridor. The Port of Seattle has a master planning process underway (July 2003) for its North Bay property (Terminal 91) and the Washington National Guard property east of the BNSF Railway between West Garfield Street and West Armory Way. This area contains 82 acres available for redevelopment. There are also 20 or more acres of private property available for redevelopment east of the BNSF Railway between West Wheeler Street and West Armory Way. Redevelopment of the North Bay property will include public surface streets with connections to the replacement for the Magnolia Bridge. Forecasts of future (year 2030) traffic demand indicate that the access provided by the Galer Flyover and West Dravus Street would be inadequate. The capacity provided by the existing Magnolia Bridge or its replacement would also be needed.

Legislation

Seattle Ordinance 120957, passed in October 2002, requires the Magnolia Bridge Replacement Study: identify possible additional surface roads from Magnolia to the waterfront (avoiding 15^{th} Avenue West and the railroad tracks); obtain community input on the proposed roads; and identify the cost for such road and include it in the total cost developed in the Magnolia Bridge Replacement Study.

Description of Alternatives

An alignment study process was implemented to help identify the specific bridge replacement alternatives to be studied in the EIS. Twenty-five concepts were developed and screened against the project goals and objectives. This resulted in nine alignment alternatives, identified as A through I, that merited further analysis. These nine went through an extensive public review and comment process as well as project screening criteria and prioritization. Initially, the top four priority alternatives, A, B, D, and H, were identified to be studied in the EIS. Early on, Alternative B was eliminated because it became clear that it violated City shoreline policies and Federal section 4(f) criteria. Upon detailed traffic analysis Alternative H was eliminated because two key intersections were predicted to function at a level of service F and could not be mitigated. The next priority, Alternative C, was then carried forward for analysis in the EIS.

Independent of this project, a new north-south surface street will be constructed on Port of Seattle property connecting 21st Avenue West at the north end of North Bay with 23rd Avenue West near Smith Cove Park. In addition, a southbound ramp will be added to the Galer Flyover to accommodate eastbound to southbound Elliott Avenue West traffic movements. The Galer Flyover ramp has been identified as a needed improvement for expected future development of property west of the railroad tracks. New surface streets through the Port of Seattle property will be located through the Port's master planning process for the North Bay property. The north-south surface street and ramp are assumed to exist in any build alternative, but are not part of this environmental process.

Typical sections and plans of the build and no-Build Alternatives are located at the end of this section.

No-Build Alternative

The No-Build Alternative, shown in Figure 3 and Figure 5, would maintain the existing bridge structure in place with the existing connections at the east and west ends. Long term strategies for maintaining the existing structure would be required for the No-Build alternative. To keep the existing bridge in service for over ten years, the following would need to be accomplished:

- An in-depth inspection of the bridge would be required to determine needed repairs and a long-term maintenance program.
- Concrete repairs would be required. These repairs could include injection of cracks with epoxy grout, repair of spalled concrete, and replacement of deficient concrete and grout.
- Preservation measures to slow corrosion of the reinforcement would be required. These measures could include a cathodic protection system.
- Any structural elements that lack the capacity to carry a tractor-trailer truck with a 20-ton gross trailer weight would need to be identified, modeled, and strengthened.

Alternative A

Alternative A would replace the existing bridge with a new structure immediately south of the existing bridge as shown in Figure 4 and Figure 6. The alternative would construct a signalized elevated intersection (Alternative A – Intersection) in the bridge's mid-span to provide access to the waterfront and the Port of Seattle North Bay property from both the east and the west. Connections at the east and west ends of the bridge would be similar to the existing bridge.

An optional half-diamond interchange (Figure 7 Alternative A - Ramps) could be constructed in lieu of the elevated intersection to provide access to the waterfront and the Port of Seattle North Bay property to and from the east only.

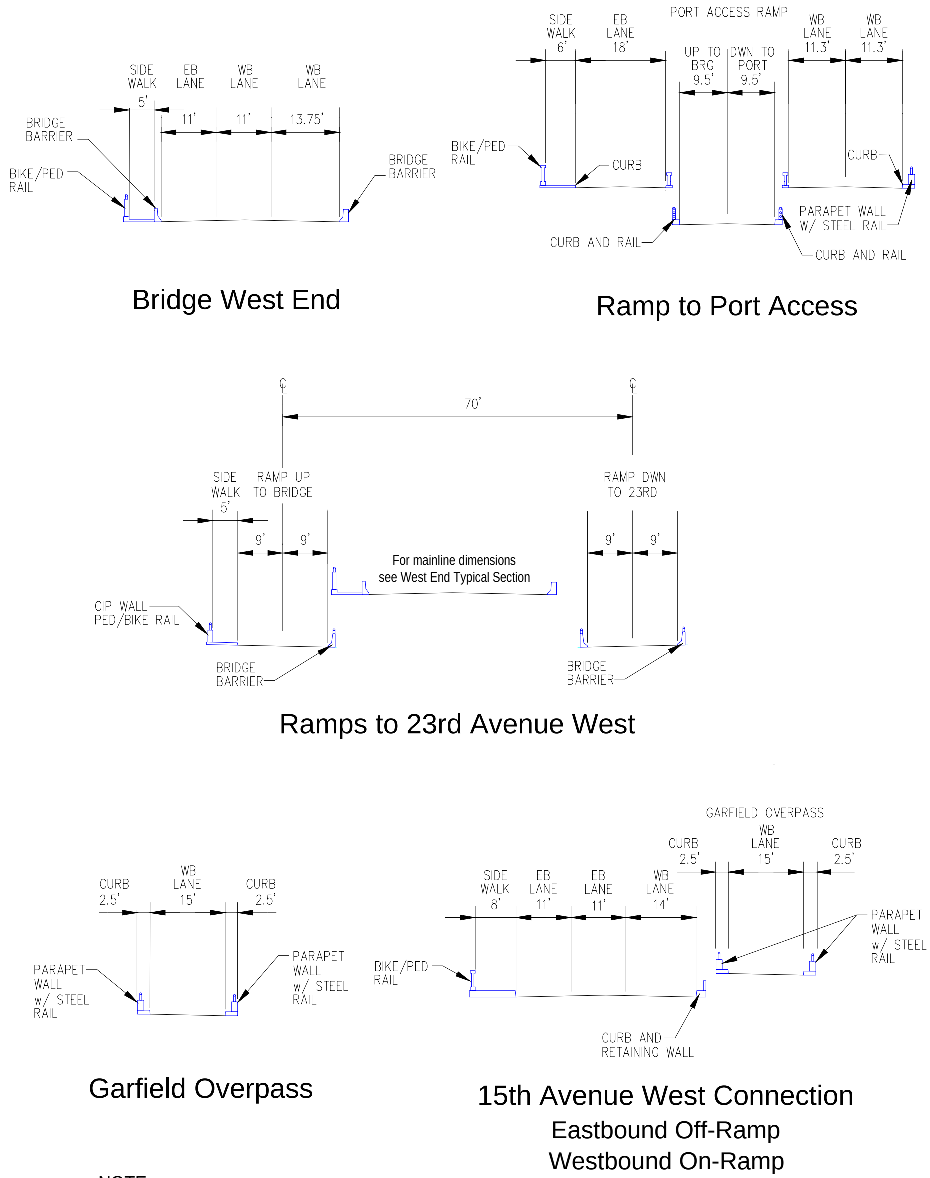
Alternative C

Alternative C would provide 2,200 feet of surface roadway within the Port of Seattle North Bay property between two structures as shown in Figure 4 and Figure 8. The alternative would descend from Magnolia Bluff on a structure running along the toe of the slope. The alignment would reach the surface while still next to the bluff, before turning east to an intersection with the north-south surface street. The alignment would continue east from the intersection, turning south along the west side of the rail yard. The alignment would rise on fill and structure, turning east to cross the railroad tracks and connect to 15th Avenue West.

Alternative D

Alternative D would construct a new bridge in the form of a long arc north of the existing bridge, as shown in Figure 4 and Figure 9. Connections at the east and west ends of the bridge would be similar to the existing bridge. This alternative would construct a signalized elevated intersection (Alternative D – Intersection) in the bridge mid-span to provide access to the waterfront and Port of Seattle North Bay property from both the east and the west.

An optional half-diamond interchange (Figure 10 Alternative D - Ramps) could be constructed in lieu of the elevated intersection to provide access to the waterfront and the Port of Seattle North Bay property to and from the east only.



NOTE:
Dimensions are approximate and obtained from construction plans and aerial photographs. The information shown has not been field verified.

Figure 3
Typical Sections – No-Build Alternative

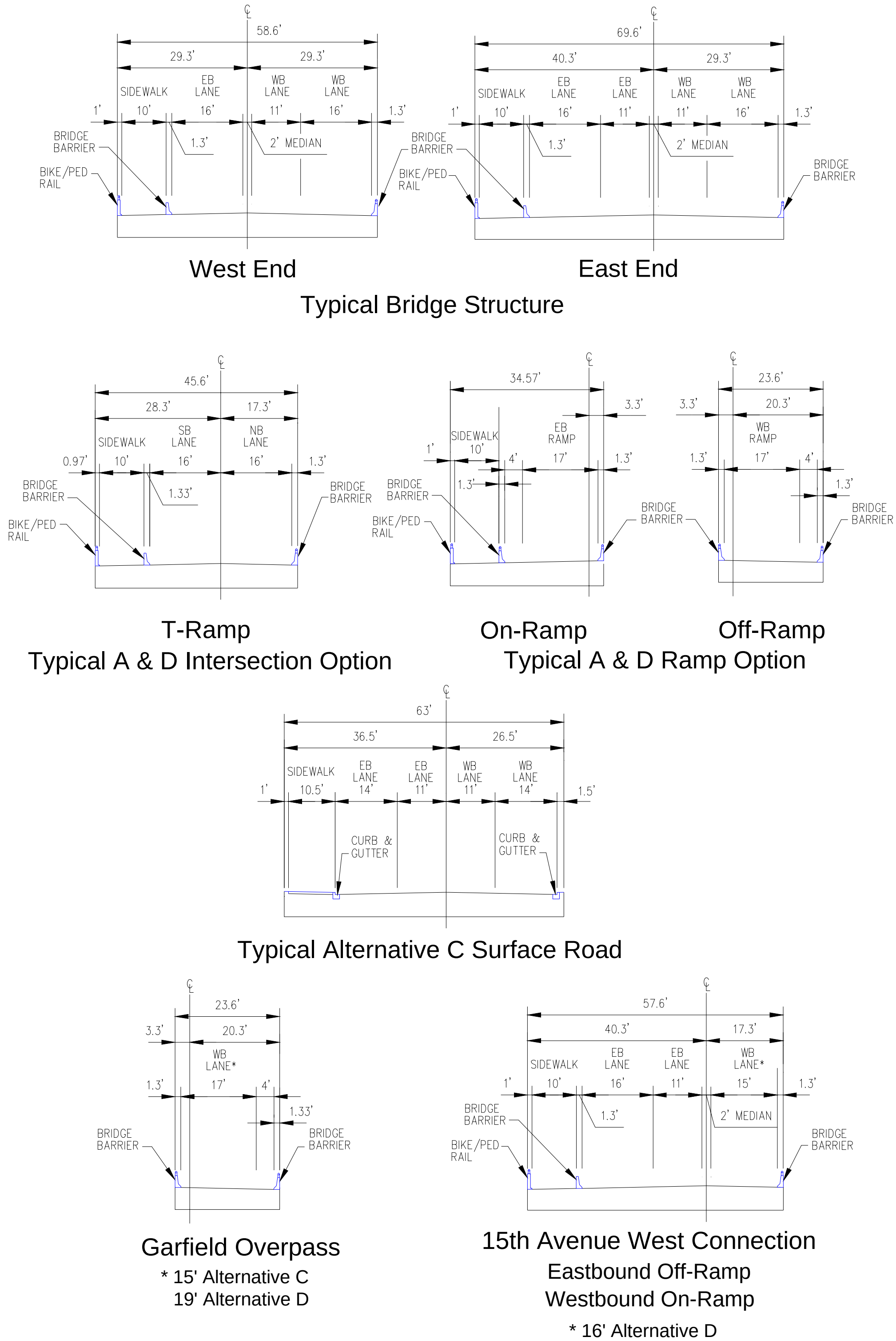


Figure 4
Typical Sections – Build Alternatives

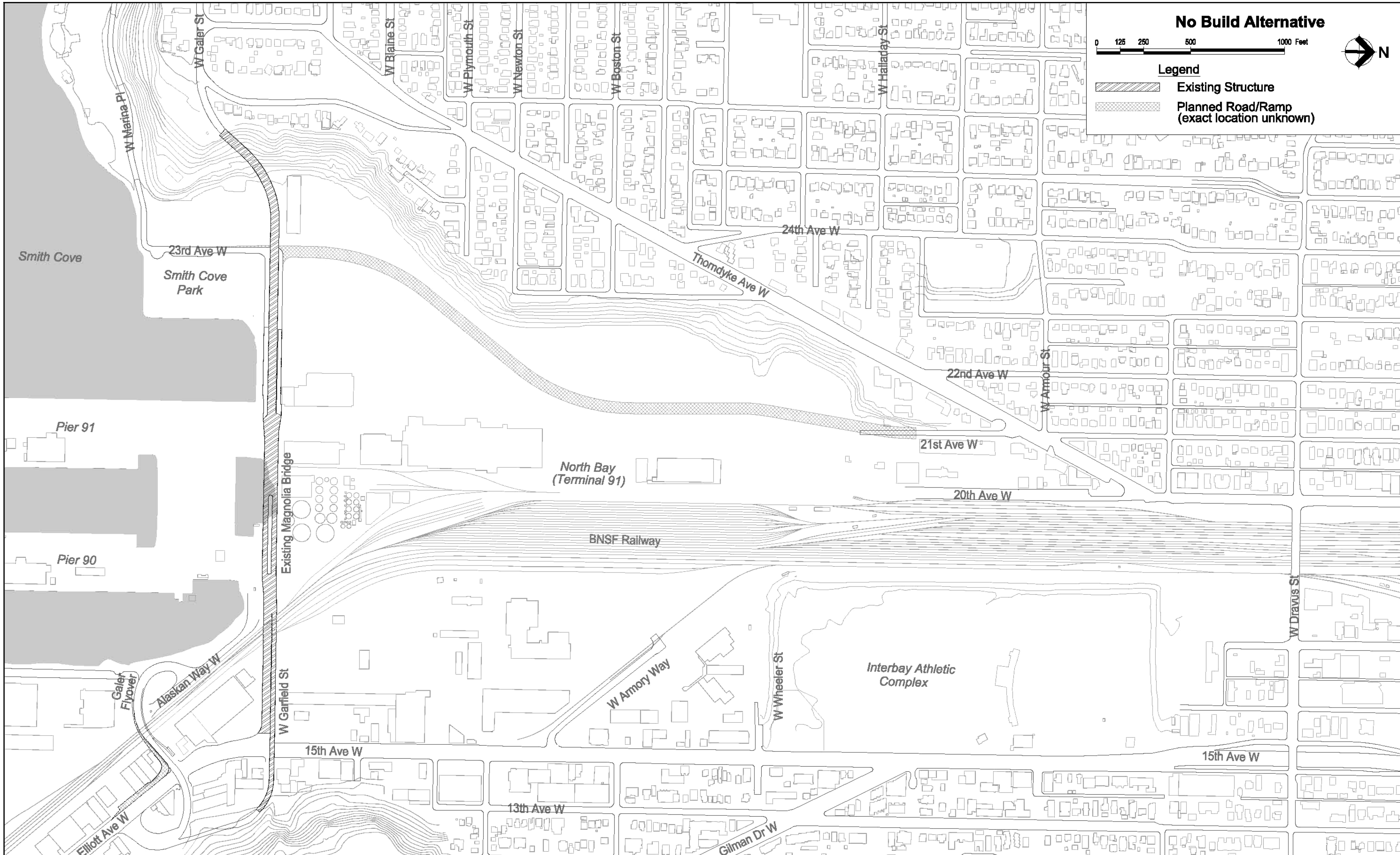


Figure 5 No-Build Alternative

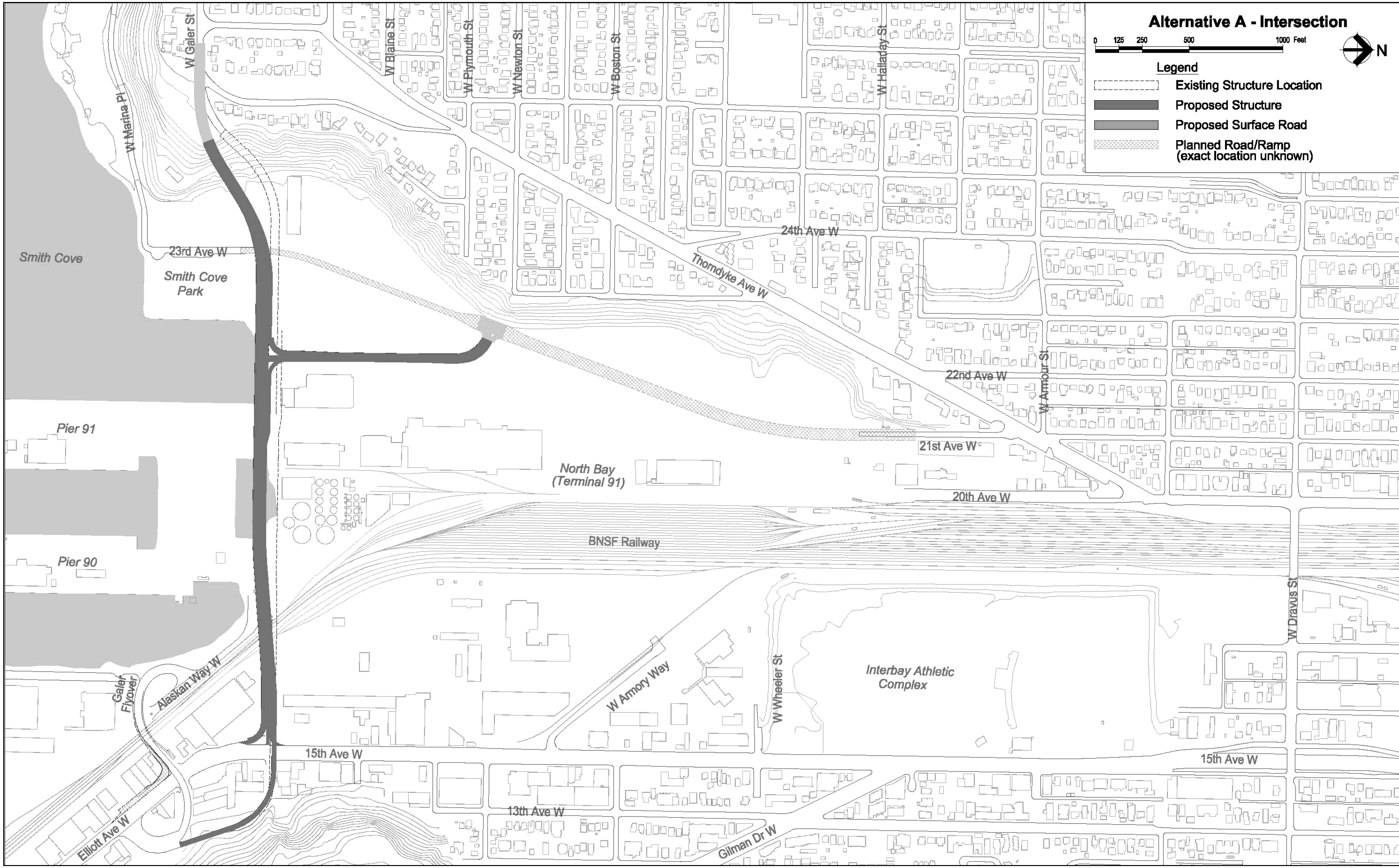


Figure 6 Alternative A - Intersection

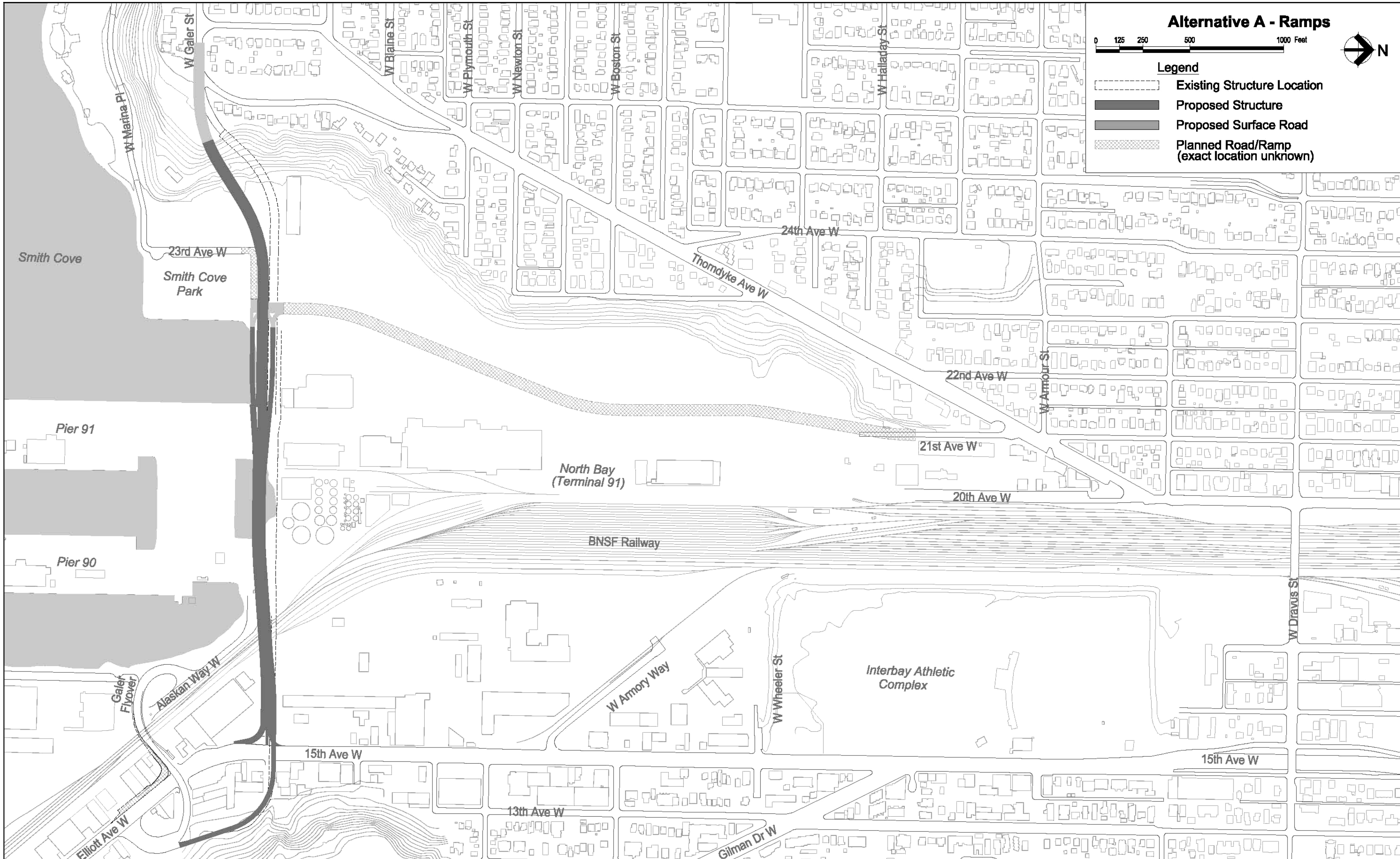


Figure 7 Alternative A - Ramps

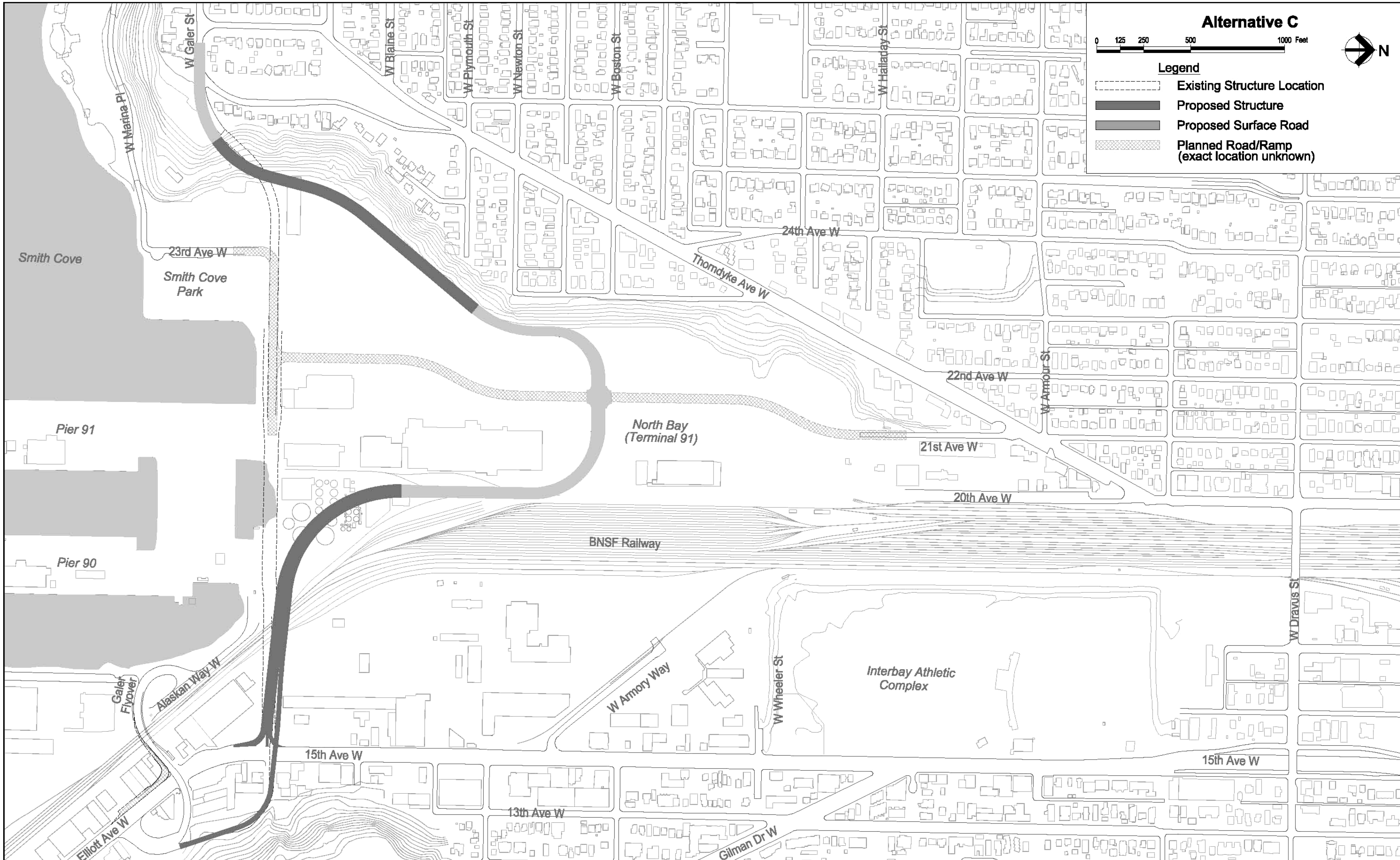


Figure 8 Alternative C

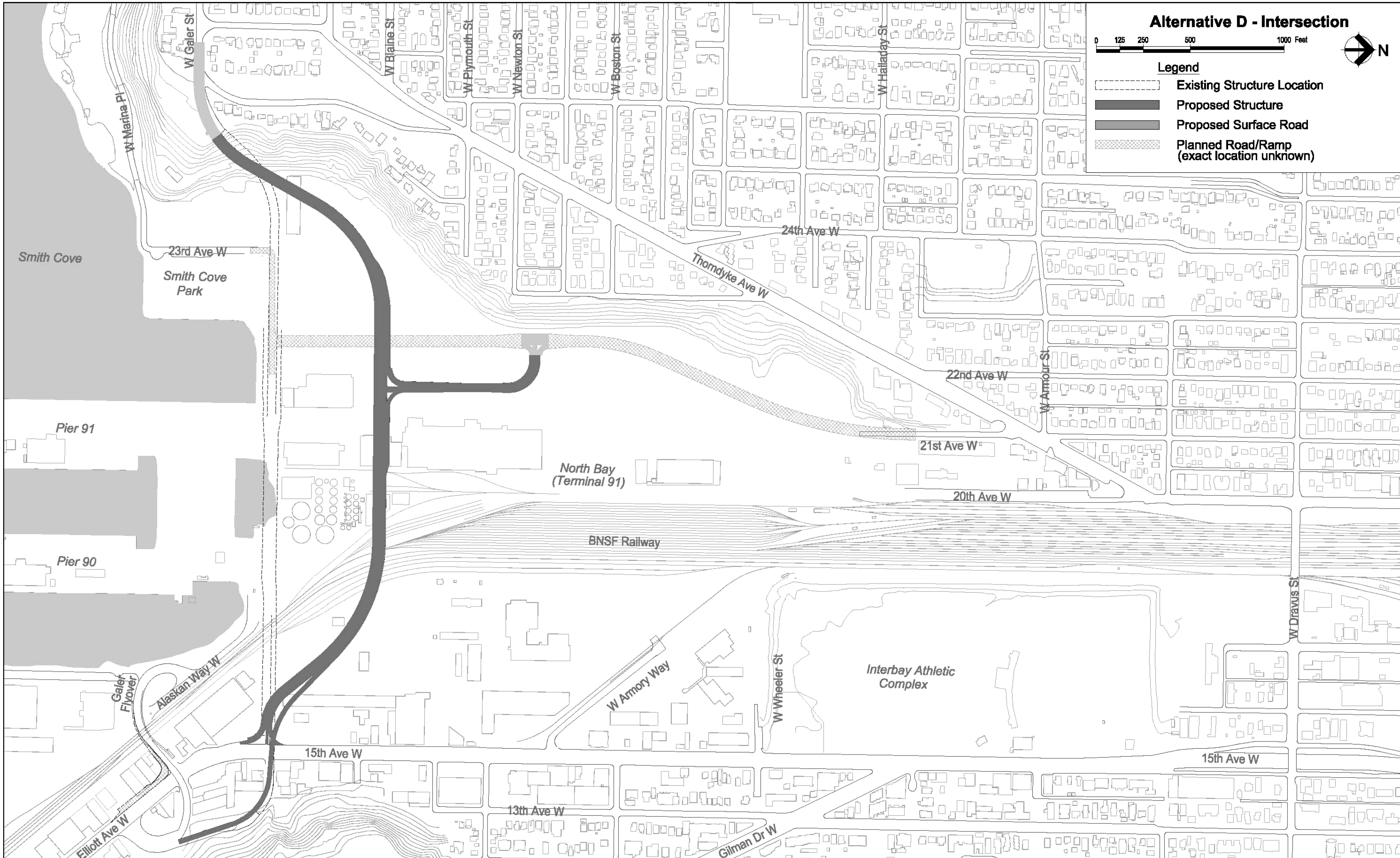


Figure 9 Alternative D - Intersection

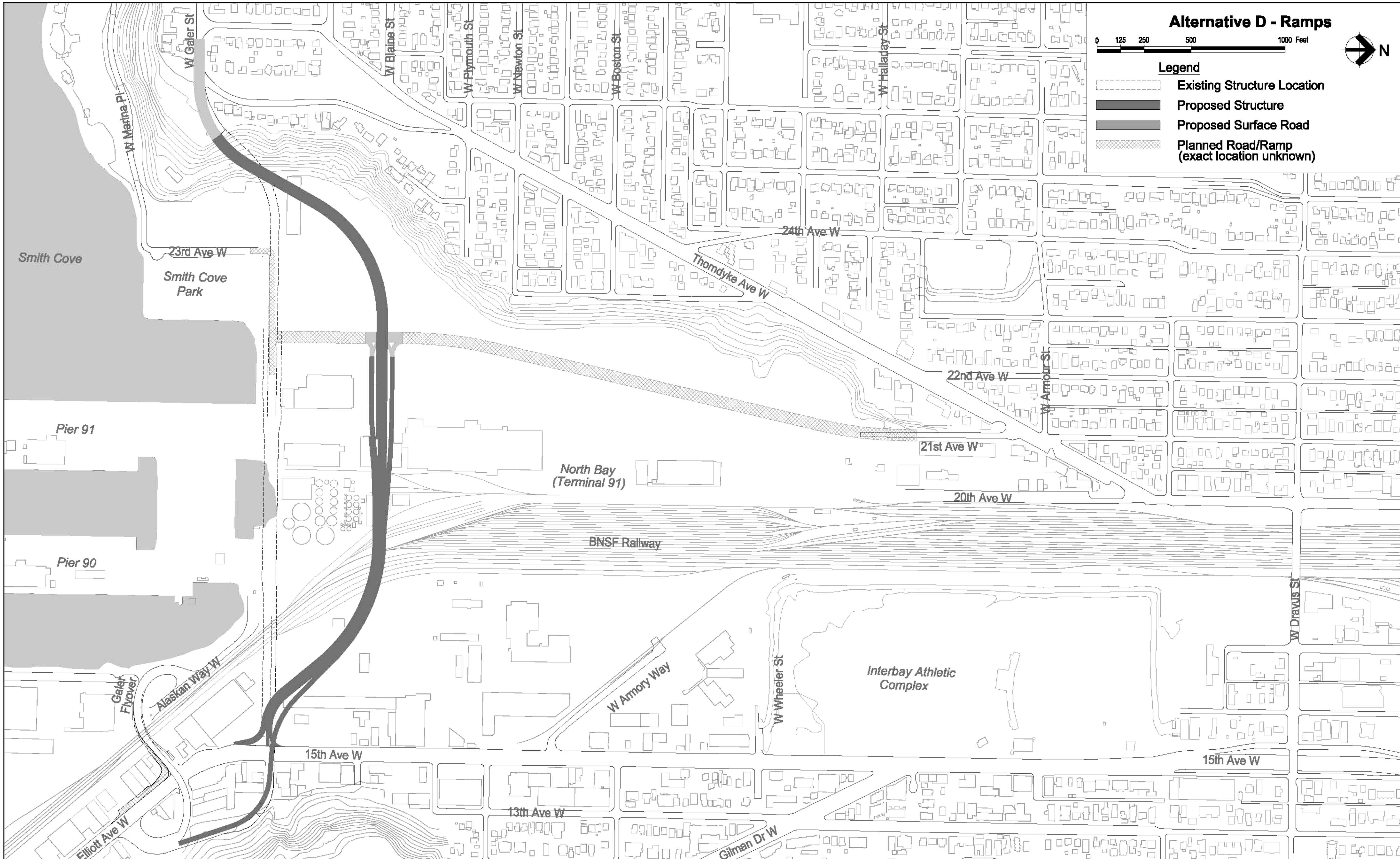


Figure 10 Alternative D - Ramps

Applicable Regulations and Policies

This water quality discipline report has been prepared consistent with the guidelines contained in Section 431 of the Washington State Department of Transportation (WSDOT) *Environmental Procedures Manual, M31-1*.

Applicable regulations, policies and rules as they relate to the project are as follows.

Federal

Under the Clean Water Act (CWA) Section 402: NPDES State Waste Discharge Individual Permit for Process Water and Storm Water, an NPDES permit is required for any discharge of pollutants into the waters of the United States. Permitted discharges must satisfy discharge permit requirements under Section 402 of the CWA and 90.48 RCW. The project will need to comply with the City of Seattle's NPDES wastewater and stormwater permits.

In addition, an NPDES permit may be required for potential modification of existing outfall(s). Because more than one acre of land will be disturbed during construction, a construction stormwater general permit will also be required for all of the Build Alternatives.

State of Washington

Through the Washington Administrative Code (WAC), The Washington State Department of Ecology (DOE) regulates discharge to surface waters of the State. The following applicable Chapters in the WAC address water quality:

- 173-201A WAC: Water Quality Standards for Surface Waters of the State of Washington. This WAC summarizes state standards for ambient water quality (Elliott Bay) and is part of the Section 401 Water Quality Certification process. The certification process examines effects of the proposed project related to the State standards and beneficial use. The Antidegredaton Policy, also included in this WAC, protects waters quality from being lowered by human activities or at least minimizing impacts by application of all known, available and reasonable methods of prevention, control and treatment (AKART).
- 173-204 WAC: Sediment Management Standards. This WAC sets standards for sediment quality in Puget Sound. Ecology recommends that models be used to evaluate the effect of a discharge on sediments.
- 173-500-040 WAC: Water Resource Inventory Areas (WRIA's). This WAC divides the State's waters into 62 areas for the purposes of watershed planning and management.

The Department of Fish and Wildlife requires a Hydraulic Project Approval (HPA) for all work performed within the ordinary high-water mark.

WSDOT's Highway Runoff Manual applies for design of water quality treatment Best Management Practices (BMP's) for roadway runoff. Instructional Letter 4020.02 provides guidance on sizing water quality BMP's to address concerns raised by the Endangered Species Act (ESA).

City of Seattle

The City of Seattle Stormwater, Grading & Drainage Control Code (Title 22.800) mandates that stormwater detention and water quality treatment facilities shall be installed and maintained to treat that portion of the site being developed.

The Code states that detention should be provided so that the "peak drainage water discharge rate from the portion of the site being developed shall not exceed 0.2 cubic feet per second per acre under the 25-year, 24-hour design storm conditions or 0.15 cubic feet per second per acre under the 2-year, 24-hour design storm conditions unless the site discharges directly to a designated receiving water (such as Elliot Bay) or to a public storm drain which the Director of SPU determines has sufficient capacity to carry existing and anticipated loads from the point of connection to a designated receiving water body."

The City of Seattle 1988 CSO Control Plan outlines a program to reduce Combined Sewer Overflows (CSOs) for seven priority basins, including Elliott Bay.

The City of Seattle Municipal Code (Title 25.09) regulates development in and provides development standards for environmentally critical areas, such as steep slopes, liquefaction prone areas, landside-prone areas, etc. Refer to the "Land Use" Discipline Report for additional information.

The City of Seattle Municipal Code (Title 23.60) regulates development within 200 feet of ordinary high water (Shoreline Overlay District). Refer to the "Land Use" Discipline Report for additional information.

Surface Water Methods

The water quality analysis presented in this document is comprised of a direct qualitative and quantitative comparison of water quality impacts (both short-term and long-term) with baseline data available for the project area. Data sources and content are discussed in detail in later sections of the report.

Short-term water quality impacts due to construction are primarily associated with land disturbance and potential impacts resulting from erosion and sediment transport and direct in-water work. The alternative comparison will focus on the estimated area of disturbance, proximity to existing shoreline, and amount of in-water work.

Because collected surface water runoff from the project area discharges directly into Elliot Bay, long-term water quality impacts are analyzed and compared with regard to predicted quality (pollutant loading) of surface water runoff associated with the proposed alternatives (i.e., no surface water quantity analysis is required).

Pollutant generating impervious surface (PGIS) areas are computed for the baseline condition and compared with each alternative. Pollutant loading via surface water runoff is analyzed qualitatively, based on the following premises:

- Project is a bridge replacement project, and no additional capacity for increased traffic will result from any of the proposed alternatives;
- Replacement of the existing bridge will require surface water quality treatment Best Management Practices (BMP's) to be employed, where there is no treatment of runoff from the existing bridge today.

Surface water runoff quantities are estimated for the baseline condition and for each alternative using the Santa Barbara Urban Hydrograph (SBUH) method, primarily as a means for preliminarily evaluating whether existing outfalls will be able to convey the required peak flows.

Groundwater Methods

Groundwater flow system information was compiled by reviewing subsurface data from water well and resource protection well reports obtained from the Washington State Department of Ecology. Boring logs and subsurface profiles were also obtained from the files of Shannon & Wilson, the City of Seattle, the Seattle-Area Geologic Mapping project office, the Port of Seattle, and published groundwater resource reports from the U.S. Geological Survey. Groundwater level monitoring data from Terminal 91 were obtained from the Port of Seattle. These data were used to develop the description of the groundwater flow system in the vicinity of the Proposed Action.

Information pertaining to the presence of groundwater rights, public water supply wells, wellhead protection areas, sole source aquifers, and aquifer recharge areas was assessed through the Ecology Water Resources Program.

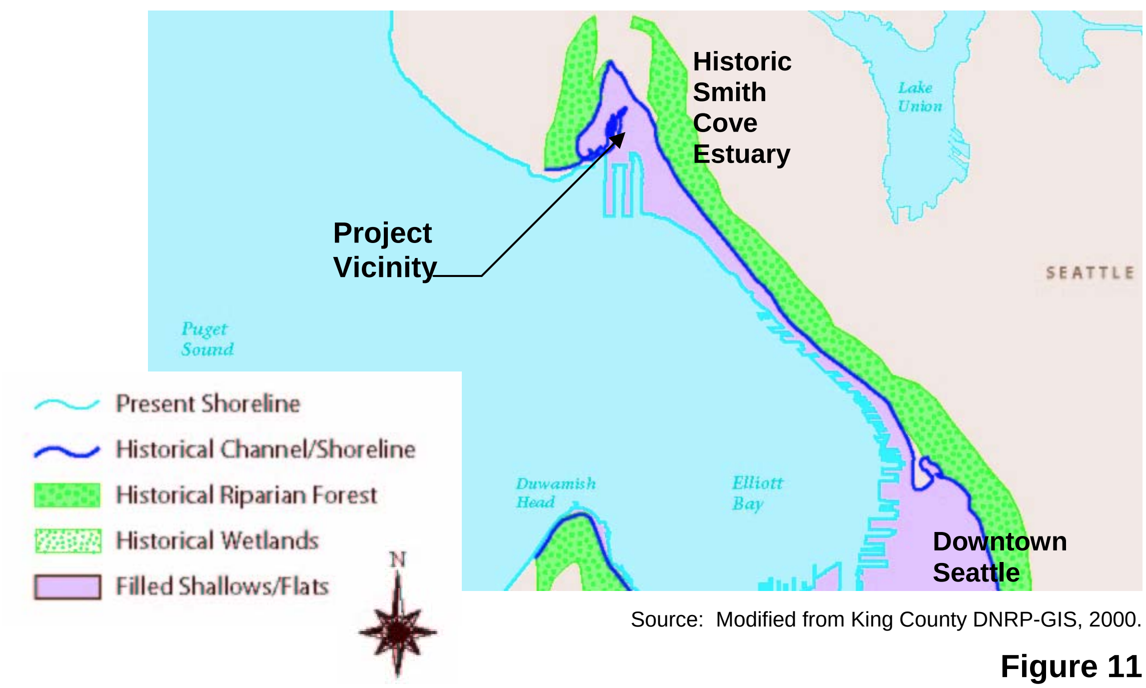
Groundwater quality information was obtained from the Washington State Department of Ecology, the Port of Seattle, and various state and federal environmental databases as compiled by Environmental Data Resources, Inc.

This section describes the affected environment of the study area as it relates to Water Quality considerations. Information in this section has been compiled consistent with the guidelines contained in Section 431 of the WSDOT Environmental Procedures Manual. Section 431 contains a checklist (Exhibit 431-C) identifying items to be evaluated in this discipline report. Appendix B of this report contains a Checklist Summary, which provides a guide to the location of each checklist item in this document or indicates why the item is not applicable to the Magnolia Bridge Replacement Project.

The purpose of this Affected Environment section is to provide a baseline for analyzing potential impacts from the alternatives. The level of detail provided for each item is commensurate with the information needed to complete the impact analysis and with potential issues associated with the alternatives. See the Impacts section below for a discussion of project factors influencing the types of impacts related to this project.

Historic Environment

The existing and proposed bridge alternatives extend across a north-trending topographic trough called Interbay. The trough is bounded on both sides by glacial uplands; Magnolia on the west and Queen Anne Hill on the east. While the uplands are comprised of very dense and hard glacial soils, the intervening topographic swale/trough of Interbay is comprised of loose to dense glacial recessional outwash, beach deposits, and soft to stiff estuarine deposits. Since the late 19th century, the historic Smith Cove estuarine area has been filled with various materials to form the Interbay / Terminal 91 area. See Figure 11 for historic channel/shore locations.



Source: Modified from King County DNRP-GIS, 2000.

Figure 11
Project Vicinity in Historic Smith Cove Estuary

Existing Built Environment

The project site is bounded by Elliott Bay on the South, W. Dravus Street on the North, Thorndyke Ave. W. on the West, and 15th Ave. W. on the East.

Topography

Topographically, the project site is relatively flat from east to west, until the alignments reach the toe of Magnolia Bluff on the west side. From the toe of the bluff's slope, the ground slope surfaces rises steeply to the elevation of the Magnolia surface streets. The maximum ground slope up to Magnolia Bluff is approximately 1.9H:1V, along Alternative A. The elevation gain up Magnolia Bluff is approximately 150 feet. Refer to "Geology and Soils" Discipline Report for additional information.

Climate

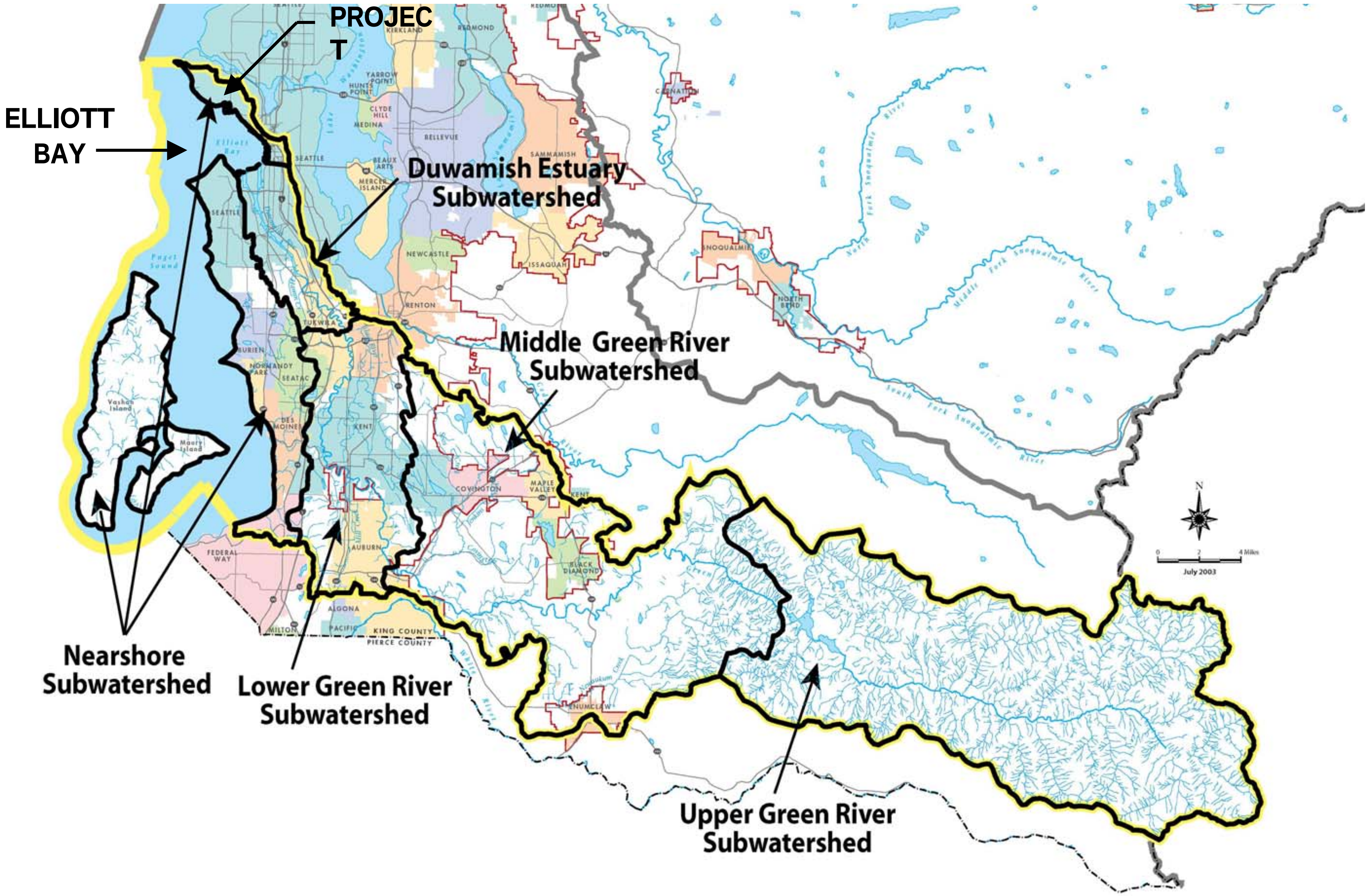
The Puget Sound area has a typical marine climate with prevailing moisture-laden winds originating from the Pacific Ocean. This phenomenon, combined with the mountainous terrain, creates relatively high overall annual precipitation. The effect of Puget Sound and the barrier provided by the Cascade Mountain Range to the east creates mild winters and cool summers.

Drainage Basins and Watersheds

The Project Site is located within the Central Puget Sound Drainage Basin (or Watershed). This watershed encompasses all of the small creeks draining into central Puget Sound and their supporting areas. On a smaller scale, the project site is located within the Green/Duwamish River Watershed, and more specifically within the Elliott Bay Sub-Basin.

The Washington State Department of Ecology (DOE) has delineated Water Resource Inventory Areas (WRIA) for the purposes of watershed planning and management. WRIA boundaries were established under Washington Administrative Code (WAC) 173-500-040 and authorized under the Water Resources Act of 1971, Revised Code of Washington (RCW) 90.54. Although the project site is officially mapped by DOE within Cedar/Sammamish WRIA #8, it appears to be managed under Duwamish/Green WRIA #9. The project site is further classified within WRIA #9 as part of the Nearshore Subwatershed (King County Nearshore Reconn., 2001). See Figure 12 for a map showing the project vicinity in relationship to the Nearshore Subwatershed and WRIA boundary.

Although the Nearshore Subwatershed excludes Harbor Island and the shoreline area immediately fed by the Duwamish River, its does include the Seattle shoreline north of Harbor Island in Elliott Bay to West Point. This developed shoreline area includes the project site and is comprised of a combination of residential, commercial, and industrial land uses. The Subwatershed has a 100-year history of development including extensive shoreline modification, dredging and filling of wetlands, and pollution. This history of urbanization has caused the loss of most of the estuarine habitat within Elliott Bay. Urban development has presented limiting factors to fish habitat such as creating fish passage barriers, reducing the amount of large woody debris and channel complexity, and causing recurring water quality problems.



Source: Modified from King County DNRP-GIS, 2004.

Figure 12

Project Vicinity in Nearshore Subwatershed, WRIA 9

Drainage Pathways

The existing Magnolia Bridge consists of 100 percent PGIS, totaling approximately 5.2 acres. Stormwater generated from the existing bridge is collected in drain inlets located on the deck surface of the bridge. See Figure 13 for photos of existing bridge drains. The drain inlets are connected to regularly-spaced 4-inch diameter downspout pipes. Because there is no formal conveyance network currently in place, water transported within these pipes, in most cases, splashes onto the underlying surface pavements. In a few cases, the bridge pipes are aligned with the underlying on-street catch basins. Surface street catch basins empty into two City stormwater outfalls: an 18-in outfall on the west (south of 23rd Ave W) discharging to Smith Cove, and an 84-in diameter outfall on the east discharging to the Smith Cove Waterway. There are no existing stormwater treatment facilities within the project site area. Existing stormwater and combined networks are shown in Figure 14.

Figure 13
Existing Bridge Drains

Surrounding properties include the Magnolia and Queen Anne neighborhoods, Terminal 91/North Bay, the BNSF West Yard, Smith Cove Park Public Access Point, and Elliott Bay Marina. The surrounding areas are essentially impervious with designated park/greenspace areas interspersed within the neighborhoods. See Figure 15 for locations of parks/ greenspaces. The greenspace areas near Elliott Bay Marina, the south end of Thorndyke Ave. W., and the Interbay Athletic Field are in the closest proximity to the existing bridge and the proposed alternatives. In addition, there is a large vegetated buffer of approximately 20 acres running along the west perimeter of Terminal 91.

The neighborhoods on the eastern edge of Magnolia Bluff are serviced by a combined City sewer, which enters the western edge project site at two separate locations. The combined City sewers join with the 96-inch diameter King County/METRO combined trunk main that generally crosses the project site from east to west along the Port Terminal 91/North Bay property, north of the existing Magnolia Bridge.

The Terminal 91/North Bay area is generally where the existing and proposed bridge alternatives span, from east to west. This area is considered 100% PGIS. Stormwater runoff is collected in surface basins and is conveyed in one of three main north-south stormwater mains, all of which outfall to Smith Cove or the Smith Cove Waterway.

Properties located between the BNSF West Yard and 15th AVE W are serviced by a 24-inch diameter north/south stormwater main which combines with the 36" diameter stormwater main that drains 15th Ave W in the area and then outfalls to the Smith Cove Waterway to the south (84-inch diameter outfall).

NOTE: Locations of Port outfalls are based on available data and are approximate. Not all storm drainage is shown.

Figure 14
Existing Stormwater / Combined Facilities

Figure 15
Surrounding Parks/Greenspaces

Surface Water Resources

Water bodies within or adjacent to the project site are Smith Cove, the Smith Cove Waterway, Lake Jacobs (an industrial pond located on Terminal 91), and Elliott Bay. There are no streams or wetlands identified within the study limits.

Elliott Bay Water Quality

DOE has specified standards for individual water quality parameters, such as fecal coliform bacteria, salinity, temperature, turbidity, dissolved oxygen, pH, and nutrient concentrations. When these criteria are exceeded, the standards impose specific limits on further degradation. The water quality standards are in place to prevent further degradation of surface water resources and to preserve existing and future uses of the water body.

Elliott Bay is among the 2002/2004 Clean Water Act section 303(d) list of impaired water bodies. Known problem areas are fecal coliform (primarily near the Denny Way CSO outfall), temperature, metals, pesticides, organics, and PCBs. Total Maximum Daily Loads (TMDL's) currently under development by DOE as of August 2004 for the Duwamish/Green WRIA #9 (including Elliott Bay) include pH, temperature, dissolved oxygen, fecal coliform and mercury. TMDL's are designed to establish limits on the discharge of pollutants to the water body at rates that allow state water quality standards to be met.

In 2003, DOE revised the 1997 Water Quality standards and is awaiting Environmental Protection Agency (EPA) approval. Upon approval of the revised 1997 Water Quality standards by the EPA, these TMDL's will apply to waters adjacent to the project site.

Some of the 2003 revisions to the 1997 Water Quality standards include changes to temperature, dissolved oxygen, bacteria, and ammonia criteria, additional criteria to protect char (bull trout), and new criteria to protect agricultural water supplies. In addition, the revised rule adopts a "use-based" system rather than a "class-based" system for applying the criteria. Under the revised rule, Elliott Bay shall meet the standards assigned to "excellent quality" for aquatic life uses, "primary" for water contact use, and "all" for miscellaneous uses. The 1997 rule is to be used until the revised standards are formally approved. By current regulations, Elliott Bay (including Smith Cove and Smith Cove Waterway) is required to meet the following Class A standards for marine waters.

Class A Marine Designation: The Class A (excellent) marine designation means that Elliott Bay's water quality should meet or exceed the requirements for all uses, or substantially all uses. The water quality should be sufficient for specific characteristic uses such as water supply, stock watering, fish and shellfish migration, rearing, spawning, and harvesting, wildlife habitat, recreation, commerce, and navigation.

Class A standards for fecal coliform bacteria stipulate that organism counts should not exceed a geometric mean value of 14 colonies per 100 ml and not more than 10 percent of samples used in calculating the mean may exceed 43 colonies per 100 ml.

Class A marine standards state that water temperature shall not exceed 16 ºC due to human activities. When natural conditions exceed 16.0 ºC, no temperature increases are permitted which will raise the receiving water temperature by more than 0.3 ºC.

Turbidity is a measurement of water clarity, which can be affected by suspended and dissolved solids, wind, and waves. The Class A marine standards require that turbidity shall not exceed 5 NTU over background conditions when the background is 50 NTU or less.

By Class A marine standards, dissolved oxygen shall be greater than 6.0 mg/L. The standards specify that when natural conditions are at or below 6.0 mg/L, dissolved oxygen levels may be degraded by human activities up to 0.2 mg/L.

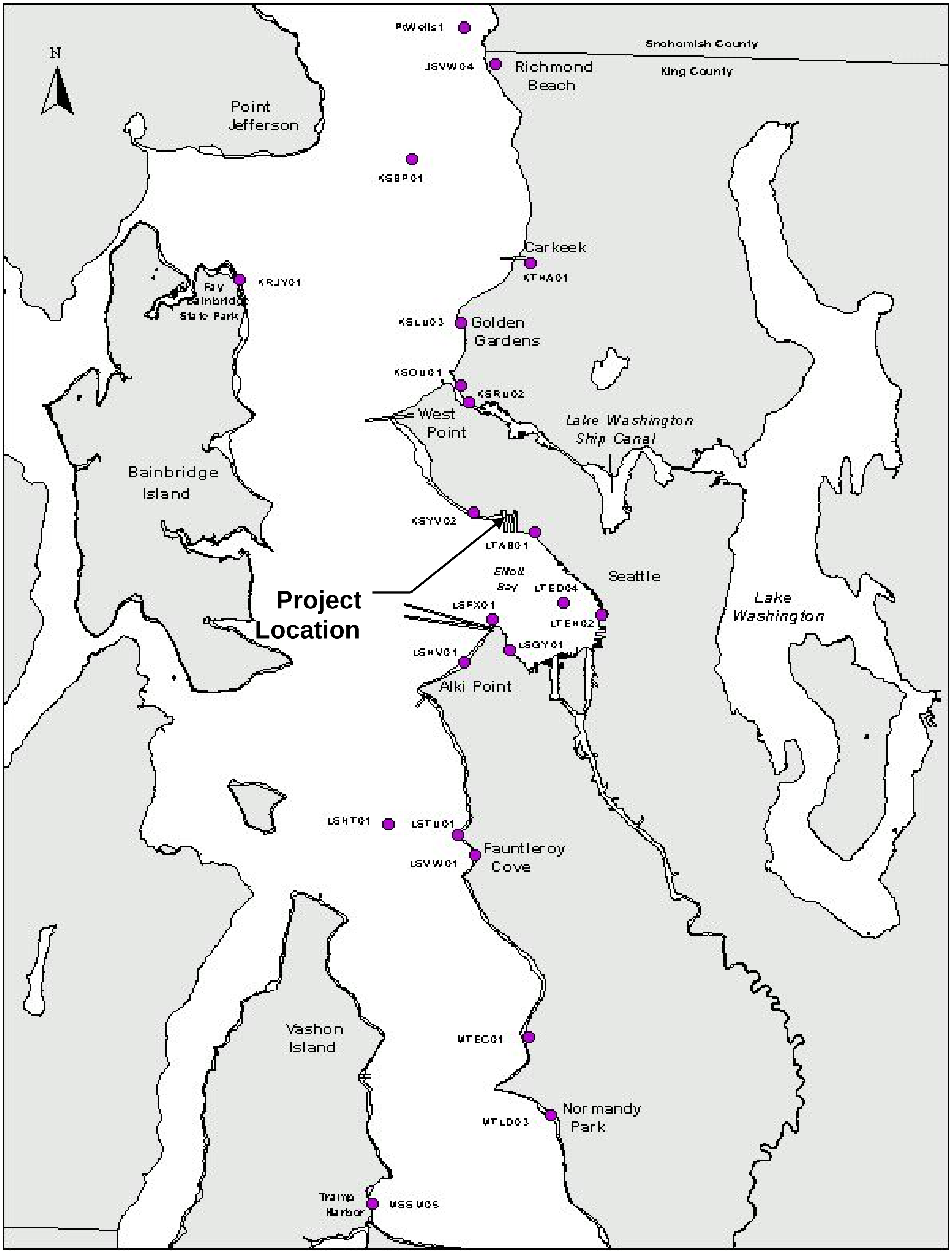
The Class A marine criteria for pH is within the range of 7.0 to 8.5. Human induced variation of this range is allowed up to 0.5 units.

Concentrations of dissolved nutrients such as ammonia and metals can be toxic to biota and to humans. The standard criteria for toxic, radioactive, or deleterious material concentrations is that they shall be below levels that "singularly or cumulatively, adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health."

The standards also cover preservation of aesthetic values, which "shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste."

Available Sampling Data: King County Department of Natural Resources and Parks regularly monitors the above water quality parameters within Elliott Bay's nearshore and offshore environments as part of Water Quality Status Report for Marine Waters. The most recent report was completed in 2001. Water quality monitoring is designed to reveal natural seasonal changes in the water column as well as distinguish human-induced changes and which standards are exceeded. Water quality monitoring encompasses both marine waters and marine sediments. Pollutants are often found in particulate form, settling on the bay floor. There are two King County ambient monitoring stations, KSYV02 (Magnolia) and LTAB01 (Inner Elliott Bay), within the closest proximity to the project site. They are located on both the east and west sides of the site area. See Figure 16 for locations of the two King County marine ambient monitoring stations adjacent to the project site. Ambient monitoring stations are positioned away from discharge sources to get a picture of general water column characteristics.

Point source monitoring station, LTBC41, is the next closest. Point source stations are established to monitor pollution from a specific source, such as an outfall pipe, and are located near the source of discharge. LTBC41 is the point source station for the Denny Way CSO. It does not apply to the project area or project work and is therefore, omitted from the following discussion. The sampling data discussed below pertain to stations LTAB01 (Inner Elliott Bay) and KSYV02 (Magnolia). The data for these stations represent the most applicable, available sampling data in regards to the project site. Each station was sampled monthly from January 2001 to December 2001. The results of the sampling data for these two stations are described below. The data paints a picture of an already degraded but not yet chronic environment.



Source: King County, 2001.

Figure 16
King County Ambient Monitoring Stations

Sampling Results: Concentrations of fecal coliform bacteria at the Inner Elliott Bay station exceeded both the State geometric mean criteria of 14 cfu/100 ml and peak criteria of 43 cfu/100ml. The peak sample from the Inner Elliott Bay station was 71 cfu/100 ml; however, fecal coliform sampling results for the Magnolia station met both criteria.

The mean water temperature recorded at the Magnolia station was 11.1ºC, and the mean water temperature for the Inner Elliott Bay station was 11.6ºC. Although the maximum temperature recorded at the Inner Elliott Bay station was 16.1ºC in August 2001, the mean values for both stations were below the Class A marine criteria of 16.0ºC.

No specific turbidity data was reported for the Inner Elliott Bay or Magnolia stations. Turbidity within Elliott Bay generally ranged from 0.5 to 6 NTU, which is well below the 50 NTU limit.

Concentrations of dissolved oxygen within the sampling data ranged from 7.7 to 8.4 with a mean of 8.0. No specific measurements were taken for the Magnolia or Inner Elliott Bay stations. None of the measurements taken were lower than the Class A criteria of 6.0 mg/L or the Department of Ecology criteria of 5.0 mg/L, which is suggested to be an indicator of problems.

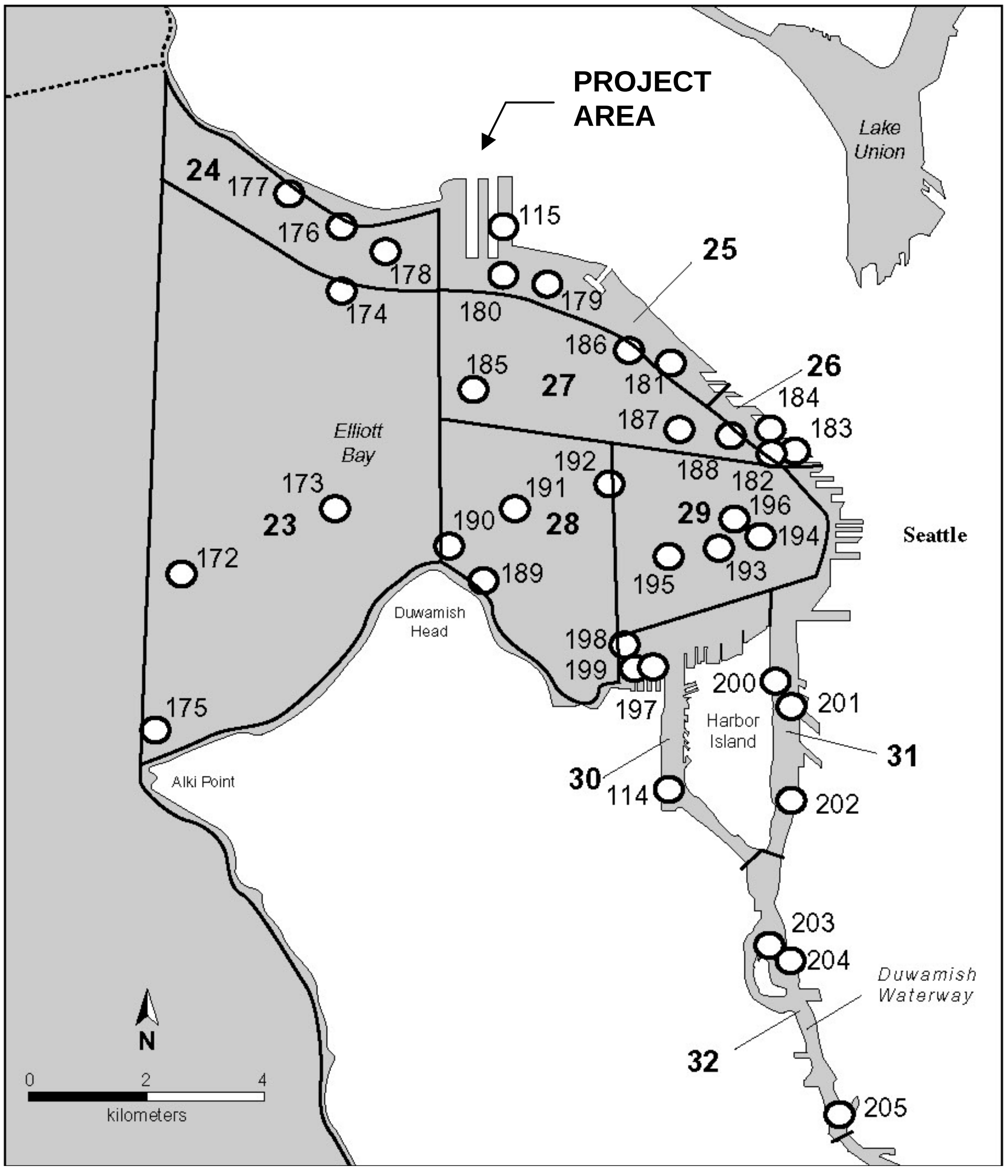
Toxic, radioactive, or deleterious material concentrations were also monitored. The mean concentration of ammonia for nearshore/beach stations was 0.025 mg/L. This is well below the established acute (0.233 mg/L) and chronic criteria (0.035 mg/L). Concentrations of contaminants within sediment samples were monitored at the Magnolia station. Dissolved metals including arsenic, cadmium, copper, lead, zinc, mercury, nickel, selenium, silver, and zinc were measured at levels below Washington State acute and chronic water quality criteria. Pesticides and PCBs monitored at the Magnolia Station were encountered at levels below detectable limits.

Elliott Bay Sediment Quality

Although sediment contamination was not characteristic of the sampling data for the Magnolia or Inner Elliott Bay stations, numerous studies have provided evidence of sediment contamination within Elliott Bay (King County, 2001). Contaminants including PCB's, PAH's, metals (mercury, cadmium, and zinc), other organic compounds, pesticides, and TBT exceed state sediment quality standards. The contaminants have historically been deposited during activities such as shipping and handling of various products (spillage), direct disposal, input of groundwater, stormwater runoff, through Combined Sewer Overflow (CSO) discharges, or from direct erosion of contaminated soils. As expected, sediment contamination within Elliott Bay is found in greater concentrations closer to the heavily developed shorelines. Concentrations (primarily mercury, cadmium, PAH's, and PCBs) are highest in the southern portion of Elliott Bay, near the mouth of the Duwamish and adjacent to Superfund sites. Mercury is prevalent along the Elliott Bay waterfront.

These contaminants have the potential to build up in benthic organisms and, therefore, become passed to many other species through the food web. Bioaccumulated contaminants may cause genetic damage or reproductive impairment.

NOAA and the State Department of Ecology studied sediment quality in Central Puget Sound in 2002. As part of the study, numerous sampling stations were established and monitored in Elliott Bay in 1998. Three nearshore stations (115, 180, and 178) were located near to or within Smith Cove and the Smith Cove Waterway, as shown in Figure 17. Toxic levels of contaminants were observed in the inner strata of Elliott Bay and the lower Duwamish River. In addition, chemical concentrations exceeded Sediment Quality Standards (SQS's) (per WAC 173-204), and exceeded Cleanup Screening Levels (CSL's), which are used to determine whether remediation is required in the area.



Source: NOAA/DOE, 2000.

Figure 17
Sampling Stations in Elliott Bay

Table 1 identifies the study results for the three nearshore stations located adjacent to or within Smith Cove and/or the Smith Cove Waterway that are most indicative to sediment quality immediately 'downstream' of the study area. High molecular weight polynuclear aromatic hydrocarbons (HPAH) and Phenols were present in levels above SQS's and/or CSL's.

Table 1
Sediment Quality Results Summary
Smith Cove Area

Station #	Concentrations > SQS (Contaminant)	Concentrations > SQS/CSL (Contaminant)	Toxicity to Amphipods / Urchin Fertilization, as % of control group
115	(HPAH: Benzo g,h,i perylene) (4-Methylphenol)	(4-Methylphenol)	95.5% / 81.0%
180	(HPAH: Benzo g,h,i perylene) (Indeno 1,2,3-c,d pyrene)	-	98.0% / 68.0%
178	-	-	No significant toxicity

Source: NOAA/DOE, 2000.

Sediment Dynamics

There are two drift cells within the Elliott Bay shore. One cell is located along Magnolia Bluff, while the second is situated between Alki Point and Duwamish Head. The Southwest Magnolia drift cell originates just west of the Elliott Bay Marina. At this location, net shore drift is primarily westerly drift converging with shore drift produced from the north side of the bluff. This convergence is forming a spit at West Point. The drift cell between Alki Point and Duwamish Head is also formed by a westerly drift, which begins south of Elliott Bay near Burien. The shoreline between Pier 91 and Duwamish Head, however, has no recordable net shore drift due to its developed condition. Erosion of unprotected fill material is the primary source of any shore drift. The presence of over water structures and the dredged depth of the water prevent alongshore transport.

Structural Nearshore Limiting Factors

The nearshore area extending from Alki Point to West Point has undergone substantial modification of the last 100 years, resulting in the loss of shoreline habitats. Excluding areas along Magnolia Bluff, this shoreline has been impacted by armoring such as levees, dikes, riprap, bulkheads, seawalls, and steepened banks. Over water structures cover 65 percent of the shoreline. According to data provided by the Port of Seattle, about 90 percent of the shoreline from Duwamish Head to Pier 91 is armored with riprap or rubble, and 16.2 percent is impacted by presence of bulkheads or seawalls. See Table 2 for a breakdown of the shoreline by type of habitat/substrate. Riprap and bulkheads situated at the top of the beach are characteristic of the area from Pier 91 to West Point.

Table 2
Duwamish Head to Pier 91

Habitat/Substrate	Percent of Shoreline
Exposed Riprap	35.7
Under Dock Riprap	49.3
Bulkhead/Seawalls	16.2
Exposed Sand/Mud	16.9

Source: King County Department of Natural Resources, 2001.

Scientific studies generally indicate that riprap banks have lower species diversity and lower densities of juvenile salmonids. Over water structures predominantly shade intertidal and shallow subtidal organisms and habitats. They can also cause physical changes such as altering wave action, climate, and substrate. Over water structures in Elliott Bay have been found to block historic migration pathways for juvenile salmonids, including ocean-type Chinook and chum salmon. Alteration of migration patterns is also thought to increase juvenile susceptibility to predation.

In May 2001, the King County Department of Natural Resources published a comprehensive summary and assessment of the condition of the nearshore ecosystem characteristics of WRIA's 8 and 9. The report provides a basis for nearshore watershed and salmon recovery planning within the watershed.

Aquatic ESA Status

The nearshore areas of Elliott Bay provide habitat for juvenile Chinook Salmon (threatened) and bull trout (threatened) during periods of migration and rearing. Juvenile Coho Salmon (candidate) have also been found near Terminal 91. Please refer to the "Wildlife, Fisheries, and Vegetation Discipline Report" for a complete discussion of project area ESA issues.

Public Water Supply and Wastewater Systems

Public water supply within the study area is provided and maintained by Seattle Public Utilities (SPU). Potable water is supplied to Seattle customers through the Cedar River Pipeline, South Fork Tolt River Pipeline, and from three wells in the Highline Well Field. These pipelines distribute water to mains that are generally located within the public right-of-way.

SPU manages and maintains wastewater services within the project area. Project area wastewater is conveyed in mains to the King County/METRO sanitary sewer trunk mains that run across Terminal 91 from east to west. The trunk sends the wastewater to the West Point Treatment Plant, where it is treated and released into Puget Sound.

Refer to the "Public Services and Utilities Discipline Report" for additional water and wastewater information and issues within the study area.

Groundwater

In the vicinity of the Proposed Action, the groundwater quality of the shallow unconfined aquifer has generally been degraded by numerous industrial activities that have historically existed in the area. In part, shallow groundwater contamination may have resulted from operations at the Port of Seattle petroleum storage tank farm, the Interbay Landfill, the BNSF railway, former and existing gasoline service stations, auto wrecking yards, iron and steel yards, and other industrial properties.

Contaminants detected in shallow groundwater in the vicinity of the Proposed Action include petroleum hydrocarbons, volatile organic compounds (VOC's), polycyclic aromatic hydrocarbons (PAH's), polychlorinated biphenyls (PCBs), and dissolved metals. Specific details regarding individual contaminants, their sources, and respective concentrations are provided in the Hazardous Materials Discipline Report.

Aquifer Systems

Three relatively distinct groundwater flow systems were identified in the vicinity of the Proposed Action based on an evaluation of available subsurface and hydrogeologic information. The principal groundwater flow system consists of a shallow unconfined aquifer system within the Interbay Channel, the lowland that underlies most of the Proposed Action. Lesser systems include upland aquifers within Queen Anne Hill and Magnolia Hill and a deep artesian aquifer located approximately 300 to 400 feet below sea level.

Shallow Unconfined Aquifer System

A shallow unconfined aquifer system underlies most of the Proposed Action. This system occupies the low-lying Interbay Channel. This channel is elongated in a north-south direction and is bordered to the west by Magnolia Hill, to the north by the Lake Washington Ship Canal (Salmon Bay), to the east by Queen Anne Hill, and to the south by Puget Sound (Smith Cove).

The aquifer is principally found in glacially unconsolidated fill (Hf), beach (Hb), estuarine (He), and recessional outwash (Qvro) materials that were deposited within the Interbay channel. To a lesser extent, it is also found in landslide (Hls), colluvium (Hc), and reworked glacial (Hrw) deposits that locally mantle the edges of the channel. The aquifer is generally thickest (approximately 120 feet thick) along the centerline of the channel and progressively thins toward and pinches out along the hillsides to the east and west. The aquifer is generally underlain by glacially over-consolidated glaciolacustrine (Qvgl) and till (Qvt) deposits. Detailed descriptions of these deposits and subsurface profiles illustrating their relationships are provided in the Geology and Soils Discipline Report.

Groundwater elevations in the shallow unconfined aquifer generally range from 5 to 15 feet (NAVD 88 datum) in the vicinity of the Proposed Action. Groundwater elevations are highest toward the north (near Alternative C) and lowest toward the south (Alternative A). The depth to the shallow water table ranges from less than 4 feet to approximately 10 feet below the ground surface at the base of the Interbay Channel. The water table may fluctuate 1 to 3 feet seasonally due to changing precipitation patterns. In addition, the shallow water table in the vicinity of Elliott Bay (Smith Cove) fluctuates in response to tidal stage changes. Actual depths to groundwater will vary based on the ground surface elevation, season of the year, and tidal stage in Elliott Bay. Maps showing specific depth to groundwater data for each of the alternatives are provided in Appendix A on Figures A-1 through A-3.

The general groundwater flow direction in the shallow unconfined aquifer system is southward toward Smith Cove and Elliott Bay. Assuming the shallow groundwater elevation in the vicinity of Alternative A (near Smith Cove) is approximately 10 feet lower than available water level data near W. Wheeler St., the southward hydraulic gradient is approximately 0.004 feet per foot beneath the Proposed Action.

The groundwater recharge area for the shallow unconfined aquifer system is inferred based on the regional topography and geologic conditions. Based on our understanding of the hydrostratigraphy and conceptual model of the flow system, the shallow unconfined aquifer is likely recharged by the infiltration of precipitation through the soils immediately above the aquifer and by lateral drainage from the upland hills to the east and west.

Groundwater discharge from the shallow unconfined aquifer is primarily into Elliott Bay (Smith Cove). This inference is made based on the correlation of the elevation of the shallow water table and Elliott Bay. Groundwater discharge from the shallow aquifer may also occur in depressions or stormwater drainage features that extend below the water table and subsequently discharge into Elliott Bay.

Upland Aquifer System

A poorly defined upland aquifer system exists beneath the Magnolia and Queen Anne Hills to the west and east of the Proposed Action area. In general, the upland aquifer is found in advance outwash (Qva) deposits that lie below the till (Qvt) deposits that mantle the upland hills. Advance outwash is exposed on the eastern slope of Magnolia Hill near the existing bridge abutment at approximately elevation 100 feet. Groundwater is generally unconfined in the upland aquifer, especially near the hillsides where it may locally discharge to springs or seeps.

Groundwater in the upland aquifer typically flows radially away from the hilltops toward the surrounding lower lying areas. In the vicinity of the Proposed Action, groundwater in the upland aquifer likely flows east from Magnolia Hill and west from Queen Anne Hill toward the Interbay Channel. Based on our understanding of the hydrostratigraphy and groundwater flow system, the upland aquifer is likely recharged by the infiltration of precipitation through the overlying deposits. Groundwater discharges either from springs or seeps along the hillsides or percolates into deeper geologic units. In the vicinity of the Proposed Action, that portion of the upland aquifer groundwater that percolates into deeper units eventually discharges as subsurface flow into the shallow unconfined aquifer or into Elliott Bay.

Deep Artesian Aquifer System

Based on a water well report for a well constructed in 1998 for Terminal 91, a deep artesian aquifer system is present beneath the shallow unconfined aquifer in the Proposed Action area. The report indicates flowing groundwater (artesian conditions) at the surface of the well. The well is screened from 340 to 385 and 425 to 445 feet below the ground surface. Based on the driller's log, the aquifer is likely confined by more than 200 feet of silt and clay. These confining deposits may correlate to the glacially over-consolidated glaciolacustrine (Qvgl) deposits that underlie the shallow unconfined aquifer.

Due to the lack of other deep well data, specific groundwater flow directions and gradients could not be determined for this aquifer. However, region-wide evidence suggests groundwater flow is likely directed upward toward Elliott Bay, the major regional groundwater discharge area.

Groundwater Rights

Two groundwater right applications were identified in the vicinity of the Proposed Action. Burlington Environmental has applied for the right to use groundwater for environmental quality purposes, which may include pollution control, dust control, flood control, or any water use that improves or maintains the quality of the environment. The Port of Seattle has also applied for the right to use groundwater for fish propagation purposes, which may include water service to ponds, reservoirs, hatcheries, and all other facilities involved in the overall purpose of fish propagation. This water right application appears to be associated with the deep artesian well described above. Both of the applications are pending. No other groundwater rights, including domestic and municipal drinking water rights, were identified within the project area, including T. 25 N., R. 3 E., Sections 23, 24, 25, or 26.

Public Drinking Water Wells

Because of the presence of a municipal water system in the Seattle area, groundwater use is generally limited to emergency and industrial supply wells for non-drinking use. The nearest known drinking water wells are found within the Highline Aquifer system, located north of the Sea-Tac airport (approximately 10 miles south of the Proposed Action). These wells are part of the City of Seattle drinking water system. These wells are screened in older coarse-grained deposits, and are not in hydraulic connection with the aquifer systems in the vicinity of the Proposed Action.

Sole Source Aquifers

No sole source aquifers were identified within the Proposed Action vicinity. The nearest sole source aquifer is the Cedar Valley (Renton) Aquifer located approximately 15 miles southeast of the Proposed Action.

Wellhead Protection Areas

The Proposed Action does not overlap any wellhead protection areas. The nearest wellhead protection area is the Highline Aquifer well field located approximately 10 miles south of the Proposed Action. The Proposed action is outside this wellhead protection area’s 10-year capture zone.

Critical Aquifer Recharge Areas

There are no critical aquifer recharge areas in the vicinity of the Proposed Action. Seattle has not designated any critical aquifer recharge areas within the city limits.

Studies and Coordination

Studies

A geotechnical boring and monitoring well analysis intended to identify the depth to groundwater was performed by Shannon & Wilson, Inc. for the purposes of this analysis. See figures located in Appendix A for results of depth to groundwater studies for each alternative.

No specific water quality studies were performed regarding surface water resources.

Data Sources

The surface water quality review was based on the catalogue of existing data available for the Elliott Bay shoreline, including water and sediment contaminant sampling studies and Subwatershed analyses performed by NOAA, Washington State DOE and by King County. The water quality sampling results provided within this analysis was based on the *2001 Water Quality Status Report for Marine Waters*, produced by the King County Department of Natural Resources and Parks. The results provided are for two ambient monitoring stations, KSYV02 (Magnolia) and LTAB01 (Inner Elliott Bay), located immediately adjacent to the project site. Sediment quality study information provided is based on *2000 Sediment Quality in Puget Sound, Year 2 – Central Puget Sound* report as prepared by NOAA/DOE.

Assessments of potential impacts were conducted consistent with the guidelines contained in Section 431 of the WSDOT Environmental Procedures Manual. Section 431 contains a checklist (Exhibit 431-4C) identifying items to be evaluated in this discipline report. Appendix B of this report contains a Checklist Summary, which provides a guide to the location of each checklist item in this document or indicates why the item is not applicable to the Magnolia Bridge Replacement Project. Elements evaluated included, but were not limited to: operational impacts, shoreline impacts, secondary and cumulative impacts and short-term construction impacts (See "Construction Impacts" section of this report).

Surface Water Impacts

Potential, long-term surface water quality impacts as a result of this project may be summarized as follows:

- Operational Impacts – Water Quality impacts due to the size, capacity, operation, maintenance and use of the existing (No-Build Alternative) or new bridge structure (Build Alternatives);
- Shoreline Impacts – Water quality impacts due to the proposed bridge location with respect to the 200-foot shoreline setback area.
- Secondary and Cumulative Impacts – Water quality impacts arising as a result of the project but that are not a direct action of the project.

Operational Impacts

No-Build Alternative

The no-build alternative serves as the operational baseline for which the Build Alternatives are compared.

As noted previously, there are no existing stormwater treatment facilities for bridge surface water runoff. The existing bridge is fitted with simple drain inlets connected to downspout drains, rather than catch basins containing sediments traps. Existing downspout drains either splash onto underlying surface pavements, or are aligned with on-street catch basins. The surface street drainage network then conveys the runoff to existing outfalls, which discharges into Smith Cove or the Smith Cove Waterway (Figure 14).

Alternatives A, C, and D

The long-term risk to water quality may reasonably be identified as stormwater-generated from operation of the new bridge, which is based on the amount of PGIS, rainfall, and the volume of traffic. The Build Alternatives vary in their location, length, and alignment but not in their function. Because the alternatives are functionally the same, their operational impacts are essentially identical. No additional traffic capacity is provided for in any of the Build Alternatives. The newly constructed bridge and intersections will be designed to support truck traffic, meaning travel lanes and curb radii will be wider than those of the existing conditions. This will better serve trucks traveling between Terminal 91 and downtown Seattle, but does not imply an increase in the volume of truck traffic.

Use of the bridge by vehicular traffic creates stormwater runoff from PGIS which may be laden with sediment and contaminants. Petroleum products such as oil and grease and transmission fluids, as well as grit deposited from tires are most frequently found in stormwater runoff produced on roadways. Metals are released through the wear of tires, auto bodies, and mechanical parts such as vehicular brake pads, which grind off small amounts with each application. The EPA has produced of lists of common contaminants found on roads and bridges. These include asbestos from brake and clutch linings, bacteria from animals, birds, hauling of livestock, soils, and litter, sulphate and bromide from roadbeds and auto exhaust, and particulates from vehicle and pavement wear. Common metals found in runoff include copper, cadmium, chromium, iron, lead, nickel, manganese, and zinc. Vehicular traffic on roadways also generates runoff containing polycyclic aromatic hydrocarbons (PAH's), which are the products of engine combustion.

Stormwater runoff produced from the bridge and surface streets may contain various amounts of the aforementioned pollutants. Pollutant load to the receiving waters may be directly correlated with the contributing area of PGIS for each alternative. Table 3 identifies the area of bridge/road PGIS and net increase in study area PGIS for each alternative. Note that the quantities shown are approximate (for comparative purposes only) and represent the footprint of the bridge, ramps, and intersections up to their tie-in points with existing surface streets.

Table 3

Estimated Pollutant Generating Impervious Surface (PGIS)

Alternative Name	PGIS Area of Bridge and Ramps (acres)	Change in PGIS from Current Conditions (acres)
No-Build	5.2	0
A – Intersection	8.5	1.1
A – Ramp	7.1	1.2
C	10.0	0.2
D – Intersection	9.2	-0.3
D – Ramp	8.3	-0.3

Each of the Build Alternatives proposes to construct a new bridge over an existing area that is largely PGIS. Alternative A results in the greatest net increase in study area PGIS primarily due to the location of the new bridge structure over water and the Smith Cove Park Parcel. Alternative C results in almost no increase in study area PGIS, and Alternative D results in a net decrease in study area PGIS, due to the demolition of the existing bridge over Lake Jacobs. Pollutant loading and resulting water quality impacts would inherently be highest for Alternative A. Alternatives C and D would result in little to no difference as compared to the No-Build Alternative.

Pollutant Loading Estimate

Annual pollutant loading values are estimated for each alternative in Table 4. Estimates are based on a study that measured the range of pollutant yields from sites in the Pacific Northwest (Horner 1992). Values are generated by multiplying the median yield values for "Road" land use against the measured PGIS for each alternative.

This is a very general estimating method intended to allow a simple comparison between alternatives. The yields should be considered as a conservative value, as the PGIS areas used represent only the area of new road bridge surface and do not reflect the actual changes in adjacent land classifications resultant from the alternative. A more detailed analysis of current and changed land classifications resulting from each alternative would yield lower total discharge values. An examination of that type is beyond the scope of this report.

Table 4

Total Annual Pollutant Yield Estimate

Alternative	Roadway & Bridge Surface Area (hectares)	Total Solids	Total Phosphorus	Total Nitrogen	Lead [3]	Zinc	Copper	Fecal Coliform Bacteria	Chemical Oxygen Demand
		Yield Estimate per Hectare (median values) [1, 2]							
		502	1.1	2.4	0.78	0.31	0.06	1.80E+08	201
		Total Annual Pollutant Yield (kilograms)							
No-Build	2.1	1054	2.3	5.0	1.64	0.65	0.13	3.78E+08	422
A Intersection	3.4	1707	3.7	8.2	2.65	1.05	0.20	6.12E+08	683
A Ramp	2.9	1456	3.2	7.0	2.26	0.90	0.17	5.22E+08	583
C	4.0	2008	4.4	9.6	3.12	1.24	0.24	7.20E+08	804
D Intersection	3.7	1857	4.1	8.9	2.90	1.15	0.22	6.66E+08	744
D Ramp	3.4	1707	3.7	8.2	2.65	1.05	0.20	6.12E+08	683

[1] Units in kilograms/hectare/year, except fecal coliform bacteria which are in number/hectare/year
[2] Source: Horner 1992
[3] Lead fuels are no longer used and lead concentrations in runoff have greatly decreased since the time of this study.

Existing Outfall Capacity

Peak runoff rates have been computed for the new bridge/road PGIS and are shown in Table 5 for the purpose of preliminarily verifying that the existing outfalls will handle the peak flows from the Build Alternatives. The peak flow rates were estimated based on the 25-year, 24-hour storm Standard Hydrograph Values for Developed Site Condition (SCS Type 1A) derived from the Santa Barbara Urban Hydrograph (SBUH) model. The 25-yr, 24-hr flows and SBUH method is frequently used for outfall sizing and capacity verifications.

In a conversation with Bill Sherwin of Seattle Public Utilities (SPU), he remarked that the City outfalls are designed and installed to be able to drain the entire basin in which they reside. According to Mr. Sherwin, it is most likely that the 84-inch and the 18-inch City outfalls on the east and west end of the bridge could accommodate the bridge drainage. He explained that the proper procedure is to submit plans to the City at the time of project design, showing a proposal to connect in one or two locations. He advised that the number of connection points, or links, should be limited for ease of maintenance. At the time plans are submitted, SPU will then verify that those outfalls can support the bridge drainage in addition to offsite flows entering the same outfalls.

Table 5

Peak Stormwater Runoff Rates

Alternative Name	Bridge/Road PGIS Area (acres)	Peak Runoff Flow Rate (cfs)
No-Build Alternative	5.2	3.8
Alternative A – Intersection	8.5	6.2
Alternative A – Ramp	7.1	5.2
Alternative C	10.0	7.3
Alternative D – Intersection	9.2	6.7
Alternative D – Ramp	8.3	6.0

Source: Project team, 2004.

A rough conveyance capacity check on the two City outfalls was performed using the King County Uniform Flow Analysis method. This method is used for the preliminary sizing of outfalls to convey the peak design flow from the 25-yr, 24-hr storm. Assuming a concrete pipe (in new condition), an 18-in outfall could support stormwater flows of 6.9-cfs, while an 84-in outfall could handle 420.4-cfs. Estimated peak design flows resulting from the Magnolia Bridge project for the 25-yr, 24-hr storm are identified in Table 5. By the initial evaluation, Alternative C, which creates the largest PGIS area, requires an additional 3.5 cfs peak capacity above and beyond the No-Build (baseline) condition. It would seem that between the two existing outfalls, this additional capacity may be accommodated. However, backwater analysis of conveyance capacity including offsite flows must still be performed.

Shoreline Impacts

Operational water quality impacts in the shoreline and nearshore areas are directly correlated with the proximity of the alternative to the existing shoreline. Figure 18 depicts the location of the Alternatives in relation to Smith Cove and Smith Cove Waterway. The 200-foot (as measured from ordinary high-water) Shoreline District boundary is included for reference. Long-term impacts to water quality in the shoreline area include:

- <u>Over-water coverage (shading effects)</u>. Increased shading may lead to deterioration of habitat for nearshore aquatic plant species, which may then impact water quality and habitat for fish and other marine organisms.
- <u>Alterations to water flow and sediment transport around in-water pier footings</u>. In-water footings would likely cause localized changes in water and sediment movement. Further, scour around bridge footings may occur. These types of

changes to water and sediment movement may impact water quality and habitat for aquatic plant and animal species by re-entrainment of suspended sediments, potential for movement and re-entrainment of contaminated sediments, altered water velocities and subsurface conditions.

- Potential for direct discharge of pollutants. The proximity of an Alternative to a water body may result in the direct discharge of debris, metals, chemical contaminants, and/or other substances which are transported with the use of the bridge by vehicular traffic. Water quality may be impaired, for example, by pollutants transported directly via littering, accidental spills, airborne transmission, etc.

Refer to the "Wildlife, Fisheries and Vegetation" Discipline Report for additional impacts to biological organisms.

No-Build Alternative

The existing bridge is within the 200 feet of the ordinary high water mark for approximately half of its length. The bridge crosses over the north end of Smith Cove. Shading is most certainly an issue in the existing condition, as are the water quality impacts associated with the existing in-water bridge piers. Because there is no formal treatment of surface water runoff from the bridge, pollutants are likely directly entering these water bodies.

Alternative A

Of all of the alternatives (including No-Build), Alternative A is in the closest proximity to the existing bridge, and is also within the 200-foot Shoreline District in multiple locations. Alternative A is aligned to the south of the existing bridge. As a result, portions of Alternative A pass directly over Smith Cove to a greater degree than the existing bridge. Alternative A will require the placement of in-water bridge pier footings. It is likely that all of the aforementioned long-term shoreline water quality impacts will be present for this alternative.

Alternative C

Alternative C, while generally the farthest away from the shoreline, enters the zone for a short length (less than 400 feet) where it is nearly coincident with the existing Magnolia Bridge. Because the new bridge structure would be located nearly 200 feet away from ordinary high-water, and no in-water footings are required, long-term impacts to shoreline water quality are not anticipated.

Alternative D

Alternative D is not within 200 feet of the ordinary high-water mark. No in-water footings are required. No long-term impacts to shoreline water quality are nticipated.

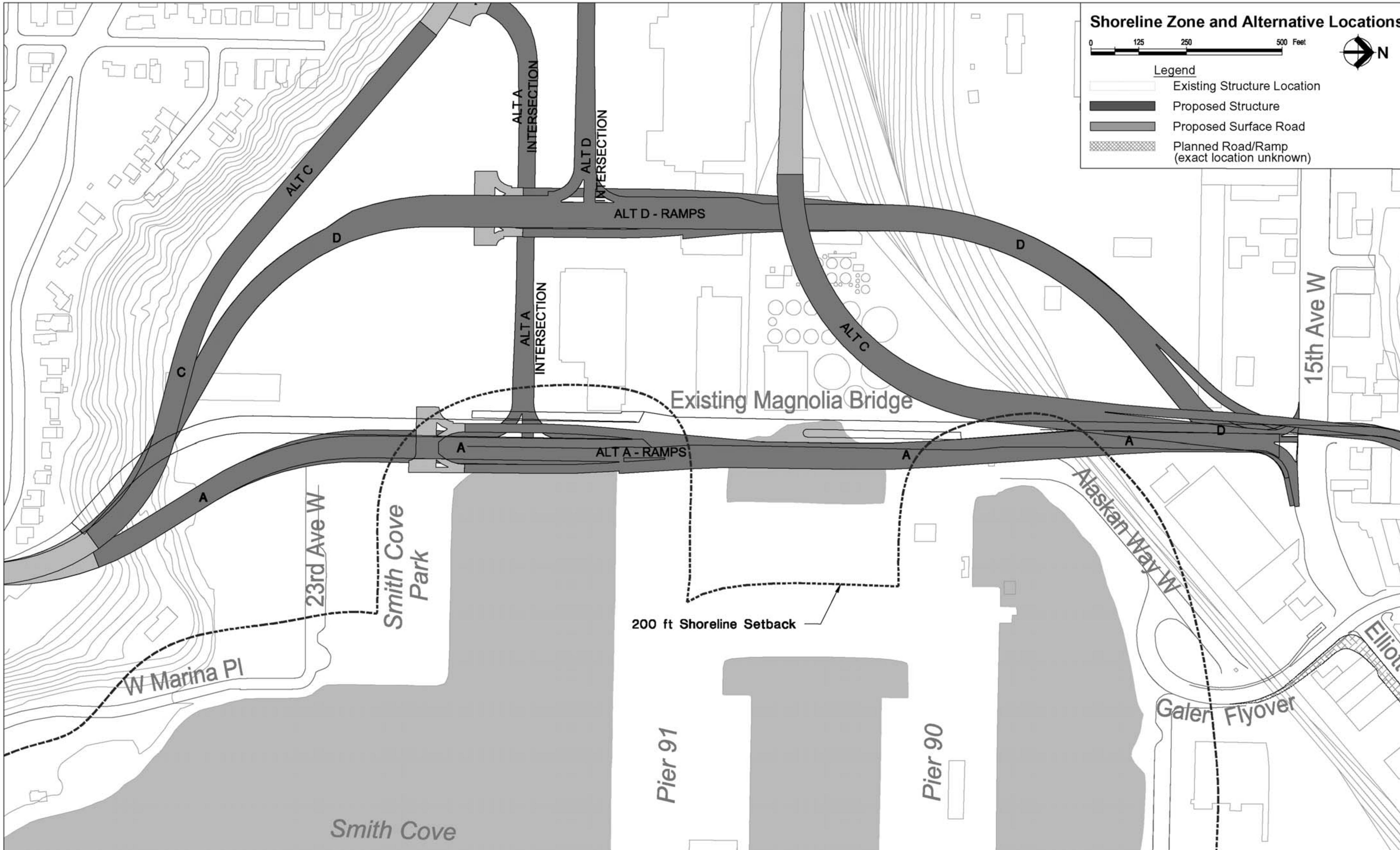


Figure 18
Shoreline Zone and Alternative Locations

Secondary and Cumulative Impacts

Secondary and cumulative impacts are those arising as a result of the project but not a direct action of the project. An example would be urban commercial/industrial development occurring on surrounding properties as a result of completing this project. Growth on surrounding properties may cause increased concerns to water quality. It is assumed that there will be no secondary or cumulative impacts to surface water quality associated with this project, because the project functions simply as a needed replacement of the existing bridge with a new bridge at the same traffic capacity.

Groundwater

Operational Impacts

No-Build Alternative

The No-build Alternative serves as the operational baseline for which the Build Alternatives are compared. No operational impacts to groundwater were identified with the No-Build Alternative.

Alternatives A, C, and D

A slight risk to groundwater may occur if new utilities or stormwater conveyance pipes are constructed below the shallow groundwater table for any of the Build Alternatives. The permeable gravel backfill typically used to fill utility trenches could create a preferential pathway for the horizontal migration of existing contaminants in the shallow unconfined aquifer.

Secondary and Cumulative Impacts

No secondary or cumulative impacts to groundwater quality were identified with this project. The project functions simply as a needed replacement of the existing bridge with a new bridge. Potential impacts associated with the project work will primarily occur at the time of construction.

Surface Water

Long-term adverse impacts to water quality consequential from vehicular use of the new bridge and intersections are primarily the discharge of sediments and chemical contaminants via stormwater runoff. Stormwater management regulations and requirements will ensure that these operational impacts are mitigated as part of any of the Build Alternatives. Any of the Build Alternatives will require the stormwater to be formally conveyed and treated for water quality in accordance with WSDOT's *2004 Highway Runoff Manual*, prior to discharging to Elliott Bay.

Stormwater Management Requirements

The 2001 DOE *Stormwater Management Manual for Western Washington (DOE Manual)* classifies the replacement of structures as "replaced impervious surface." Per Figure 2.3 in the DOE Manual, Minimum Requirements #1 through #10 apply to the new and replaced impervious surfaces. The Minimum Requirements are summarized and will be applied to the Build Alternatives as follows:

- Minimum Requirement #1 – Preparation of Stormwater Site Plans. Stormwater site plans will need to be prepared in accordance with Chapter 3 of the DOE Manual for the project area.
- Minimum Requirement #2 – Construction Stormwater Pollution Prevention Plan (SWPPP). Temporary Erosion and Sedimentation Control (TESC) plans will be prepared for the project will serve as the Construction SWPPP. The plans must address construction access, downstream flow control, sediment controls, soil stabilization, slope protection, drain inlet protection, pollutant control, dewatering control, and maintenance of BMP's.
- Minimum Requirement #3 – Source Control of Pollution. Since this is a public roadway project, source control BMP's are implemented as part of the City of Seattle's roadway operation and maintenance policies (e.g. street sweeping).
- Minimum Requirement #4 – Preservation of Natural Drainage System and Outfalls. Runoff leaves the existing project site area via man-made conveyance systems to two City outfalls. Runoff to these systems and outfalls will need to be preserved.
- Minimum Requirement #5 – On-site Stormwater Management. On-site retention, infiltration, and/or dispersion of runoff are preferred management practices. Due to the major structural element, types of fill soils and urban setting of the study area, these options may not prove to be feasible. In addition, direct discharge to Puget Sound (saltwater) with no detention is allowed by DOE.
- Minimum Requirement #6 – Runoff Treatment. Under the 2001 DOE Manual, the project requires runoff treatment facilities from the Basic Menu because the project discharges directly to salt waters. In addition, BMP's chosen from the Oil Control Menu will likely be required to treat runoff from high-use intersections with ADT's greater than 25,000 on the main roadway and 15,000 on the intersecting street (15th Ave W and W. Garfield St.).

- Minimum Requirement #7 – Flow Control. Not Applicable. The project drains into Elliott Bay (Puget Sound), exempting it from runoff quantity requirements.
- Minimum Requirement #8 – Wetlands Protection. Not Applicable. There are no wetlands within or downstream of the study site.
- Minimum Requirement #9 – Basin/Watershed Planning. The stormwater treatment approach must consider concerns as documented watershed plans for the Puget Sound Basin. For example, the project will need to address surface water runoff TMDL's as developed by DOE and approved by EPA. Sampling and monitoring of the surface water discharge may be required to ensure that TMDL's are not exceeded.
- Minimum Requirement #10 – Operation and Maintenance. The storm drainage facilities installed as a part of this project will be operated and maintained by the City of Seattle in accordance with current policies.

The Minimum Requirements will be implemented in conformance with the Highway Runoff Manual, which defines All Known, Available, and Reasonable methods of prevention and Treatment (AKART) for stormwater runoff discharges, consistent with state and federal law.

In addition to the DOE Manual, stormwater conveyance and treatment will be designed and installed in compliance with the WSDOT Bridge Manual and the Highway Runoff Manual (HRM), and the City of Seattle Stormwater, Grading, and Drainage Control Code.

Operational Mitigation

No-Build Alternative

The existing baseline and No-Build water quality condition represent the worst-case scenario. The existing bridge contains no formal conveyance network and there are no treatment facilities between the bridge and Elliott Bay. As such, sediments and other typical roadway contaminants enter Elliott Bay completely unmitigated.

Alternatives A, C and D

Installation of a formal conveyance network and of stormwater treatment BMP's are required with any of the Build Alternatives. Per the DOE Manual, Minimum Requirement #6, structural treatment BMP's would be required to:

- Separate the oil from surface water runoff in the high-use intersection areas (via oil/water separators), and;
- Remove at least 80% total suspended solids (TSS) from surface waters (via wetponds, bioswales, wetvaults, or sand filters). The BMP's would be located between the bridge structure and the outfalls.

The project Build Alternatives do not create additional traffic capacity, and although there is greater contributing PGIS area (and associated peak flows) in the Build Alternatives, the net effect is that the surface water quality will likely be improved because of the required BMP's.

Maintenance BMP's, such as regular vactor-sweeping of the new bridge structures, and vactoring of the catch basin sumps will become part of the City's ongoing roadway maintenance program. Maintenance of the structural treatment BMP's is a requirement of the DOE Manual and will be ensured during the permitting process.

Shoreline Mitigation

Alternative A

Increase in over-water coverage and potential shading effects associated with Alternative A are somewhat mitigated by the increased height of the bridge structure relative to the existing structure.

Avoidance of potentially contaminated nearshore sediments is the preferred approach. Water and sediment flow around in-water footings may be modeled and footings constructed and located in such a way to avoid and/or minimize disturbance of these sediments.

Groundwater

Operational Mitigation

No-Build Alternative

No operational impacts to groundwater were identified for the No-Build Alternative and no operational mitigation is required.

Alternatives A, C and D

The creation of preferential migration pathways for existing groundwater contaminants along new utility or stormwater conveyance trenches may be mitigated in several ways. Possible mitigation options may include; aligning future utility trenches to avoid areas where groundwater contamination has been identified (see the Hazardous Materials Discipline Report) and/or not extending trenches below the shallow groundwater table. Another possible option includes construction of low permeability dams within the trench backfill to restrict horizontal groundwater movement and subsequent contamination migration.

Surface Water

Impacts

No-Build Alternative

Maintenance activities occurring (such as mechanical sweeping) with the No-Build Alternative could potentially result in the direct mobilization of sediment, debris, paint chips, epoxies, grit, and chemical contaminants into open water areas if not properly contained. Impacts to water quality could also arise from accidental spills on the bridge structure via stormwater runoff.

Other potential discharges may result from work associated with the repair or seismic retrofit of the existing bridge structure, including: leakage of petroleum products from construction equipment, barges or trucks.

Alternatives A, C and D

Construction of the replacement bridge within all Build Alternatives will involve work items including grading (excavation and fill), staging, delivery and storage of parts and bulk materials, slope stabilization, utility improvements, welding, painting, and truck traffic through the site area. Concrete required for construction will be delivered by trucks, and barges could be used to deliver precast bridge components, select fill, and other bulk materials. Demolition of the existing bridge will accompany construction of each alternative, with the exception of the No-Build. Demolition will involve cutting off existing bridge footings at a defined clearance zone. Some existing footings are located within open water. The proposed alternatives vary only slightly in terms of total construction period, and items of work. See Table 6 for the estimated duration of construction for each alternative. The construction period is a rough estimate of duration, assuming construction will occur through all seasons.

Table 6
Estimated Duration of Construction

Alternative Name	Number of Stages	Construction Period (months)
No-Build Alternative	-	-
Alternative A – Intersection	3	39
Alternative A – Ramp	3	39
Alternative C	3	41
Alternative D – Intersection	3	45
Alternative D – Ramp	3	45

Source: Project team, 2003.
Note: The timing and duration of in-water construction work is limited by permit. It will be necessary to stage the construction accordingly. Durations noted above include in-water work

For all Build Alternatives, the following construction activities may result in temporary exceedance of State water quality standards, if not properly addressed:

- Demolition and construction within all Build Alternatives could result in direct mobilization of dust, debris, paint chips, epoxies, grit, and chemical contaminants.
- Exposed earth (via clearing, grading, or stockpiling) may erode and sediment (and potential contaminants) may be conveyed to Elliott Bay via uncontrolled stormwater runoff. Erosion and sedimentation issues are exacerbated when constructing during the wet months (typically October thru April). In addition, if the soils are contaminated and are not properly controlled, surface water runoff may transport hazardous materials (as identified in the "Hazardous Materials" Discipline Report) to Elliott Bay.
- Construction equipment, barges, or trucks may leak directly or contaminants may be conveyed via surface runoff to Elliott Bay.
- Excavations for bridge footings and utility trenches may expose potentially contaminated groundwater or potentially liberate substances to groundwater.
- Project staging areas (where construction materials and/or equipment is stored) may become contaminated with metals, sediment, oils and grease, etc. and may be conveyed via surface runoff to Elliott Bay.
- Increased traffic to other routes (detours) may result in additional contaminants being introduced into other basins.

Alternative A, unlike the other alternatives, will require construction of new bridge footings within open water. Due to in-water construction activities, Alternative A may have additional impacts or an overall greater impact to water quality than the other Build Alternatives. There is the potential for increased dust, turbidity, and sedimentation during installation of the bridge footings. Although Terminal 91 is a dredged, deep-water, historically-contaminated basin, there may be potential for loss of small pockets of marine habitat where the new bridge footings will reside. Additionally, in-water construction may result in the re-release of contaminated sediments to the water column during the digging activities associated with installation of the new footings. Distribution of these sediments has the potential to contaminate local plants and animals, impacting their survival and creating the opportunity for transmission of contaminants through the food chain.

Work near sensitive areas will occur as part of all of the Build Alternatives. Sensitive area construction includes:

- <u>Slope stabilization at the tie-in to W. Galer St. on the west end of the bridge</u> – Alternative A, C & D slope stabilization may involve construction of tie-backs and timber lagging with permanent concrete facing, or soldier pile with concrete facing, along the steep slopes of Magnolia Bluff.
- <u>Work within the shoreline area</u> - Alternative A and C require work directly above or within 200 feet of the ordinary high water mark.

See Table 7 for a summary of the potential sources of impacts for each alternative.

Mitigation

The project will avoid and minimize impacts to water quality by compliance with permit conditions and requirements. In addition mitigation measures should include:

- Construction and demolition over and within open water areas will require methods of additional mitigation, such as the use of tarps, safety nets, or a barge to capture debris and other freed materials including paint chips.
- The timing of in-water and over-water construction activities will be regulated to avoid and minimize impacts to salmon. These impacts may include increased turbidity during construction or temporary displacement of fish by the presence of barges. The timing of in-water work will be scheduled not to coincide with resident adult/juvenile migration and adult spawning periods. Juvenile salmonid out-migration generally occurs between mid-March to mid-June or is as determined by the National Marine Fisheries Service, U.S. Fish & Wildlife Service, and the Washington Department of Fish and Wildlife.

Should any unforeseen adverse impacts occur, they will be mitigated for appropriately.

Groundwater

Impacts

No-Build Alternative

Water quality impacts to the shallow unconfined aquifer system could occur during construction associated with the repair and seismic retrofit of the existing bridge. These impacts could include increases in total dissolved solids as a result of infiltration of turbid stormwater or releases of petroleum hydrocarbons or other contaminants into the groundwater as a result of spills or leaks due to improper hazardous material storage or handling.

Alternatives A, C, and D

Water quality impacts to the shallow unconfined aquifer system could occur during construction. These impacts could include increases in total dissolved solids as a result of infiltration of turbid stormwater or releases of petroleum hydrocarbons or other contaminants into the groundwater as a result of spills or leaks due to improper hazardous material storage or handling.

Construction dewatering could produce contaminated groundwater discharge from the shallow unconfined aquifer. Groundwater contaminants in the shallow unconfined aquifer could be induced to migrate toward areas where construction dewatering takes place. Land settlement could occur in areas where construction dewatering takes place.

Groundwater discharge patterns in the upland aquifer system could be affected by bridge construction activities that occur within advance outwash deposits along the eastern slope of Magnolia Hill. Cut walls could induce groundwater seepage.

Retaining walls, bridge abutments, and fill embankments could restrict groundwater seepage and divert it around impermeable structures.

If stormwater infiltration facilities are constructed, the water table elevation in the shallow unconfined aquifer may rise in the immediate vicinity of such facilities. These facilities may provide positive benefit by enhancing shallow aquifer recharge.

No impacts to the deep artesian aquifer system have been identified.

See Table 7 for a summary of the potential sources of impacts for each alternative.

Mitigation

Potential water quality impacts to the shallow unconfined aquifer system from construction activities associated with the No-Build and Build Alternatives may be mitigated by implementing effective stormwater, hazardous material, and spill response management practices.

The production of contaminated groundwater discharge or the induced migration of groundwater contaminants from shallow unconfined aquifer construction dewatering may be mitigated by utilizing water-tight shoring systems in excavations that extend below the water table. If the production of contaminated discharge water is unavoidable due to construction requirements, the discharge may be contained and treated on-site to meet relevant water quality criteria before final disposal. Depending on the volume of discharge and specific contaminant levels, the discharge, if properly permitted, may be disposed to the sanitary or stormwater sewer systems.

The potential for land settlement resulting from construction dewatering in the shallow unconfined aquifer may be mitigated by utilizing water-tight shoring systems to minimize dewatering or by re-injecting groundwater to prevent excessive drawdown around the dewatered area.

Summary of Findings

Affected Environment

Surface Water

Surface water bodies within the study area have been historically degraded and contaminated by development occurring over the last century. Specific water bodies present within the site area are Smith Cove, the Smith Cove Waterway, Lake Jacobs (an industrial pond located on Terminal 91), and Elliott Bay. The site is classified within WRIA #9 and Elliott Bay Nearshore Subwatershed. Smith Cove was an estuary prior to being filled to form the Terminal 91 uplands. Urbanization has caused the loss of most of the estuarine habitat within Elliott Bay through shoreline modification and through the discharge of contaminants. Elliott Bay's waters are currently required to meet the Class A (Excellent) marine standards for water quality and must be suitable for nearly all uses.

Elliott Bay is among the 1998 Clean Water Act section 303(d) list of impaired water bodies. Known problem areas are fecal coliform, metals, pesticides, organics, and PAH's, and PCBs. TMDL's currently under development as of September 2003 for the Duwamish and Elliott Bay WRIA #9 include pH, dissolved oxygen, fecal coliform and mercury. TMDL's are designed to establish limits on the discharge of pollutants to the water body at rates that allow state water quality standards to be met. Upon approval of the standards by the EPA, these TMDL's will apply to waters adjacent to the project site. The adopted changes to the 2003 rule cannot be used for federal Clean Water Act actions until the Environmental Protection Agency approves the standards.

Sediments near the Terminal 91 piers in Smith Cove contain contaminants (HPAH's and Phenols) above Sediment Quality Standards (SQS's), and in one case, exceeding Cleanup Screening Levels (CSL's), which are used to determine whether remediation is required in the area.

Stormwater runoff produced from the existing Magnolia Bridge currently discharges untreated into Elliott Bay, or infiltrates into groundwater and an underlying aquifer.

Groundwater

Three relatively distinct groundwater flow systems were identified in the vicinity of the Proposed Action. The principal groundwater flow system consists of a shallow unconfined aquifer system within the Interbay Channel, the lowland that underlies most of the Proposed Action. Lesser systems include upland aquifers within Queen Anne Hill and Magnolia Hill and a deep artesian aquifer located approximately 300 to 400 feet below sea level.

The shallow unconfined aquifer system is principally found in glacially unconsolidated deposits. The aquifer is generally thickest (approximately 120 feet thick) along the centerline of the Interbay Channel and progressively thins toward and pinches out along the hillsides to the east and west. Groundwater elevations generally range from 5 to 15 feet (NAVD 88 datum). Groundwater elevations are highest toward the north (near Alternative C) and lowest toward the south (Alternative A). The general groundwater flow direction in the shallow unconfined aquifer system is southward toward Smith Cove and Elliott Bay. The depth to the shallow water table ranges from less than 4 feet to approximately 10 feet below the ground surface at the base of the Interbay Channel. The water table may fluctuate 1 to 3 feet seasonally due to changing precipitation patterns. In addition, the shallow water table in the vicinity of Elliott Bay (Smith Cove) fluctuates in response to tidal stage changes. Actual depths to groundwater will vary based on the ground surface elevation, season of the year, and tidal stage in Elliott Bay.

In the vicinity of the Proposed Action, the groundwater quality of the shallow unconfined aquifer has generally been degraded by numerous industrial activities that have historically existed in the area. In part, shallow groundwater contamination may have resulted from operations at the Port of Seattle petroleum storage tank farm, the Interbay Landfill, the BNSF railway, former and existing gasoline service stations, auto wrecking yards, iron and steel yards, and other industrial properties. Contaminants detected in shallow groundwater in the vicinity of the Proposed Action include petroleum hydrocarbons, volatile organic compounds (VOC's), polycyclic aromatic hydrocarbons (PAH's), polychlorinated biphenyls (PCBs), and dissolved metals.

Two pending groundwater rights for environmental quality and fish propagation purposes were identified in the project area. No domestic or municipal drinking water rights were identified. No public drinking water wells, sole source aquifers, wellhead protection areas, or critical aquifer recharge areas exist within the vicinity of the Proposed Action.

Impacts

Potential impacts to water quality include long-term operational impacts resultant from daily use of the bridge by vehicular traffic, shoreline impacts due to the proximity of the bridge to water bodies, and short-term construction impacts generated over lengthy construction periods. See Table 7 for a summary of the impacts to surface water and groundwater quality.

Operational Impacts

Surface Water

Since the project area drains directly to Elliott Bay (saltwater body), there are no impacts associated with increased volumes of surface water runoff from any of the Build Alternatives.

A vast majority of the existing study area consists of PGIS. As such, any increase in pollutant loading to receiving waters may be directly linked to the net increase in study area PGIS as a result of any of the Build Alternatives. Alternative A is the only alternative with a significant (1.2 acre) increase in net study area PGIS. The increase is as a result of the bridge location over Smith Cove, Lake Jacobs, as well as the Smith Cove Park parcel.

Table 7
Summary of Impacts

Impact Classification	Impact	No-Build Alternative	Alternative A	Alternative C	Alternative D
Operational	Surface Water Quality – Pollutant Loading Directly Correlates with Net Increase in Study Area PGIS	Baseline = 0	+1.1 to 1.2 Acre	+0.2 Acre	-0.3 Acre
	Surface Water Runoff Quantity	N/A – Project Drains to Saltwater (No Detention Required)			
	Maintenance	Common to All Alternatives			
	Possible Migration of Subsurface Contaminants in Utility Trenches	No Impact	Common to All Build Alternatives		
Shoreline	Bridge Footprint Area Within 200' of OHW	2.6 Acre	3.4 Acre	0.2 Acre	0 Acre
	Bridge Footprint Area Directly Over Water	0.3 Acre	0.8 Acre	0 Acre	0 Acre
	Water & Sediment Flow Around In-Water Footings	Bridge Has In-Water Footings	Requires Greater No. of In-Water Footings than No-Build	No In-Water Footings	No In-Water Footings
	Direct Discharge of Pollutants	Possible Impact	Greater Probability than No-Build	No Impact	No Impact
Secondary & Cumulative	No Impacts Identified				
Construction	Leakage of Petroleum Products from Construction Equipment	Possible, Due to Seismic Retrofit	Common to All Build Alternatives		
	Accidental Spills	No Impact	Common to All Build Alternatives		
	Mobilization of Dust, Debris, Contaminants	No Impact	Common to All Build Alternatives		
	Erosion & Sedimentation due to Earthwork	No Impact	Common to All Build Alternatives		
	Footing Excavation and/or dewatering may expose subsurface contaminants	No Impact	Common to All Build Alternatives		
	Staging Area Contamination	Possible, Due to Seismic Retrofit	Common to All Build Alternatives		
	Increased Traffic to Other Routes (Detours)	Possible, Due to Seismic Retrofit	Common to All Build Alternatives		
	Construction Near to or Within Sensitive Areas	No Impact	• Steep Slopes • Within 200' of OHW	• Steep Slopes • Within 200' of OHW	• Steep Slopes
	Introducing contaminants to subsurface waters	Possible, Due to Seismic Retrofit	Common to All Build Alternatives		
	Induction or restriction of groundwater seepage in upland aquifer system	No Impact	Common to All Build Alternatives		

Source: Project team, 2004.

Groundwater

A slight risk to groundwater may occur if new utilities or stormwater conveyance pipes are constructed below the shallow groundwater table for any of the Build Alternatives. The permeable gravel backfill typically used to fill utility trenches could create a preferential pathway for the horizontal migration of existing contaminants in the shallow unconfined aquifer.

Shoreline Impacts

Alternative A will likely have the greatest operational-related shoreline impacts due to being located south of the existing bridge. Portions of Alternative A will be located directly over water, which will require the placement of in-water bridge footings. Impacts may include increased shading of nearshore waters, alterations to water flow and sediment transport around in-water pier footings, and potential for direct discharge of pollutants to Smith Cove.

Secondary and Cumulative Impacts

It is assumed that there will be no secondary or cumulative impacts to surface water or groundwater quality associated with this project, because the project functions simply as a needed replacement of the existing bridge with a new bridge at the same traffic capacity.

Construction Impacts

Surface Water

It is assumed that seismic retrofit work will be required on the existing bridge structure for the No-Build Alternative. As such, construction impacts such as re-mobilization of sediment and other contaminants, leaking construction equipment and/or accidental spills are common to all of the Alternatives.

Generally, construction impacts are similar for all of the Build Alternatives, as the construction type and period do not vary significantly. However, due to required in-water construction, Alternative A will likely have additional impacts or an overall greater impact to water quality than the other Build Alternatives. These additional impacts may include increased in-water noise levels and re-suspension of potentially contaminated sediments to the water column.

Groundwater

Water quality impacts to the shallow unconfined aquifer system could occur during construction of any of the Build Alternatives. These impacts may include increases in total dissolved solids as a result of infiltration of turbid stormwater or releases of petroleum hydrocarbons or other contaminants into the groundwater as a result of spills or leaks due to improper hazardous material storage or handling.

Construction dewatering could produce contaminated groundwater discharge from the shallow unconfined aquifer. Groundwater contaminants in the shallow unconfined aquifer could be induced to migrate toward areas where construction dewatering takes place. Land settlement could occur in areas where construction dewatering takes place.

Groundwater discharge patterns in the upland aquifer system could be affected by bridge construction activities that occur within advance outwash deposits along the eastern slope of Magnolia Hill. Cut walls could induce groundwater seepage. Retaining walls, bridge abutments, and fill embankments could restrict groundwater seepage and divert it around impermeable structures.

The water table elevation could rise and the local groundwater flow pattern in the shallow unconfined aquifer could change if stormwater infiltration facilities are constructed.

Mitigation Measures

All of the anticipated Build Alternative impacts to water quality may be mitigated. Further, mitigation will be required as a result of the environmental and permitting processes associated with any of the Build Alternatives. As such, it is anticipated that there will be a net improvement to water quality as a result of implementation of any of the Build Alternatives relative to the existing conditions.

Operational Mitigation

Surface Water

Potential increases in pollutant loading as a result of the Build Alternatives are required to be mitigated (by the DOE Manual) via the implementation of the ten Minimum Requirements. Included in these requirements is the installation of stormwater treatment BMP's. Application of stormwater treatment prior to discharge through an existing outfall may result in a net-benefit to stormwater quality and water, as there is no existing treatment today. Flow from the high-use intersection area(s) will also be diverted to an oil/water separator or other appropriate oil removal BMP prior to discharge.

Maintenance BMP's, such as regular vactor-sweeping of the new bridge structures, and vactoring of the catch basin sumps will become part of the City's ongoing roadway maintenance program. Maintenance of the structural treatment BMP's is a requirement of the DOE Manual and will be ensured during the permitting process.

Groundwater

The creation of preferential migration pathways for existing groundwater contaminants along new utility or stormwater conveyance trenches may be mitigated in several ways. Where possible, future utility trenches should avoid areas where groundwater contamination has been identified (see the Hazardous Materials Discipline Report) or should not extend below the shallow groundwater table. Constructing low permeability "dams" within the trench backfill to restrict horizontal groundwater movement may also mitigate the potential for contaminant migration.

Shoreline Mitigation

Shoreline impacts to water quality, primarily associated with Alternative A, may also be mitigated. Shading effects are mitigated by the increased bridge height. Disturbance of potentially contaminated nearshore sediments will be avoided and/or minimized by defining the extent of contamination and designing and locating in-water pier footings appropriately.

Construction Mitigation

Surface Water

The DOE Manual requires mitigation measures be developed and employed to curb the potential impacts of construction. These measures include contractor execution of a comprehensive Construction Stormwater Pollution Prevention Plan (SWPPP) to manage and control erosion and sedimentation on the construction site. Structural and source control Best Management Practices (BMP's) will be designed and implemented to reduce construction-related sediment and/or contaminant discharges to open water and to stormwater.

Construction and demolition over and within open water areas will require methods of additional mitigation, such as the use of tarps, safety nets, or a barge to capture debris and other freed materials including paint chips.

The timing of in-water construction will be mandated by the Agencies and will be scheduled not to coincide with resident adult/juvenile migration and adult spawning periods.

Groundwater

Potential water quality impacts to the shallow unconfined aquifer system from construction activities may be mitigated by implementing effective stormwater, hazardous material, and spill response management practices.

The production of contaminated groundwater discharge from shallow unconfined aquifer construction dewatering may be mitigated by utilizing water-tight shoring systems in excavations that extend below the water table. If the production of contaminated discharge water is unavoidable due to construction requirements, the discharge may be contained and treated on-site to meet relevant water quality criteria before final disposal.

The induced migration of contaminated groundwater in the shallow unconfined aquifer resulting from construction dewatering may be mitigated by utilizing watertight shoring systems in excavations that extend below the water table to minimize dewatering requirements.

The potential for land settlement resulting from construction dewatering in the shallow unconfined aquifer may be mitigated by utilizing water-tight shoring systems to minimize dewatering or by re-injecting groundwater to prevent excessive drawdown around the dewatered area.

References

City of Seattle. 2000. *Stormwater, Grading and Drainage Control Code (Title 22.800).* Volume 4 - Appendix A. Seattle, WA: Department of Design Construction and Land Use.

Environmental Protection Agency. *Best management Practices to Protect Water Quality.* Bridge Maintenance and Repair. Web Page: http://www.nalms.org/bclss/service.html

Horner, R.R. 1992. Water quality criteria/pollutant loading estimation/treatment effectiveness estimation. In R.W. Beck and Associates. *Covington Master Drainage Plan*. King County Surface Water Management Division. Seattle, Washington.

King County. 1995. *An Atlas of the Watersheds of King County, Washington*. Regional Needs Assessment for Surface Water Management. Web Page: http://dnr.metrokc.gov/wlr/BASINS/rnaatlas.pdf

King County. 2000. *Habitat Limiting Factors and Reconnaissance Report - Green/Duwamish and Central Puget Sound Watersheds, WRIA #9 and Vashon Island*. Executive Summary. Washington State Conservation Commission. Web page: ftp://dnr.metrokc.gov/dnr/library/2000/kcr728/execsum/execsum.pdf

King County. 1998. *Surface Water Design Manual*. Chapter 4. Department of Natural Resources.

King County Department of Natural Resources and Parks. 2003. *Green/Duwamish and Central Puget Sound Watershed, Water Resource Inventory Area (WRIA) 9*. Water and Land Resources Division. Web Page: http://dnr.metrokc.gov/Wrias/9/index.htm

King County Department of Natural Resources and Parks. 2003. *Marine Monitoring.* Water and land Resources Division. Web page: http://dnr.metrokc.gov/wlr/waterres/marine/monitor_parms.htm

King County Department of Natural Resources and Parks. 2001. *Reconnaissance Assessment of the State of the Nearshore Ecosystem.* Chapter 11 – Elliott Bay and Duwamish River Estuary. Seattle, WA. Web Page: http://dnr.metrokc.gov/wlr/watersheds/puget/nearshore/sonr.htm

King County Department of Natural Resources and Parks. 2001. *Water quality Status Report for Marine Waters.* Water and Land Resources Division. Web page: ftp://dnr.metrokc.gov/dnr/library/2002/kcr64/Section3.pdf

King County Department of Natural Resources and Parks. 2001. *Year 2000 King County Human Population Statistics*. Water and Land Resources Division GIS and Visual Communications Unit. Web Page: ftp://dnr.metrokc.gov/dnr/VCGIS/maps/county/0112-population-growth.pdf

National Oceanic and Atmospheric Administration & Washington State Department of Ecology. 2000. *Sediment Quality in Puget Sound. Year 2 – Central Puget Sound.*

Port of Seattle. 2001. *Terminal 91 Technical Memorandum.* Team Otak.

Project Team. 2003. *Replacement Alternatives A, D, and H Conceptual Construction Sequences.* Seattle, WA.

Sherwin, Bill. July 16th, 2003. Seattle Public Utilities (SPU). Personal Communication.

Washington State Department of Ecology. 2000. *Cedar/Sammamish Water Resources Inventory Area #8.* Map-State and Map-8. GIS Technical Services. Web Page: http://www.ecy.wa.gov/services/gis/maps/wria/wria.htm

Washington State Department of Ecology. *Duwamish-Green Basin – WRIA #9.* Summary. Web Page: www.ecy.wa.gov/programs/wq/wria_summaries/wria9.pdf

Washington State Department of Ecology. 2003. *TMDLs Under Development – September 2003.* Web Page: http://www.ecy.wa.gov/programs/wq/tmdl/tmdl_status.html

Washington State Department of Ecology. 2001. *Water Quality Standards for Surface Waters of the State of Washington – Proposed Chapter 173-201A WAC*. Web Page: http://www.ecy.wa.gov/programs/wq/swqs/rev_rule.html

Washington State Department of Transportation (WSDOT). 2003. *Environmental Procedures Manual.* Section 431 and 510. Web Page: http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/EPM.htm

Water Quality Standards for Surface Waters of the State of Washington – Chapter 173-201A WAC. 1997. Web Page: http://www.ecy.wa.gov/biblio/wac173201a.html

Washington State Department of Transportation (WSDOT). 2003. *Environmental Procedures Manual.* M31-11. Web Page: http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/EPM/EPM.htm

Appendix A
Depth to Shallow Groundwater Figures

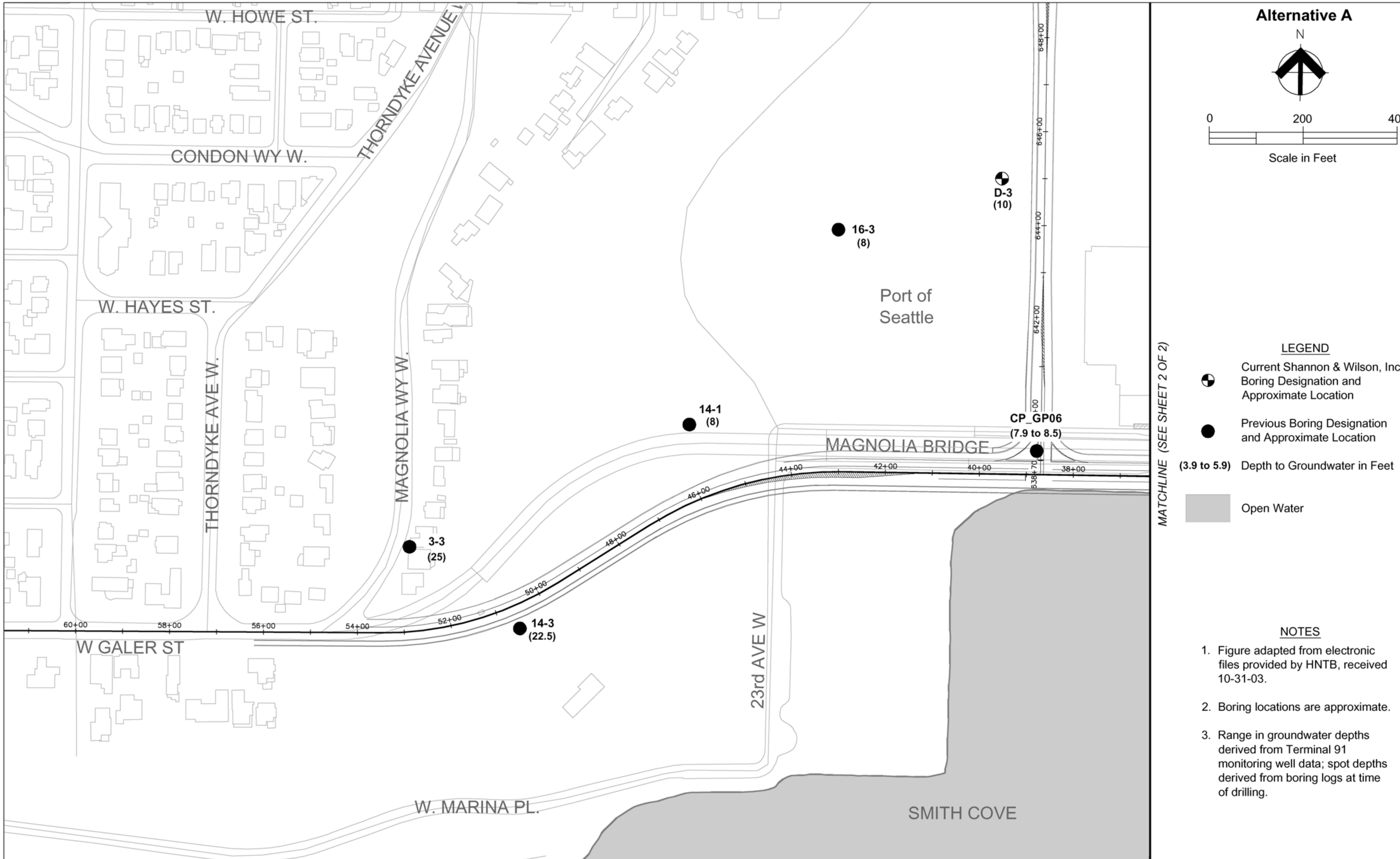


Figure A-1, Sheet 1 of 2 - Depth to Shallow Groundwater - Alternative A

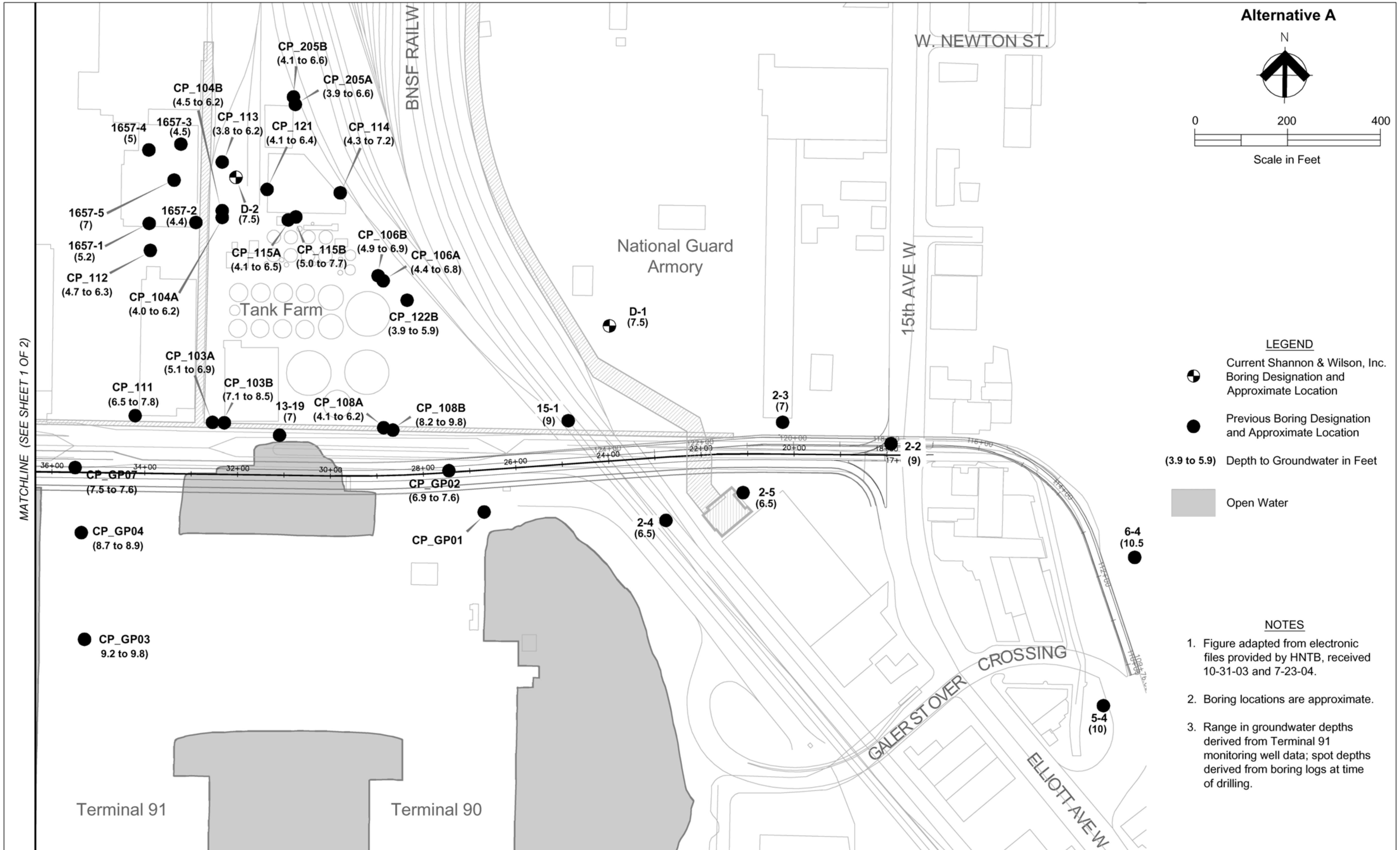


Figure A-1, Sheet 2 of 2 - Depth to Shallow Groundwater - Alternative A

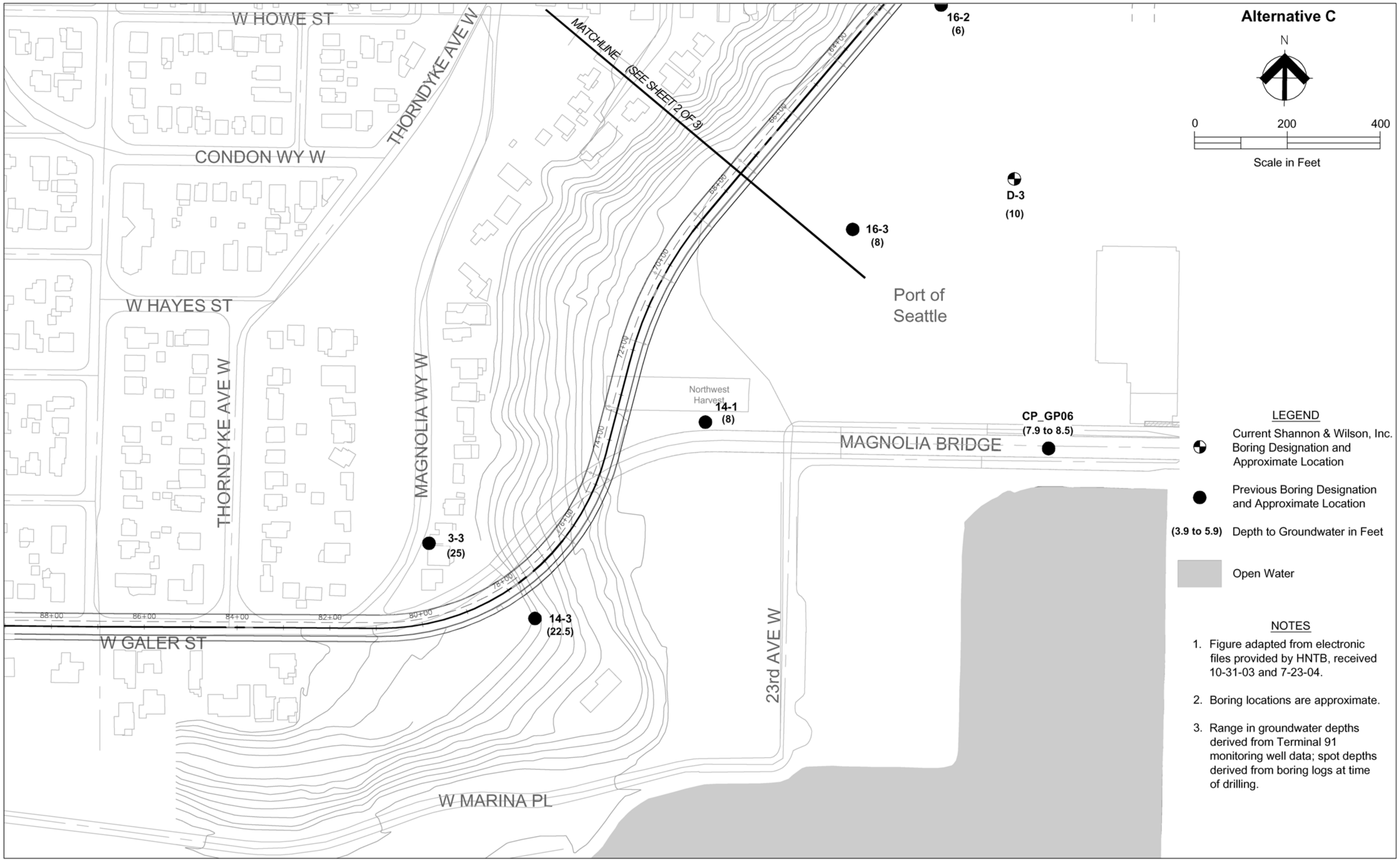


Figure A-2, Sheet 1 of 3 - Depth to Shallow Groundwater - Alternative C

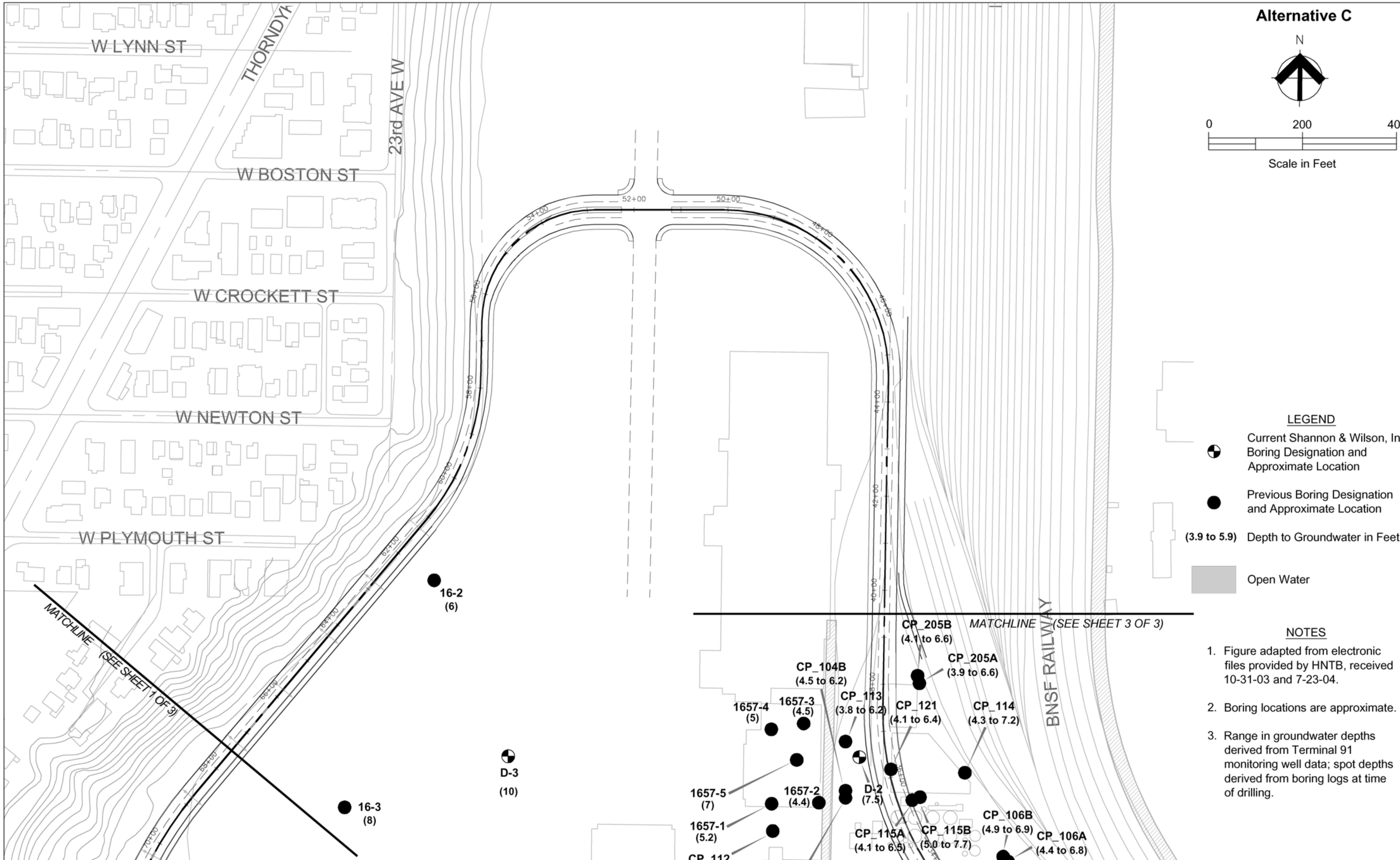


Figure A-2, Sheet 2 of 3 - Depth to Shallow Groundwater - Alternative C

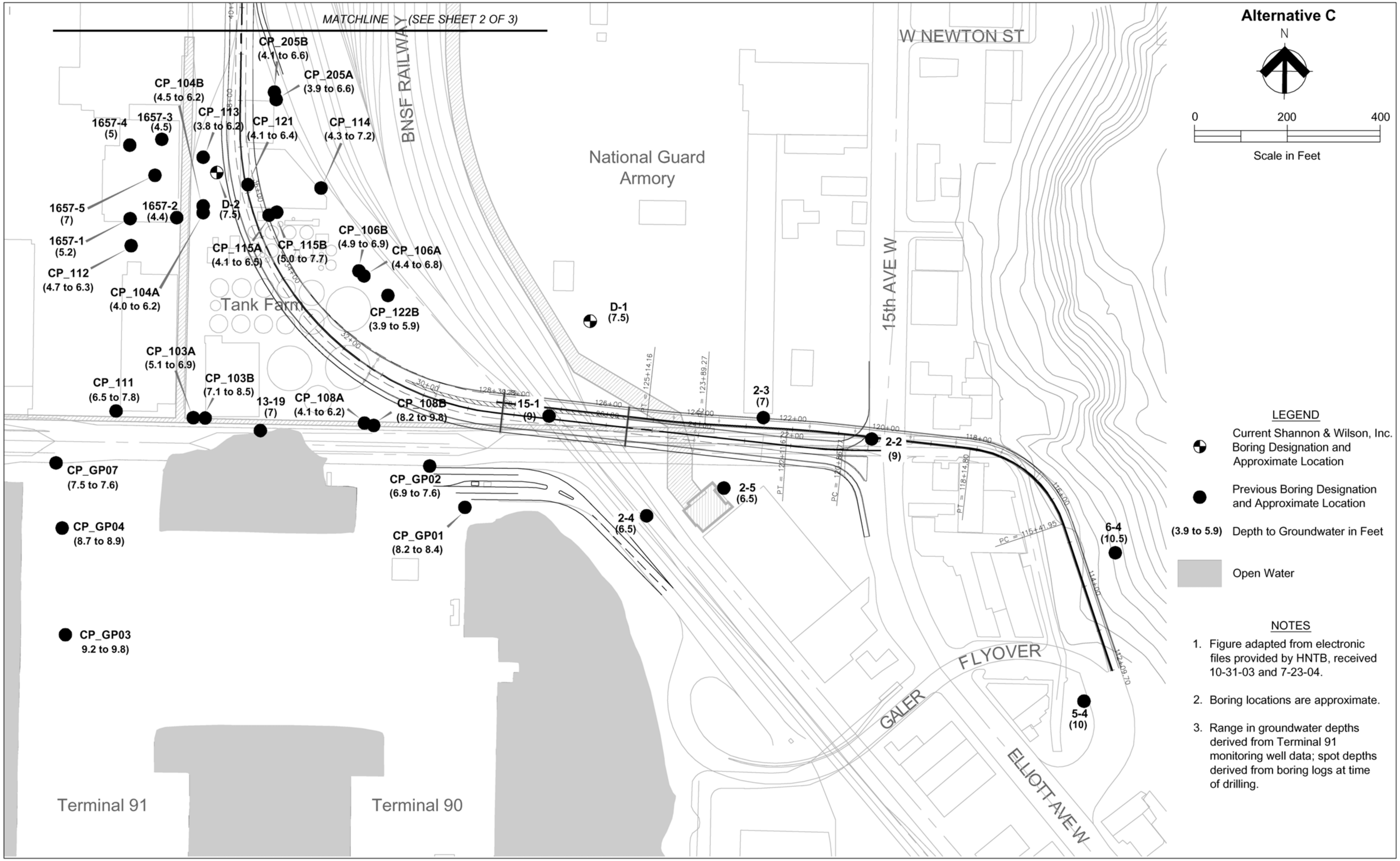


Figure A-2, Sheet 3 of 3 - Depth to Shallow Groundwater - Alternative C

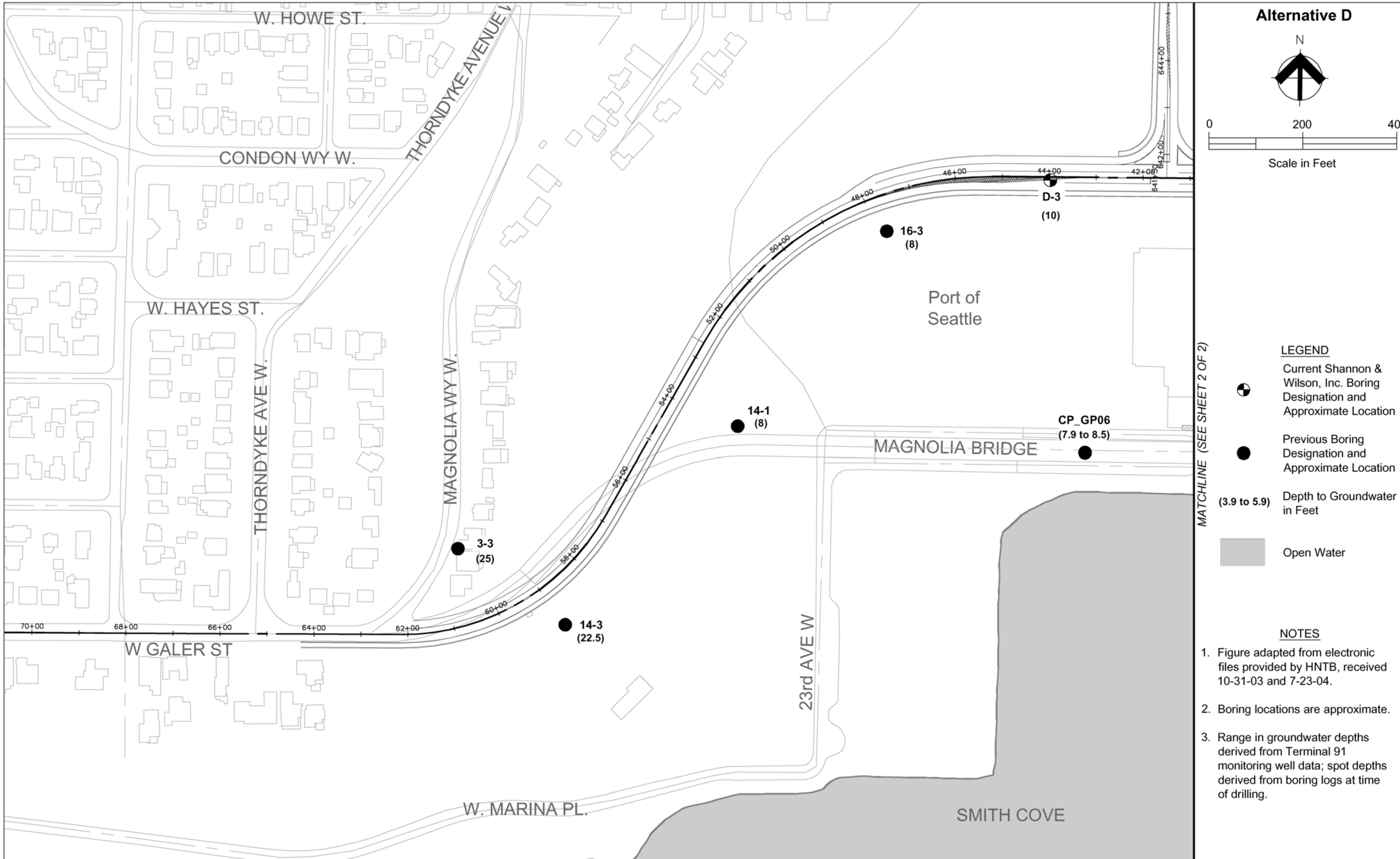


Figure A-3, Sheet 1 of 2 - Depth to Shallow Groundwater - Alternative D

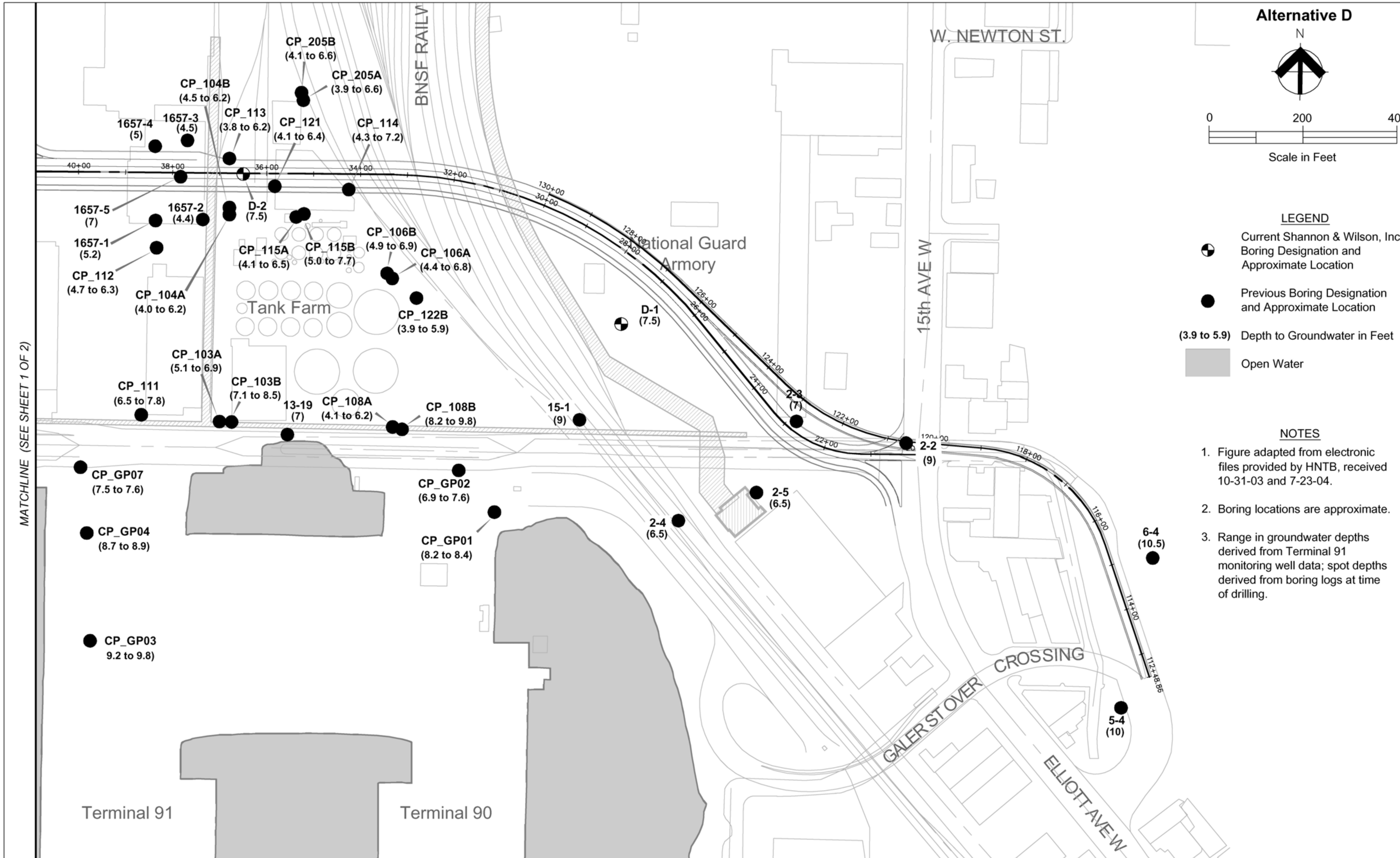


Figure A-3, Sheet 2 of 2 - Depth to Shallow Groundwater - Alternative D

Appendix B
Water Quality Elements Checklist Summary

Water Quality Elements Checklist Summary

Item Number		Applicable	Document Location & Comments
I.	A.	X	p.1-5, Purpose and Need p.61-63, Summary of major water quality concerns
	B.	X	p.61-63, Summary of WQ differences between alternatives
	C.	X	p.2-3, Vicinity & Study area Maps
	D.	X	p.12-16, Alternative Figures
II.	A.		
	A.1	X	p.28, Potentially affected surface waters
	A.2	X	p.41, Studies and Coordination p.67, References
	A.3	X	p.41, Studies and Coordination
	B.	X	p.17-19, Methodology and Data Used
	C.		
	C.1	X	p.18, SDOT Programs & Policies
	C.2		N/A, Replacement bridge: No change in land use
	C.3	X	p.19, Applicable watershed regulations p.22, Watershed plans, analysis
	C.4	X	p.18, Critical Areas ordinances
	C.5		N/A, No wetlands within or downstream of study area.
	C.6	X	p.18, CSO Reduction Plan
	C.7	X	p.31-33, TMDL's
	C.8	X	p.33, Limiting factors
	C.9	X	p.18, Shoreline Plans and Ordinances
	C.10		N/A, No shellfish harvesting within study area
III.	A.		
	A.1	X	p.22, Topography
	A.2	X	p.22, Climate
	B.		
	B.1	X	p.22, Basins and Watersheds
	B.2	X	p.22, WRIAs
	B.3	X	p.31, Sampling Data
	B.4		N/A, No streams within or downstream of study area
	B.5	X	p.30-33, Water Quality Standards
	B.6		N/A, no CWA 305(d) listed waters
	B.7	X	p.31, Source Identification
	B.8		N/A, No streams within or downstream of study area
	B.9	X	p.25, Drainage pathways
	B.10	X	p.30-35, Limiting Factors
	B.11		N/A, No streams within or downstream of study area
	B.12		N/A, No lakes within or downstream of study area
	B.13	X	p.35, Drift & Current
	B.14	X	p.36, ESA Issues

Item Number		Applicable	Document Location & Comments
	B.15	X	p.35, Sediment Quality and Contamination
	B.16	X	p.17, Antidegredation
	B.17		N/A, No wetlands within or downstream of study area.
	B.18		N/A, No separate groundwater report
	B.19		N/A, No streams within or downstream of study area
	B.20	X	p.36, Fisheries Report reference
	C.		
	C.1	X	p.36, Public water supply
	C.2	X	p.36, Public wastewater systems
	C.3		N/A, No Spill Data specific to area
	C.4	X	p. 36-39, Wellhead Protection Areas and Critical Aquifer Recharge Areas
	C.5	X	p. 37, Groundwater, and reference to Hazardous Materials Discipline Report
IV.	A.		
	A.1	X	p.57-59, Erosion & Sedimentation
	A.2	X	p.58, In-water & Near Water work
	A.3	X	p.58, Sensitive Areas work
	A.4		N/A, No streams within or downstream of study area
	A.5		N/A, No lakes within or downstream of study area
	A.6	X	p.57-59, Clearing and grading impacts
	A.7	X	p.57-59, Staging area impacts
	A.8	X	p.59, Water & Sewer impacts
	A.9		N/A, No separate groundwater report
	A.10	X	p.58, Hazardous materials study reference
	A.11	X	p.47, 59, Spill Control BMP's
	B.1	X	p.43, ADT discussion & impact
	B.2	X	p.43-44, Maintenance Impacts
	B.3	X	p.43-44, PGIS Impacts
	B.4		N/A, No lakes within or downstream of study area
	B.5	X	p.43-44, Stormwater sediments
	B.6	X	p.47, Reference to Fisheries Report
	B.7	X	p.47, Spills
	B.8		N/A, No wetland, floodplain reports.
	D.		
	D.1	X	p.43-44, Runoff & Nonpoint sources
	D.2		N/A, No quantity concerns required – draining to saltwater
	D.3		N/A, No streams within or downstream of study area
	D.4		N/A, Replacement bridge: No change in land use
	E.		
	E.1		N/A, Replacement bridge: No secondary impacts
	E.2		N/A, Replacement bridge: No future development applies
	F.	X	p.63, Summary of impacts & sources

Item Number		Applicable	Document Location & Comments
V.	A.		
	A.1	X	p.53, TESC BMP’s
	A.2	X	p.53, Permit & DOE Manual Requirements
	A.3	X	p.53, SWPPP
	A.4	X	p. 54-55, Operational Mitigation, and p. 59-60, Construction Mitigation
	A.5	X	p.59, Sewer Protection
	A.6	X	p.51-52, Structural BMP requirements
	B.		
	B.1	X	p.51, Water quality treatment BMP’s
	B.2	X	p.51-52, DOE Manual Requirements
	B.3	X	p.52, Maintenance BMP’s
	B.4	X	p. 54-55, Operational Mitigation, and p. 59-60, Construction Mitigation
	B.5	X	p.54, Monitoring
	C.	X	p.54-55 and p.59-60, Mitigation for significant impacts
	D.	X	p.54-55 and p.59-60, Mitigation required by DOE manual

Notes: X = Checklist item is applicable to the project. If left blank, item is not applicable
Source: WSDOT Environmental Procedures Manual, Exhibit 431-4C