3. PROJECT DESCRIPTION

3.1 BACKGROUND

As described in Section 1, the I-5 CRC project is a multimodal transportation project focused on improving safety, reducing congestion, and increasing mobility of motorists, freight, bicyclists, and pedestrians along a 5-mile section of the I-5 corridor connecting Vancouver, Washington and Portland, Oregon, and extending the Yellow Line MAX from Delta Park in Portland to Clark College in Vancouver. The project area stretches from SR 500 in northern Vancouver, south through downtown Vancouver and over the I-5 bridges across the Columbia River to just north of Columbia Boulevard in north Portland (Figure 3-1).

The project proposes to:

- Replace the existing Columbia River bridges with two new structures.
- Widen the existing North Portland Harbor bridge and construct three additional structures across the harbor.
- Improve seven interchanges and roadways along and adjacent to I-5 in Portland and Vancouver.
- Improve highway safety and mobility along I-5 in Portland and Vancouver.
- Extend LRT from north Portland to downtown Vancouver.
- Add improved bike/ped access on the new bridges and surrounding areas.
- Construct three new park and ride facilities in Vancouver.
- Expand the Ruby Junction Maintenance Facility to accommodate additional LRT vehicles.
- Construct stormwater BMPs and provide a high level of stormwater runoff treatment.
- Demolish existing Columbia River bridges.

3.2 PROJECT AREA

The project area is defined as all areas that will be directly impacted by the project, including the footprint of the permanent and temporary structures, widened highway segments, new interchanges, city street realignments, associated road shoulder excavation and fill areas, stormwater facilities, areas contributing runoff to the stormwater facilities, wetland mitigation areas, and staging and access areas, including areas in the Columbia River and North Portland Harbor where work will occur from barges and temporary structures. The project area described is the immediate area involved in the action and is not equivalent to the “Action Area” defined in Section 3.15, a term required under the ESA to describe the area affected by the action.

Figure 3-1. Highway and Transit Elements Near the Columbia River

Columbia River CROSSING

Along the I-5 corridor, the project area extends 5 miles from north to south, beginning at the I-5/SR 500 interchange in Vancouver, Washington, and extending to the I-5/Victory Boulevard in Portland, Oregon (Figure 3-1). At its northern end, the project area extends west into downtown Vancouver and east to near Clark College to include high-capacity transit alignments, transit stations, park and ride locations, and city road improvements included as part of this project. Heading south along the existing over-water bridge alignments, the project area extends 0.25 mile on either side of the bridges to include the new Columbia River and North Portland Harbor bridges, as well as the adjacent areas where construction and demolition activities will occur. At its southern end, the project area extends east into Portland and includes city road improvements along Victory Boulevard.

The project area includes potential staging and casting yards at the Port of Vancouver, Alcoa/Evergreen, Sundial, Red Lion at the Quay, and Thunderbird Hotel staging sites (Figure 1-1). In Gresham, the project area includes a 10.5-acre expansion of the Ruby Junction Maintenance Facility. Along the Hood River in Oregon and along the Lewis River in Washington, the project area includes compensatory mitigation sites.

The project area described here includes all associated cut and fill slopes and stormwater treatment facilities.

3.3 PROJECT DESIGN HISTORY

The project presented in this BA is a result of a conscious effort by the design team to minimize impact to aquatic species and their habitats through multiple design refinements. The major design changes incorporated into the project description are listed in the items 1 through 3 below. In addition, the project has chosen a conservative treatment method for stormwater. This methodology is listed in item 4.

Throughout the development process, the project has made a number of major design changes to minimize impacts to the environmental baseline including the following:

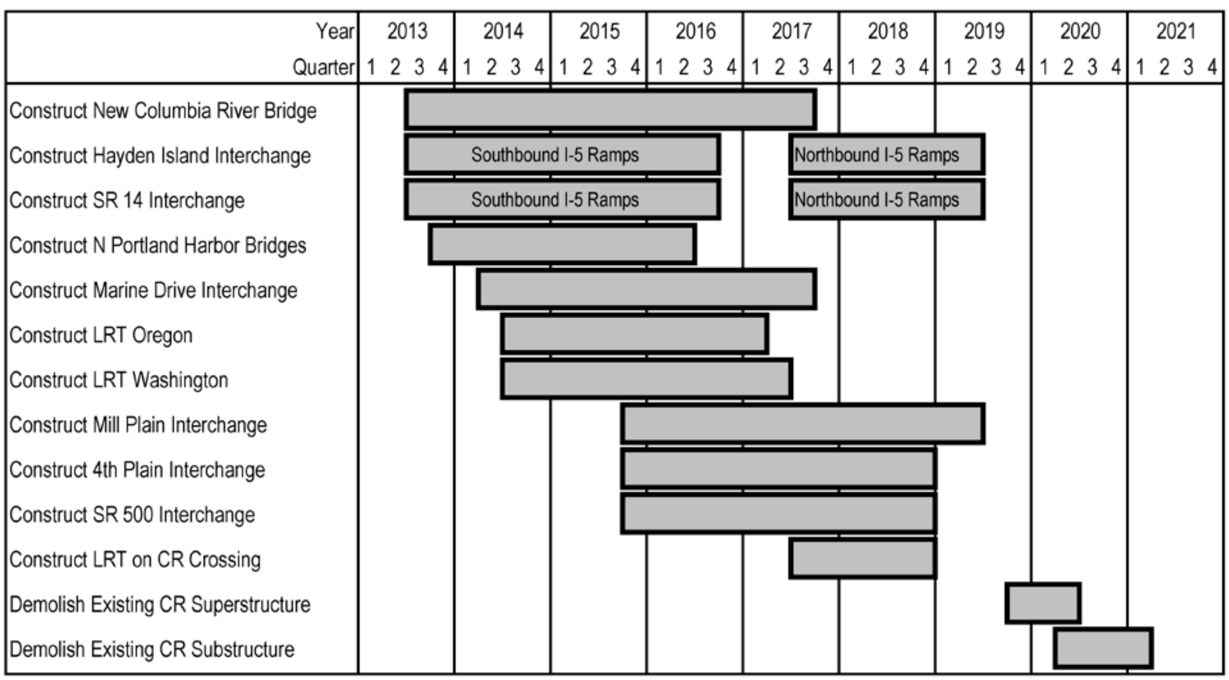
1. The permanent in-water piers of the Columbia River and North Portland Harbor crossings will be constructed using drilled shafts, rather than with impact pile driving. Originally, the project proposed to drive numerous 96-inch steel piles, involving over 200 days of in-water impact pile driving and creating noise levels that will far exceed injury thresholds for listed fish throughout large portions of the Columbia River and North Portland Harbor within the action area. The current design significantly reduces the amount of impact pile driving, the size of the piles, and the amount of in-water noise. Drilled shafts have been minimized from 16 shafts per pier in the original design to a maximum of nine shafts per pier in the current design.

2. Earlier alternatives considered three bridges across the Columbia River: one for I-5 northbound traffic, one for I-5 southbound traffic, and one for LRT and bike/ped traffic. The current design proposes a stacked alignment, with LRT conveyed under the deck of the southbound structure and a bike/ped path beneath the northbound structure. This design reduces the number of in-water piers in the Columbia River by approximately one-third, and greatly reduces both the temporary construction impacts and the permanent effects of in-water piers.

3. The project proposes six in-water pier complexes for a total of 12 piers for the Columbia River bridges. Earlier designs considered up to 21 in-water piers, but the design has been refined to the minimum number necessary for a safe structure. Piers have been designed to withstand the design scour without armor-type scour protection (e.g., riprap).
4. The project provides a high level of stormwater treatment. The project area intersects several jurisdictions, each of which has different standards for stormwater treatment. The CRC project team will employ the most restrictive water quality requirements project-wide, meaning that in many cases, the level of stormwater treatment exceeds that of the local jurisdiction. In addition to treating the new impervious surfaces created by the project, the project has identified approximately 188 acres of existing impervious surfaces that will be retrofitted to meet current stormwater treatment standards. Together, these measures are expected to reduce impacts to the environmental baseline to a greater degree than by using the standards of the individual jurisdictions.

3.4 TIMELINE AND SEQUENCING

As shown in Figure 3-2, construction of the Columbia River and North Portland Harbor bridges sets the sequencing for other project components. The Columbia River bridges and immediately adjacent highway improvements will require the longest construction timelines. Construction will begin with the Columbia River bridges, though other elements of the project will be started well before these bridges are finished.



CR = Columbia River; LRT = Light Rail Transit; N = North; SR = State Route

Figure 3-2. Representative Schedule of CRC Construction Activities

The estimated start date for construction is 2013; the estimated end date is 2021. Funding will be a large factor in determining the overall sequencing and construction duration. Contractor schedules, weather, materials, and equipment could also influence construction duration.

Figure 3-2 provides an overview of the anticipated project timeline and sequencing of project elements. Table 3-1 summarizes the estimated interchange construction schedule timelines.

Table 3-1. Estimated Interchange Construction Schedule Timelines

Interchange	Partial Interchange Including Southbound Approaches (years)	Full Interchange (years)	Interchange Completion (total years)
SR 14	2.5	1.5	**4**
Hayden Island	1.5	2.5	**4**
Marine Drive and Victory Blvd	N/A	3	**3**
Mill Plain Blvd	N/A	3.5	**3.5**
Fourth Plain Blvd	N/A	2.7	**2.7**
SR 500/39th Street	N/A	4	**4**

The following provides a brief overview of the major construction sequencing issues. To the extent practicable, the timing of in-water work has been tailored to minimize impacts to aquatic species.

Columbia River Bridges Construction. The project will build two new spans over the Columbia River. The general sequence of bridge construction includes the following steps:

- **Initial preparation**: Mobilize construction materials, heavy equipment, and crews; prepare staging areas.
- **Installation of temporary in-water work structures**: Install temporary piles for work bridges and work platforms that will support construction equipment.
- **Installation of foundation shafts**: Drill and install shafts to support columns and superstructure.
- **Shaft caps**: Construct and anchor concrete foundations on top of the shafts to support pier columns.
- **Pier columns**: Construct or install pier columns on the shaft caps.
- **Bridge superstructur**e: Build or install the horizontal structure of the bridge spans across the piers. The superstructure will be steel or reinforced concrete. Concrete will be cast-in-place or precast off site and assembled on site (Section 3.5).

North Portland Harbor Bridges Construction. The project will build three new spans and widen one existing span over North Portland Harbor. The general sequence of bridge construction includes the following steps:

- **Initial preparation**: Mobilize construction materials, heavy equipment, and crews; prepare staging areas.
- **Installation of temporary in-water work structures**: Install temporary piles for work bridges and work platforms that will support construction equipment.
- **Installation of foundation shafts**: Drill and install shafts to support structures.
- **Bent columns**: Construct or install bent columns on the drilled shafts.

- **Bridge superstructur**e: Build or install the horizontal structure of the bridge spans across the bents. The superstructure will be steel or reinforced concrete. Concrete will be precast off site and assembled on site (Section 3.5).

SR 14 and Hayden Island Interchange Construction. Proper sequencing of interchange construction, particularly of construction of the SR 14 and Hayden Island interchanges, is critical to maintain traffic flow across the river during the entire project. Interchanges on each side of the bridge must be partially constructed before any traffic can be transferred onto the new structure. For the SR 14 interchange, it will take approximately 2.5 years to complete the southbound approaches and ramps and to allow traffic onto the new southbound Columbia River bridge (Table 3-1). Completion of the rest of the interchange will require approximately 1.5 additional years. For the Hayden Island interchange, it will require approximately 1.5 years to complete the southbound approaches needed to allow traffic onto the new southbound Columbia River bridge and approximately another 2.5 years to complete the full interchange. Both interchanges will need to be completed at the same time in order to move traffic onto the new southbound lanes and to allow construction of the remaining northbound lanes and ramps.

Marine Drive and Victory Boulevard Interchange Construction. Like the SR 14 and Hayden Island interchanges, construction of the Marine Drive interchange will require coordination with construction of the Columbia River bridge southbound lanes. Specifically, the use of the southbound collector-distributor (CD) system (Figure 3-13) requires the work to occur in the same period. Without construction of a new Marine Drive interchange, the light rail system cannot be completed as currently designed. The Marine Drive interchange is expected to take 3 years to construct, including work at the Victory Boulevard interchange.

Mill Plain Boulevard, Fourth Plain Boulevard, and SR 500/39th Street Interchange Construction. These three interchanges can be constructed independently. It will be most efficient to complete all highway construction north of SR 14 concurrently. Detours of I-5 around the SR 500/39th Street interchange will also facilitate efficient construction in this area. All three interchanges can be constructed in 4 years. More aggressive and costly staging could shorten this timeframe.

Demolition of Existing Bridges. Demolition of the existing river crossing structures is expected to take approximately 1.5 years. It can begin after traffic is rerouted to the new Columbia River bridges. However, work must be completed at the SR 14 and Hayden Island interchanges before the existing bridge can be demolished. The new northbound bridge and the northbound off-ramp to SR 14 must be completed and opened before traffic can be routed to the new bridges.

Ruby Junction Maintenance Facility Expansion. Expansion of the Ruby Junction Maintenance Facility is scheduled to begin in 2015.

Light Rail Construction. Light rail construction will require about 4 years for completion. LRT will use the southbound bridge across the Columbia River, and will be on a new, separate structure over North Portland Harbor. Any bridge structure work will be separate from the actual light rail construction activities and must be completed first. As noted, there are some staging considerations for the Marine Drive interchange construction. If not coordinated, design changes or temporary connections will be necessary to open the line.

3.5 IN-WATER AND OVER-WATER BRIDGE CONSTRUCTION

New bridges will be constructed over the Columbia River and North Portland Harbor, a side channel of the Columbia River. See Section 5.2 for a discussion of existing conditions.

3.5.1 Overview

3.5.1.1 Columbia River Bridges

The existing structures over the Columbia River consist of two separate bridges that are functionally obsolete (i.e., the existing configuration does not meet current bridge standards and traffic demand). The existing structures include lift spans that must be raised for certain river traffic, and that causes automobile traffic delays when lifted. Each has three lanes, substandard shoulders, and a bike/ped sidewalk that does not meet current Americans with Disabilities Act (ADA) accessibility standards.

The new Columbia River crossing will carry traffic on two separate bridges and include a new LRT line and improved bike/ped facilities. Each new bridge will carry three through-travel lanes and two to three auxiliary lanes for traffic entering and exiting the highway in each direction, as well as full standard safety shoulders. The eastern structure will carry northbound traffic on its upper deck, with bike/ped traffic below; the western structure will carry southbound traffic on its upper deck, with LRT below. Both existing bridges will be removed after the new bridges are constructed and related interchange work is completed.

The new bridges will be subject to multiple clearance constraints. Vertical clearances underneath the bridges must accommodate river traffic below. The project team, in consultation with the USCG and industry representatives, established a vertical minimum of 95 feet of clearance for the new bridges, so that the new structure could be built without a lift span. In addition, the bridges must not be so high as to interfere with flights from Portland International Airport (PDX) and Pearson Field, a historic airport just to the east of the project area. The top of deck of the new bridges will range in elevation from approximately 100 to 135 feet (North American Vertical Datum of 1988 [NAVD88]) over the Columbia River. Because of these elevation restrictions and the need to construct curved structures to match existing on-land infrastructure, suspension or cable-stay bridge designs are not practicable.

The new structures over the Columbia River will not include lift spans, allowing more free-flowing automobile and river traffic. In addition, grades on the proposed structure will meet current ADA standards for pedestrian accessibility.

3.5.1.2 North Portland Harbor Bridges

The project will widen the existing I-5 southbound bridge over North Portland Harbor and will add three new bridges adjacent to the existing bridges. Starting from the east, these structures will carry:

- A three-lane northbound CD ramp carrying local traffic from North Portland to Hayden Island.
- Northbound and southbound I-5 on the widened existing bridge across the North Portland Harbor with three through lanes and one auxiliary lane each.

- A southbound CD ramp with two through lanes and one merging lane. This structure will carry local traffic from Hayden Island to North Portland.
- LRT combined with a bike/ped path.

The bottom of the bridges over North Portland Harbor will be at approximately 40 to 45 feet elevation (NAVD88). The structures over North Portland Harbor do not and will not include lift spans.

3.5.1.3 Summary of Bridge Construction Timing

The ODFW- and WDFW-specified in-water work window for this portion of the Columbia River and North Portland Harbor is November 1 through February 28. Because of the large amount of in-water work involved, this project will not be able to complete the in-water work during this time period. Therefore, the project will request a variance to the published in-water work window. Some in-water construction activities are proposed to occur year-round, as shown in Table 3-2. Activities taking place outside of the normal in-water work will occur in coordination with ODFW, WDFW, NMFS, and USFWS and in compliance with the terms and conditions of all regulatory permits obtained for this project. Table 3-3 shows the proposed timing of activities that are *not* considered in-water work activities. Section 3.5.2 includes explanations of various structural terms such as shaft caps, etc.

Table 3-2. Proposed Timing of In-Water Work in the Columbia River and North Portland Harbor

Activity	Description	Activity Duration (2013-2021)	Timing
1. Install small-diameter piles (≤48") with impact methods.[a]	Small-diameter piles will be used in the construction of temporary work bridges/platforms, tower cranes, and oscillator support platforms.	Up to 1 hour/day (impact hammer operation). 138 days in CR, 134 days in NPH.	Only within approved extended in-water work window of September 15 through April 15 each year.
2. Install small-diameter piles (≤48") with non-impact methods.	Small-diameter piles will be used in the construction of temporary work bridges/platforms, barge moorings, tower cranes, and oscillator support platforms.	Length of work day is subject to local noise ordinances, however could be up to 24 hours/day. 138 days in CR, 134 days in NPH.	Year-round provided work does not violate water quality standards.
3. Extract small-diameter piles (≤48") (not including cofferdams).	Removal of small-diameter piles will be done using vibratory equipment or direct pull.	Length of work day is subject to local noise ordinances, however could be up to 24 hours/day.	Year-round provided work does not violate water quality standards.
4. Install/remove cofferdam for construction of Columbia River bridges.	Used to construct piers nearest to shore in the Columbia River (pier complexes 2 and 7). Steel sheet pile sections to be installed by non-impact means to form a cofferdam. Sheet pile removal can be direct pull or use a vibratory hammer.	Cofferdams could be in place for a maximum of 250 work days each. Installation and dewatering of each cofferdam will not take more than 65 workdays; cofferdam removal will not take more than 25 workdays. Length of work day is subject to local noise ordinances.	Year-round provided work does not violate water quality standards.
5a. Install large-diameter drilled shaft casings (≥72") using vibratory hammer, rotator, or oscillator outside of a cofferdam.	Used to construct piers and bents not immediately adjacent to shore in the Columbia River and North Portland Harbor.	CR: 110 – 120 days / pier complex NPH: ~8 days/shaft	Year-round provided work does not violate water quality standards.
5b. Install large-diameter drilled shaft casings (≥72") using vibratory hammer, rotator, or oscillator inside of a water- or sand-filled cofferdam.	Used to construct piers and bents nearest to shore in the Columbia River and North Portland Harbor.	CR PC 2 and PC 7: ~84 days each NPH: ~ 8 days/shaft	Year-round provided work does not violate water quality standards.
6. Clean out shafts and place reinforcing, concrete inside steel casings.	Applies to all piers and shafts. All activities/materials will be contained within the casings and have no contact with the water.	CR: 110 – 120 days / pier complex NPH: ~8 days/shaft	Year-round provided work does not violate water quality standards.

Activity	Description	Activity Duration (2013-2021)	Timing
7a. Perform placement of reinforcement and concrete for a cast-in-place pile cap.	Possible construction method for shaft cap at pier complexes 2 and 7. All activities and materials will be contained within forms and will have no contact with the water. The bottom of the pier caps may sit below the mud line.	Estimate 95 work days per pier.	Year-round. For pier caps nearest shore: year-round if work occurs within a dewatered cofferdam.
7b. Place a prefabricated pile cap, form, pile template, or similar element into the water.	At CR pier complexes 3 - 6. Potentially at pier complexes 2 and 7. Assume contact with the water surface, but not with the riverbed.	100 work days per pier.	For deep water piers: year-round provided work does not violate water quality standards. For piers nearest shore: year-round if work occurs within a dewatered cofferdam.
8. Install and remove cofferdam for demolition of existing Columbia River bridges.	Steel sheet pile sections will be driven, usually with a vibratory hammer, to form a cofferdam. Sheet pile removal can be direct pull or use a vibratory hammer. More than one cofferdam is to be in use at a time.	~ 370 days Installation: 10 work days per pier, Demolition: 20 work days per pier, Removal: 10 work days per pier.	Year-round provided work does not violate water quality standards.
9a. Perform wire saw/diamond wire cutting outside of a cofferdam at or below the water surface.	Used throughout for demolition of existing bridges to cut concrete piers into manageable pieces. These pieces could then be loaded onto barges and transported off site.	Pier cutting and removal to take approximately 7 work days per pier.	Year-round provided work does not violate water quality standards.
9b. Perform wire saw/diamond wire cutting or a hydraulic breaker inside of a cofferdam.	Used for demolition of the existing Columbia River bridges. Used in water to cut concrete piers into manageable pieces. Cofferdam may not be dewatered.	Pier cutting and removal to take approximately 7 work days per pier.	Year-round provided work does not violate water quality standards.
10. Remove material from river bed.	Old pier/bent foundations or riprap from North Portland Crossing may be removed. Will use bucket dredge.	Less than 7 work days during the published standard IWWW per pier.	No variance requested. 11/1 to 2/28.
10a. Spot remove debris and riprap from river bed	Guided removal (likely underwater diver assisted) of specific pieces of debris or large riprap only in the location where the shaft will be drilled. In North Portland Harbor only. Will use bucket dredge.	Up to 2 hrs/day. Less than 7 work days.	Year-round provided work does not violate water quality standards.

Note: Proposed timing is contingent upon obtaining an in-water work variance from all relevant regulatory agencies.

a As a minimization measure, temporary piles that are load-bearing will be vibrated to refusal, then driven and proofed with an impact hammer to confirm load-bearing capacity.

Table 3-3. Proposed Timing for Activities Not Considered In-Water Work (Columbia River and North Portland Harbor)

Activity	Description	Activity Duration (2013-2019)	Proposed Timing
1. Construction activity above the water surface (not superstructure).	Constructing the pier and pier table includes forming, reinforcing, and placing concrete above the water surface in the Columbia River and North Portland Harbor.	Constructing the pier, pier table, and cantilevers to take approximately 160 work days per pier complex in the Columbia River. In North Portland Harbor, ~57 to 142 days/bridge.	Year-round
2. Superstructure construction – form construction, placement of reinforcing, and concrete placement.	Concrete to be transported to the over-water work sites via barge or work bridges in the Columbia River and North Portland Harbor. Numerous barge trips may be required; alternatively, concrete could be pumped to the work site via temporary work/utility bridges.	In Columbia River: 750 work days. In North Portland Harbor: ~640 work days.	Year-round
3. Superstructure construction – precast or prefabricated element assembly.	In CR and NPH. Installation of bridge superstructure (pier tables, cantilevers, decking, etc.). Precast or prefabricated elements will be transported to the over-water work sites via barge or work platform. Numerous barge trips may be required.	CR: approximately 500 days per pier complex. NPH: 100 to 190 days per bridge.	Year-round
4. Use of equipment and facilities already installed in the water.	This will include use of in-water structures (work bridges/platforms, tower cranes, cofferdams, oscillator support platforms) previously installed in the water.	In Columbia River ~750 work days, In North Portland Harbor: ~ 640 work days.	Year-round
5. Work on the bridge over the water.	Work on the bridge will cover many activities, including striping, overlays, lighting systems, etc.	In Columbia River ~750 work days, In North Portland Harbor: ~ 640 work days.	Year-round
6. Demolition of concrete over water in the Columbia River.	After installation of containment measures, concrete sections (existing bridge deck or piers) will be cut and removed from the existing structures. Cut sections could be loaded onto barges and transported off-site or trucked off the bridge.	Demolition of concrete bridge deck and piers to take approximately 255 work days.	Year-round
7. Cut off/remove existing timber piles or concrete pier inside of a cofferdam.	Exposed piles will be cut off several feet below the mud line from beneath the existing Columbia River bridge piers.	If applicable, cutting and removal of pile to take approximately 7 work days per pier.	Year-round
8. Remove existing Columbia River superstructure over water.	Lifting partitioned truss sections off their piers and loading them onto barges for transport to a dismantling site.	Demolition of bridge deck, towers, and all 10 spans to take approximately 255 work days.	Year-round

Note: The determination of activities that are not considered in-water work was made in consultation with ODFW, WDFW, NMFS, and USFWS biologists. See Appendix G for Pre-BA meeting dates and discussion topics.

Note: The in-water work window is a regulatory guide established by ODFW. The guideline was created to assist the public in minimizing potential impacts to important fish, wildlife, and habitat resources. The guidelines are based on ODFW district fish biologist's recommendations. The IWWW can apply to any activity that is subject to the regulatory requirements of the Clean Water Act Section 404 and the State of Oregon's Removal-Fill Law. WDFW administers Chapter 77.55 RCW (Construction projects in state waters). Chapter 77.55 RCW requires anyone wishing to use, divert, obstruct, or change the natural flow or bed of any river or stream to first obtain a Hydraulic Project Approval (HPA) so that potential harm to fish and fish habitat can be avoided or corrected. WDFW has the "Gold and Fish" guide that was written as a guide when gold placer mining can occur during the calendar year, but it can be applied to other projects requiring an HPA. There are some circumstances where it may be appropriate to perform in-water work outside of the preferred work period indicated in the guidelines (i.e., an in-water work window variance). ODFW and WDFW may consider variations in climate, location, and category of work that will allow more specific in-water work timing recommendations on a project by project basis.

3.5.2 Columbia River Bridges

The project will construct two new bridges across the Columbia River downstream (to the west) of the existing interstate bridges. Each of the structures will range from approximately 91 to 136 feet wide, with a gap of approximately 15 feet between them. The over-water length of each new mainstem bridge will be approximately 2,700 feet (Table 3-4).

Table 3-4. Columbia River Bridges Over-Water Dimensions

Bridge	Approximate Length Over Water	Approximate Width
I-5 Northbound	2,700 feet	Varies: 91 to 130 feet
I-5 Southbound (with LRT)	2,650 feet	Varies: 91 to 136 feet

The Columbia River bridges will consist of six in-water pier complexes of two piers each, for a total of 12 in-water piers. Each pier will consist of up to nine 10-foot-diameter drilled shafts topped by a shaft cap. In-water pier complexes are labeled Pier 2 through Pier 7 (noted as P-2 through P-7 in Figure 3-3 and elsewhere in this document), beginning on the Oregon side. Pier complex 1 is on land in Oregon and pier complex 8 is on land in Washington. Portions of pier complex 7 occur in shallow water (less than 20 feet deep). Piers are designed to withstand the design scour without armor-type scour protection (e.g., riprap).

Figure 3-3 shows the basic configuration of these bridges, the span lengths, and the layout of the bridges relative to the Columbia River shoreline and navigation channels. More detailed information on pier size, depth, and other specifications appear in Section 3.5.2.1.

The USCG will require bridge lighting on the new bridges to be brighter than the background lighting. While there is likely to be a large amount of illumination on the bridge spans high above the water, permanent lighting at the water surface will likely be minimal, limited to navigation lights, which are typically small, dim, and not cast directly on the water surface.

Figure 3-3.
Proposed Layout of Columbia River Bridge Showing Piers and Existing Navigation Channels

Columbia River CROSSING

3.5.2.1 Columbia River Bridge Design

The proposed Columbia River mainstem crossing design uses dual stacked bridge structures. The western structure will carry southbound I-5 traffic on the top deck, with LRT on the lower deck. The eastern structure will carry northbound I-5 traffic on the top deck, with bike/ped traffic on the lower deck (Figure 3-4).

Each bridge will consist of a dual-level superstructure constructed on top of a series of six in-water piers. Each in-water pier will be constructed on a column, which will in turn be constructed on a shaft cap supported by up to nine 10-foot-diameter drilled shafts. The basic configuration of each pier is shown in Figure 3-5.

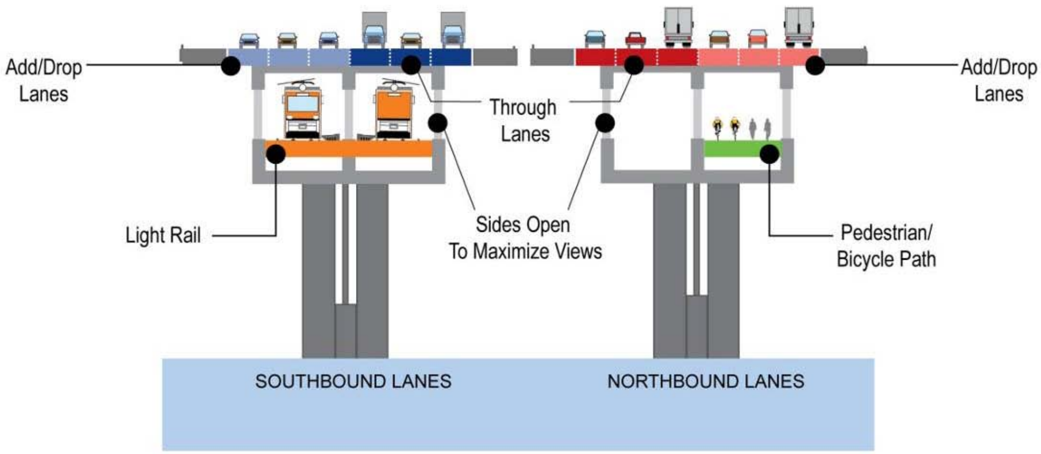
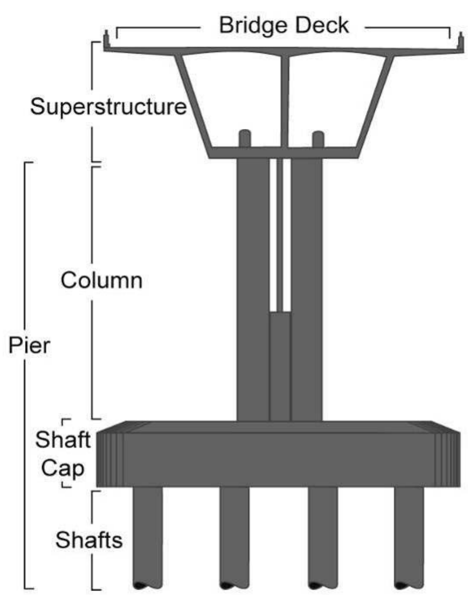


Figure 3-4. Schematic Representation of the Stacked Transit/Highway Bridge Configuration



NOTE: The bridge type shown is for display purposes only.

Figure 3-5. Schematic Representation of the Bridge Configuration

At each pier complex, sequencing will occur as listed below. Details of each activity are presented in the following sections.

- Install temporary cofferdam (applies to pier complexes 2 and 7 only).
- Install temporary piles to moor barges and to support temporary work platforms (at pier complex 3 through 6) and work bridges (at pier complex 2 and 7).
- Install drilled shafts for each pier complex.
- Remove work platform or work bridge and associated piles.
- Install shaft caps at the water level.
- Remove cofferdam (applies to pier complexes 2 and 7 only).
- Erect tower crane.
- Construct columns on the shaft caps.
- Build bridge superstructure spanning the columns.
- Remove tower crane.
- Connect superstructure spans with mid-span closures.
- Remove barge moorings.

All the activities listed above may occur at more than one pier complex at a time as shown in Appendix A and discussed in Section 3.5.2.2.

All activities will require the use of artificial lights for safety. Temporary over-water lighting sources will include the barges, work platforms/bridges, oscillator platforms, and tower cranes. The project will implement measures that minimize the effects of lighting on fish. Measures may include using directional lighting with shielded luminaries to control glare and direct light onto work areas, instead of surface waters.

3.5.2.2 Columbia River Bridge Construction Sequencing

A construction sequence was developed for building the new Columbia River bridges and demolishing the existing structures. The sequence was developed to prove constructibility of the proposed design and is a viable sequence for construction of the river bridges. Once a construction contract is awarded, the contractor may sequence the construction in a way that may not conform exactly to the proposed schedule but that best utilizes the materials, equipment, and personnel available to perform the work. However, the amount of in-water work that can be conducted at any one time is limited, and is based on three factors:

1. The amount of equipment available to build the project will likely be limited. Based on equipment availability, the CRC engineering team estimated that only two drilled shaft operations could occur at any time.
2. The physical space the equipment requires at each pier will be substantial. The estimated sizes of the work platforms/bridges and associated barges are shown in Appendix A. (This is a conceptual design developed by the CRC project team to provide a maximum area of impact. The actual work platforms will be designed by the contractor; therefore, actual sizes will be determined at a later date). The overlap of work platforms/bridges and

barge space limits the amount and type of equipment that can operate at a pier complex at one time.

3. The USCG has required that one navigation channel be open at all times during construction, to the extent feasible.

The 10-phase sequence is shown graphically in Appendix A.

3.5.2.3 Columbia River Bridge Construction Timeline

Construction is currently estimated to occur between 2013 and 2017.

3.5.2.4 Temporary Structures

Temporary Cofferdams

Pier complexes 2 and 7 will each require one temporary cofferdam. Cofferdams will consist of interlocking sections of sheet piles to be installed with a vibratory hammer or with press-in methods. Table 3-5 provides an estimate of the dimensions of the cofferdams and Table 3-6 estimates the duration that they will be present in the water. Cofferdams will be removed using a vibratory hammer or direct pull.

Table 3-5. Potential Dimensions of Temporary Cofferdams Used in Columbia River Bridge Construction

Length (ft)	Width (ft)	Height (ft)t	Area per Cofferdam (sq. ft.)	Total Cofferdams	Total Area of Cofferdams (sq. ft.)
105	75	30	7,875	2	15,750

Table 3-6. Construction Summary for Cofferdams in Columbia River

Location	Duration to Install (Days)	Duration of Construction (Days)	Duration to Remove (Days)
Pier Complex 2	70	330[a]	20
Pier complex 7	70	470[a]	20

a. Days represent approximate number of calendar days, cofferdam are in place. This duration represents approximately 240 to 300 working days.

Cofferdams will be installed in a manner that minimizes fish entrapment. Sheet piles will be installed from upstream to downstream, lowering the sheet piles slowly until contact with the substrate. When cofferdams are used, fish salvage must be conducted according to protocol approved by ODFW, WDFW, and NMFS (Appendix E). Cofferdams will not be dewatered.

Temporary In-Water Work Structures

The project will include numerous temporary in-water structures to support equipment during the course of construction. These structures will include work platforms, work bridges, and tower cranes. They will be designed by the contractor after a contract is awarded, but prior to construction.

Work platforms will be constructed at pier complexes 3 through 6. Figure 11 of Appendix A shows a conceptual design of a temporary in-water work platform. Work platforms are each estimated to be approximately 18,225 sq. ft. in area and will surround the future location of each shaft cap. Work bridges will be installed at pier complexes 2 and 7 so that equipment can access these pier complexes directly from land. Temporary work bridges will be placed only on the landward side of these pier complexes (Appendix A, Figures 1 and 4). The bottom of the temporary work platforms and bridges will be a few feet above the water surface. The decks of the temporary work structures will be constructed of large, untreated wood beams to accommodate large equipment, such as 250-ton cranes. After drilled shafts and shaft caps have been constructed, the temporary work platforms and their support piles will be removed.

After work platforms/bridges are removed at a given pier complex, one tower crane will be constructed between each pair of adjacent piers that makes up the pier complex. The crane will construct the bridge columns and the superstructure. Following construction of the columns and superstructure, the tower cranes and their support piles will be removed.

Both battered and vertical steel pipe piles will be used to support the structures. In addition, four temporary piles could surround each of the drilled shafts (see Appendix A, Figure 11). Due to the heavy equipment and stresses placed on the support structures, all of these temporary piles will need to be load-bearing. Load-bearing piles will be installed using a vibratory hammer and then proofed with an impact hammer to ensure that they meet project specifications demonstrating load-bearing capacity. The number and size of temporary piles for these structures is listed in Table 3-7.

Table 3-7. Summary of Steel Pipe Piles Required for Temporary Overwater Structures During Construction of Columbia River Bridges

Type of Structure	Number of Structures	Pile Diameter	Pile Length	Piles per Structure	Total Number of Piles
Work platforms/bridges	6	18”–24”	70’–90’	100	600
		42”–48”	120’	32	192
Tower cranes	6	42”–48”	120’	8	48
Barge moorings	N/A	18”–24”	70’–90’	Varies	80
Total	**12**	**---**	**---**	**---**	**920**

Not all of these structures will be in place at the same time. It is estimated that only 120 to 400 steel piles will be in the water at any one time.

Barges

Barges will be used as platforms to conduct work activities and to haul materials and equipment to and from the work site. Barges will be moored to non-load-bearing steel pipe piles and adjacent to temporary work structures (Appendix A, Figures 1-10). The approximate dimensions of mooring piles are listed in Table 3-7.

Several types and sizes of barges will be used for bridge construction. The type and size of a barge will depend on how the barge is used. No more than 12 barges are estimated to be moored or moving equipment for Columbia River bridge construction at any one time throughout the construction period (Appendix A, Figures 1-10). The number and the area of the barges are estimated in Table 3-8.

Area and Duration of Temporary Structures

Table 3-8 summarizes the area of temporary structures required for construction in the Columbia River as well as their duration in the water. The number of temporary platforms or bridges in the Columbia River will vary between zero and three during construction. Up to four work platforms and two work bridges will be required to install drilled shafts and construct shaft caps. Each work platform/bridge will require 22 to 25 work days to install. Each work platform/bridge will be in place for approximately 260 to 300 work days. Each tower crane will require approximately two work days to drive support piles and an additional 13 work days to construct the platform. Each tower crane will be in place for approximately 153 to 272 work days.

Barges will be moored around each pier complex. Approximately 80 mooring piles will be installed over the life of the project, each in place for approximately 120 work days. Up to 12 barges at one time would be on the site over the life of the project. Barges vary in size, but can be up to 30,000 sq. ft. in area. With several barges on the site, the over-water footprint could be up to 120,000 sq. ft. at any one time (estimate based on worst case scenario of 12 barges as shown in Appendix A, Figure 4).

Table 3-8. Summary of Temporary Structures Required for Construction in the Columbia River

Type of Structure	Structures	Total Piles (all sizes)	Total In-Water Area for Piles (sq. ft.)	Total Over-Water Area/ Footprint (sq. ft.)	Approx. Time to Install (Days/Platform)[a]	Duration Present in Water (Days - Each)
Work platforms/ bridges	6	792	3,393	148,000	22-25	260-315
Tower cranes	6	48	603	3,200	15	153-262
Barge moorings	N/A	80	251	N/A	N/A	120/mooring
Barges (cumulative, at a single time)	Up to 12	N/A	N/A	Up to 100,000[b]	N/A	Varies
Total	**18 to 30**	**920**	**6,844**	**Up to 251,200**	**---**	**---**

a Assumes two crews.
b Assumes more than one barge (see Appendix A, Figure 4).

Installation of Temporary Piles

Temporary piles will be used for mooring barges and to support in-water work structures. Mooring piles will be vibrated into the sediment until refusal. Vibratory installation will take between 5 and 30 minutes per pile.

Load-bearing piles (used for work platforms/bridges and tower cranes) will be vibrated to refusal (approximately 5 to 30 minutes per pile), then driven and proofed with an impact hammer to confirm load-bearing capacity. An average of six temporary piles could be installed per day using vibratory installation to set the piles, and up to two impact drivers to proof them. Rates of installation will be determined by the type of installation equipment, substrate, and required load-bearing capacity of each pile. Temporary piles will be installed and removed throughout the construction process. No more than two impact pile drivers will operate at one time. Generally, use of two impact pile drivers will occur at only one pier complex at a time.

In general, temporary piles will extend only into the alluvium to an approximate depth of 70 to 120 feet. Standard pipe lengths are 80 to 90 feet, so some piles may need to be spliced to achieve these depths.

Estimated pile installation specifications[1] are provided in Table 3-9. The number of pile strikes was estimated by WSDOT Geotechnical and CRC project engineers based on information from past projects and knowledge of site sediment conditions. The actual number of pile strikes will vary depending on the type of hammer, the hammer energy used, and substrate composition. The strike interval of 1.5 seconds (40 strikes per minute) is also estimated from past projects and is based on use of a diesel hammer. This estimate is within the typical range of 35–52 strikes per minute for diesel hammers (HammerSteel 2009). It is worth noting that for any one 12-hour daily pile driving period, less than one hour of impact driving will occur.

Table 3-9. Pile-Strike Summary for Construction in Columbia River

Pile Size	Estimated Piles Installed per Day	Estimated Strikes per Pile	Estimated Maximum Strikes per Day	Hours of Pile Driving/12-hr Work Day
18–24”	3	300	600	0.25
42–48”	3	300	1.200	0.50
Total	**6**	**--**	**1,800**	**0.75**[a]

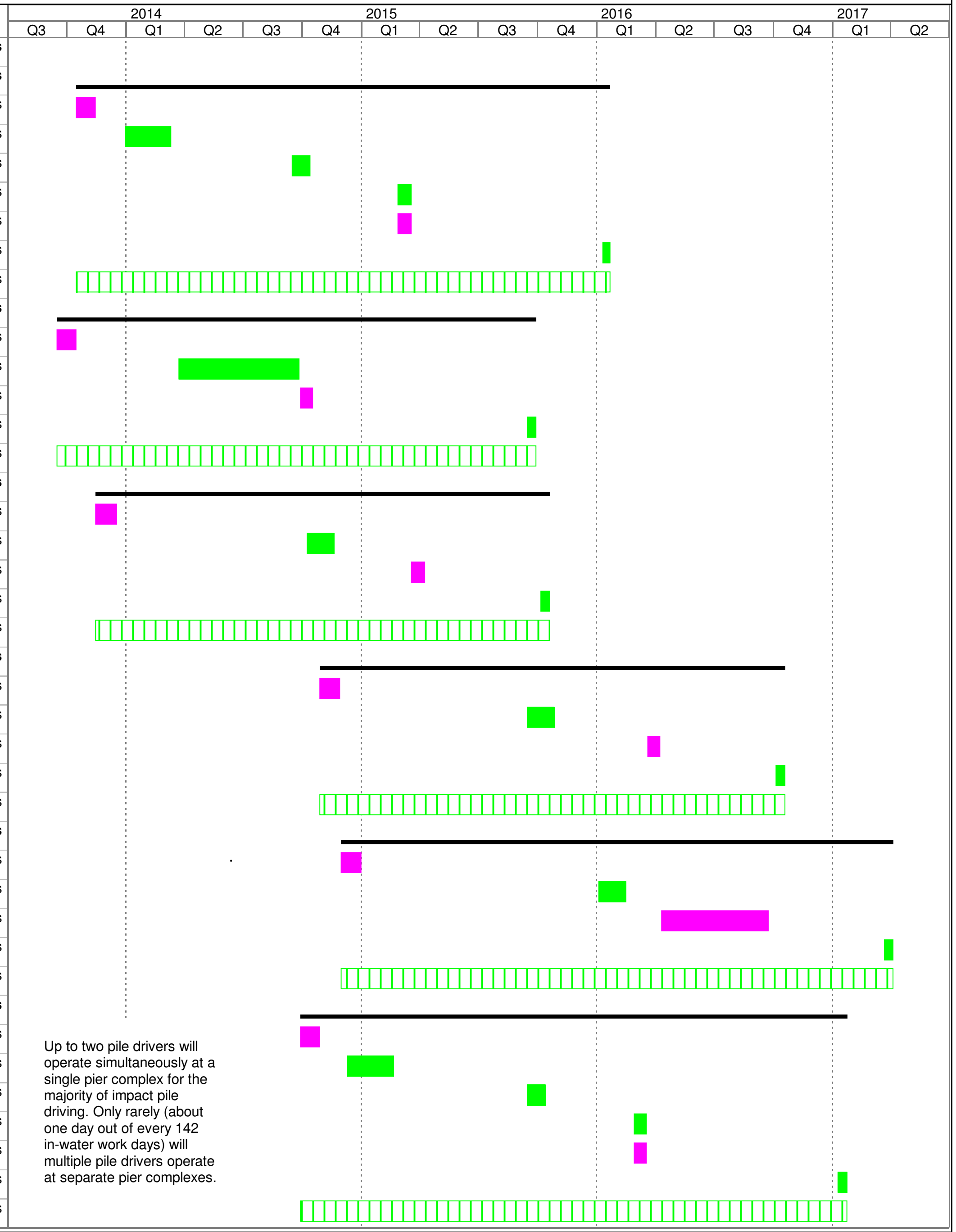
a. This scenario assumes just one pile being driven at a time. During construction, up to two piles may be driven at the same time in the Columbia River. If this were to occur, the strike numbers would stay the same, but the actual driving time would decrease.

Figure 3-6 illustrates the schedule of impact and vibratory pile driving, based on the assumption that the first impact pile driving will start on September 15, 2013. The exact timing will vary as the start date varies (as early as September 2012), but will likely follow the general timeline as shown in Figure 3-6. Impact pile driving could potentially occur any day between September 15 and April 15; however, impact pile driving is more likely to occur in the first 18 months of construction as pier complexes are started. After the first 18 months, most of the pier complexes will be well underway, leaving only the work required to finish a couple of pier complexes and provide bases for superstructure construction.

[1] Number of piles driven per day, strikes per pile, total strikes per day, and duration of driving per day are estimates rather than maximums. The size and extent of this project requires contractor flexibility while minimizing effects to listed species. The CRC project is proposing performance measures that use these variables, in addition to the amount of attenuation, to calculate “exposure factors” on a weekly basis. The exposure factor uses the variables for daily piles strikes, timing and duration of piles strikes, days of pile driving within a week, size of pile (initial sound levels), fish speed, and fish mass to estimate the potential exposure to fish that are within or pass through the project area. Different combinations of any of these elements (such as pile strikes, duration or timing of pile strikes, and initial sound levels) will yield different exposure factors. For example, a higher number of pile strikes in a given time period may result in the same exposure factor as a lower number of pile strikes conducted on a pile that has higher initial sound levels. Section 3 of Appendix K provides detailed information on how typical and maximum exposure factors were calculated and provides details on how exposure factors will be calculated during construction activities. During construction, the contractor will calculate the weekly, maximum yearly, average yearly, and total project exposure factor to ensure that exposure to listed fish are not exceeded in accordance with Section 7 of this document.

Figure 3-6. Sequencing of Pile Driving and Removal for Construction in the Columbia River

Task Name	Start	Finish	Duration
Bridge Construction Scenario 2/5/13	**9/16/13**	**4/5/17**	**928 days**
Pier 2	**10/16/13**	**1/22/16**	**593 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	10/16/13	11/14/13	22 days
Install Cofferdam (Vibratory Installation)	12/31/13	3/11/14	51 days
Remove Work Bridge & Piles (Vibratory Removal)	9/16/14	10/13/14	20 days
Remove Cofferdam (Vibratory Removal)	2/27/15	3/19/15	15 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	2/27/15	3/19/15	15 days
Remove Tower Crane (Vibratory Removal)	1/11/16	1/22/16	10 days
Barge Moorings (Vibratory Installation & Removal)	10/16/13	1/22/16	593 days
Pier 3	**9/16/13**	**9/29/15**	**532 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	9/16/13	10/15/13	22 days
Remove Work Platform & Piles (Vibratory Removal)	3/24/14	9/26/14	135 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	9/29/14	10/17/14	15 days
Remove Tower Crane (Vibratory Removal)	9/16/15	9/29/15	10 days
Barge Moorings (Vibratory Installation & Removal)	9/16/13	9/29/15	532 days
Pier 4	**11/15/13**	**10/20/15**	**503 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	11/15/13	12/17/13	23 days
Remove Work Platform & Piles (Vibratory Removal)	10/9/14	11/19/14	30 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	3/20/15	4/9/15	15 days
Remove Tower Crane (Vibratory Removal)	10/7/15	10/20/15	10 days
Barge Moorings (Vibratory Installation & Removal)	11/15/13	10/20/15	503 days
Pier 5	**10/29/14**	**10/19/16**	**516 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	10/29/14	11/28/14	23 days
Remove Work Platform & Piles (Vibratory Removal)	9/16/15	10/27/15	30 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	3/21/16	4/8/16	15 days
Remove Tower Crane (Vibratory Removal)	10/6/16	10/19/16	10 days
Barge Moorings (Vibratory Installation & Removal)	10/29/14	10/19/16	516 days
Pier 6	**12/1/14**	**4/5/17**	**613 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	12/1/14	12/31/14	23 days
Remove Work Platform & Piles (Vibratory Removal)	1/5/16	2/15/16	30 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	4/11/16	9/23/16	120 days
Remove Tower Crane (Vibratory Removal)	3/23/17	4/5/17	10 days
Barge Moorings (Vibratory Installation & Removal)	12/1/14	4/5/17	613 days
Pier 7	**9/29/14**	**1/23/17**	**606 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	9/29/14	10/28/14	22 days
Install Cofferdam (Vibratory Installation)	12/11/14	2/20/15	52 days
Remove Work Bridge & Piles (Vibratory Removal)	9/16/15	10/13/15	20 days
Remove Cofferdam (Vibratory Removal)	2/29/16	3/18/16	15 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	2/29/16	3/18/16	15 days
Remove Tower Crane (Vibratory Removal)	1/10/17	1/23/17	10 days
Barge Moorings (Vibratory Installation & Removal)	9/29/14	1/23/17	606 days



Conceptual Schedule Only

Pier Activitiy Summary — Vibratory and Impact Activities

Vibratory Activities — Vibratory Activities (Intermittent)

Note: This is a proposed schedule, so activity dates are likely to change.

April 2010

In accordance with an approved hydroacoustic monitoring plan (see Section 7.1.5) a noise attenuation device will be used during all impact pile driving, with the exception of during hydroacoustic monitoring when the noise attenuation device will be turned off to measure its effectiveness. A period of up to 7.5 minutes per week with no attenuation device has been allocated in the analyses and hydroacoustic minimization measure (see section 7.1.5) to allow for monitoring and for time to shut-down activities should an attenuation device fail. If the attenuation device fails, pile driving activities will cease as soon as practicable and resolution of the problem will occur. By incorporating this time into the analysis, the project may still proceed in event of an equipment failure without exceeding the thresholds listed in the hydroacoustic minimization measure. With the exception of hydroacoustic monitoring, intentional impact pile driving wihout a noise attenuation device is not proposed nor will it be allowed. In addition, to limit hydroacoustic effects, there will be a consecutive 12-hour period of no impact pile driving for every 24-hour day.

3.5.2.5 Construction of Permanent Piers

In-water drilled shaft construction consists of installing large diameter steel casing to a specified depth to the top of the competent geological layer known as the Troutdale Formation. The top layer of river substrate is composed of loose to very dense alluvium (primarily sand and some fines), beneath which is approximately 20 feet of dense gravel, underlain by the Troutdale Formation.

A vibratory hammer, oscillator, or rotator will be used to advance a casing (up to -270 feet NAVD88). If casing are installed by a vibratory hammer, installation is estimated to be one work day per casing. If casings need to be welded together, one work day is estimated for the weld. No more than two casings are estimated per shaft. Soil will be removed from inside the casing and transferred onto a barge as the casing is advanced. The soil will be deposited at an approved upland site. Drilling will continue below the casing approximately 30 feet into the Troutdale Formation to a specified tip elevation. After excavating soil from inside the casing, reinforcing steel will be installed into the shaft and then the shaft will be filled with concrete.

During construction of the drilled shafts, uncured concrete will be poured into water-filled steel casings, creating a mix of concrete and water. As the concrete is poured into the casing, it will displace this highly alkaline mixture. The project will implement BMPs to contain the mixture and ensure that it does not enter any surface water body. Once contained, the water will be treated to meet state water quality standards and either released to a wastewater treatment facility or discharged to a surface water body. The steel casing may or may not be removed, depending on the installation method. Figure 3-7 through Figure 3-10 depict typical drilled shaft operations and equipment.

No contaminated sediments have been documented within the installation areas. Adherence to the terms of water quality certifications and implementation of impact minimization measures will ensure that, should contaminated sediments be encountered, that they will be dealt with properly.

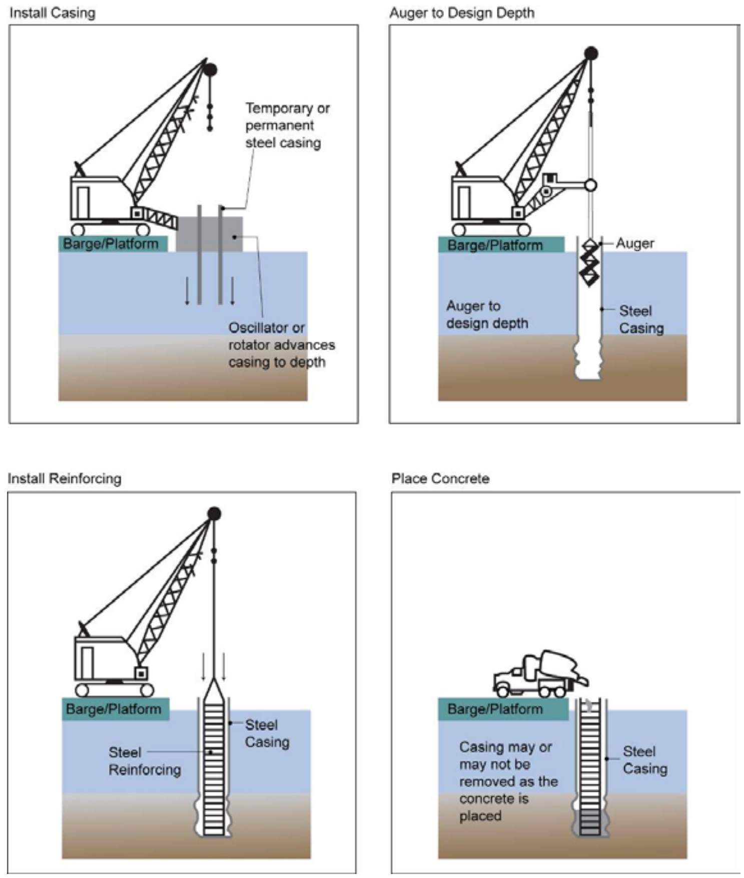


Figure 3-7. Typical Drilled Shaft Installation from Barge or Platform

Figure 3-8. Water-Based Drilled Shaft Installation

Figure 3-9. Clamshell Used for Removing Material from Drilled Shaft Casing

Figure 3-10. Preparation of a Steel Reinforcement Cage for a Drilled Shaft

Duration of Installation of Permanent Shafts

The total duration of the permanent shaft installation could vary considerably depending on the type of installation equipment used, the quantity of available installation equipment, and actual soil conditions. Installation of each drilled shaft is estimated to take approximately 10 days. With the limited in-water work window for impact pile driving and construction phasing constraints, the total duration of drilled shaft installation will be approximately 30 months. Phasing of construction is anticipated to follow the conceptual schedule shown in Figure 3-6.

Quantity of Permanent Shafts

Table 3-10 summarizes the permanent shafts to be constructed for each bridge over the Columbia River.

Table 3-10. Summary of Permanent Shafts in the Columbia River

Location	Shafts per Pier	Total Shafts	Total Plan Area of Shafts (sq. ft.)	Approx. Depth from Observed Lowest Water (0' CRD)
Piers 3–6 on northbound structure	Varies: 6 to 9	32	2,513	Varies: 24 to 32
Piers 3–6 on southbound structure	Varies: 6 to 9	32	2,513	Varies: 24 to 32
Pier complex 2	6	12	942	Varies: 21 to 25
Pier complex 7	6	12	942	Varies: 20 to 27
Total	**24 to 30**	**88**	**6,910**	**---**

Note: CRD = Columbia River datum.

Shaft Caps

Pre-cast shaft caps will be placed on top of the drilled shafts. The shaft caps will be fabricated off-site at a casting yard (Section 3.11) and then transported to the site. Installation of the shaft caps will require cranes, work barges, and material barges. Table 3-11 summarizes the dimensions of each shaft cap.

Table 3-11. Summary of Shaft Caps in the Columbia River

Type	Number	Width	Length	Total Area (sq. ft.)
Pier complexes 3–6	8	75	75	45,000
Pier complexes 2 & 7	4	75	45	13,500
Total	**12**	**---**	**---**	**58,500**

3.5.2.6 Column Construction

Columns will be constructed of cast-in-place reinforced concrete or precast concrete. Precast columns be fabricated at a casting yard (Section 3.11). Column construction is estimated to take 120 days for each pier complex. Construction columns will require cranes, work barges, and material barges in the river year-round (Figure 3-11).

Figure 3-11. Typical Column and Superstructure Construction Using Barge-Mounted Cranes

3.5.2.7 Superstructure

The superstructure will be constructed of structural steel, cast-in-place concrete, or precast concrete. Precast elements will be fabricated at a casting yard (Section 3.11). Construction will require cranes, work barges, and material barges in the river year-round. Figure 3-11 and Figure 3-12 depict typical activities related to construction of the superstructure.

Figure 3-12. Platform-Mounted Crane Placing a Winch on a Superstructure Element

3.5.3 North Portland Harbor Bridge

The existing North Portland Harbor bridge will be upgraded to meet current seismic standards and widened to accommodate an additional southbound I-5 on-ramp. The seismic retrofit activities will consist solely of minor modifications to the bent caps and girders that will not require in-water work. Widening of the existing structure will require adding additional shafts adjacent to the existing bridge bents to support the additional structure width. In addition, three new bridges will be constructed across North Portland Harbor. Starting from the east, these structures will carry a CD ramp for northbound I-5, a CD ramp for southbound I-5, and LRT combined with a bike/ped path.

3.5.3.1 North Portland Harbor Bridge Design

The existing North Portland Harbor bridge was constructed in the early 1980s of pre-stressed concrete girders and reinforced concrete bents. The bents are supported by driven steel piling. Two previous bridges, constructed in 1917 and 1958, were built at the same location as the current bridge, but may not have been fully removed during subsequent replacement efforts. These bridges had reinforced concrete bents supported on timber piles. Some of this material may still be present, but this will not be confirmed until construction begins. Some removal of previous bridge elements is anticipated prior to installation of the new bridge shafts. Removal of remnant bridge elements will be with a clamshell dredge.

Table 3-12 gives the approximate dimensions of the new or improved bridges over the North Portland Harbor and the approximate water depth at each bent location. The existing bridge will be widened by up to 50 feet to accommodate new lanes. Bridge widths will vary due to merging of lanes on some structures. The three new bridge structures will consist of spans of varying lengths (Figure 3-13).

Table 3-12. Dimensions of North Portland Harbor Bridges

Bridge		LRT and Bike/Ped Path	I-5 Southbound Collector-Distributor	Widened Mainline	I-5 Northbound Collector-Distributor
Width Over Water		Varies 50-65 ft	Varies 50-82 ft	Varies 162-200 ft	Varies 57-82 ft
Length Over Water		Approx. 875 ft	Approx. 945 ft	Approx. 990 ft	Approx. 1,020 ft
Approximate Depth from Observed Lowest Water (0’ CRD) (ft)	Bent 2	13	9	---	---
	Bent 3	15	13	---	---
	Bent 4	14	13	4	---
	Bent 5	20	14	12	---
	Bent 6	-4	---	13	13
	Bent 7	---	---	15	13
	Bent 8	---	---	16	17
	Bent 9	---	---	0	12

Note: CRD = Columbia River datum.

Figure 3-13. Proposed Layout of North Portland Harbor Bridges

Exisiting Bridge Piers

Exisiting Bridge Pillars

Project Design Footprint

Project Bridge Piers

Project Bridge Piers

Project Footprint, Paved Surfaces

Bathymetry

Depth (CRD, ft.)

- 0
- 5
- 10
- 15
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55

N
W E
S

0 110 220
Feet

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: Mar. 29, 2010: File Name: HydroSound_MG246_NPH.mxd

Each bridge will have four to five in-water bents, consisting of one to three 10-foot-diameter drilled shafts (Figure 3-13). Unlike the Columbia River piers, shafts will not be topped by a shaft cap. Current designs place all of the bents in shallow water (less than 20 feet deep). Bents are designed to withstand the design scour without armor-type scour protection (e.g., riprap) (Figure 3-14).

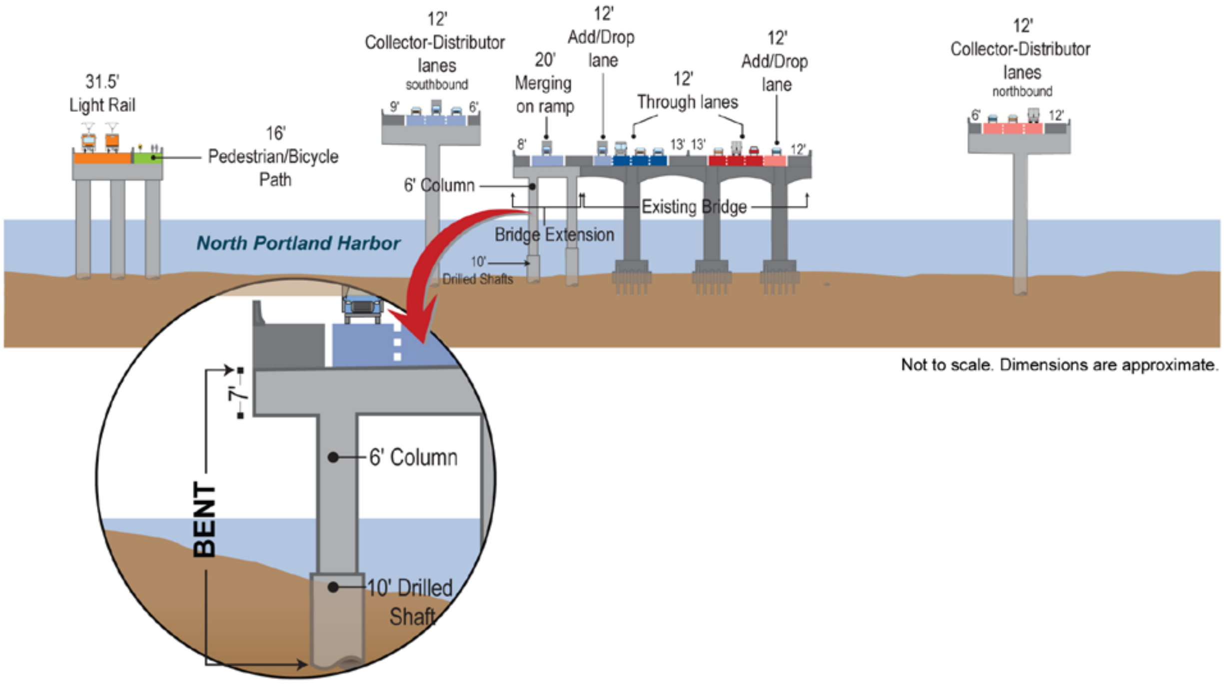


Figure 3-14. North Portland Harbor Mainline Bridge Cross-Section (Schematic)

3.5.3.2 North Portland Harbor Bridge Construction Sequencing

Construction is expected to be sequential, beginning with either of the most nearshore bents of a given bridge and proceeding to the adjacent bent. The actual sequencing will be determined by the contractor once a construction contract is awarded. No more than two of the four bridges are likely to have in-water work occurring simultaneously.

For the bents closest to shore, construction will occur from work bridges. At the other in-water bents, construction will likely occur from barges and oscillator support platforms[2]. Table 3-14 summarizes the areas of these structures located both in and over the water.

[2] Oscillator support platforms are used to support the oscillators used to install the steel casing for drilled shafts. Although this document uses the term oscillator support platform throughout, the platform may support equipment for vibratory or rotator installation of steel casings.

General construction activities to build the bents and superstructure are similar to those for the Columbia River bridges, except that shaft caps will not be used and bridge decks will be placed on girders instead of balanced cantilevers (Figure 3-14). General sequencing of the construction of a single bridge appears below.

- Construct oscillator support platforms and work bridges using vibratory and impact pile drivers.
- Vibrate temporary piles to moor barges.
- Extract large pieces of debris as needed to allow casings to advance.
- Install drilled shafts at each bent.
- Construct columns on the drilled shafts.
- Construct a bent cap or crossbeam on top of the columns at a bent location.
- Erect bridge girders on the bent caps or crossbeams.
- Place the bridge deck on the girders.
- Remove temporary work bridges, oscillator support platforms, and supporting piles.

Some of these activities will occur simultaneously at separate bents.

3.5.3.3 North Portland Harbor Bridge Construction Timeline

Construction is currently estimated to occur between 2013 and 2020.

3.5.3.4 Temporary In-Water Work Structures

At the eight bents closest to shore, nine temporary work bridges will be constructed to support equipment for drilled shafts. In addition, at each of the 31 bent locations, one oscillator support platform will be constructed, each consisting of four load-bearing piles. The bridges and oscillator support platforms will be designed by the contractor after a contract is awarded, but prior to construction. The estimated size of the structures is summarized in Table 6-13 in Section 6 of this document. The bottom of the temporary work structures will be between 0 and 5 feet above the water line. Due to the heavy equipment and stresses placed on these structures, the supporting piles will need to be load bearing. All will be installed first with a vibratory hammer and then proofed with an impact hammer to ensure that they meet specifications for load-bearing capacity. The number and size of piles for temporary in-water work structures are listed in Table 3-13.

Table 3-13. Approximate Number of Steel Pipe Piles Required for Construction of North Portland Harbor Bridges

Type of Structure	Structures	Pile Diameter (inches)	Pile Length (feet)	Average Piles per Structures	Total Piles
Work bridges	9	18–24	70–120	25	225
Oscillator support platforms	31	36–48	120	4	124
Barge Moorings	N/A	36–48	120	N/A	216
Total	**40**	**–**	**–**	**29**	**565**

Following installation of the drilled shafts, the temporary work structures and their support piles will be removed through vibratory methods.

Other temporary piles will be installed to moor barges adjacent to the new bents (Table 3-13). These piles will not need to be load bearing, and therefore, they will be installed through vibratory methods only.

The need for steel pipe piles will be staged over the construction period. Steel piles will be installed and removed during the multi-year construction of the temporary support structures. Although the project will use over 500 piles in North Portland Harbor, only 100 to 200 piles are estimated to be in the water at any one time.

Barges

Barges will be used as platforms for conducting work activities and to haul materials and equipment to and from the work site. Barges will be moored with steel pipe piles adjacent to temporary work bridges or bents. The approximate number, size range, and length of mooring piles are listed in Table 3-13.

Several types and sizes of barges will be used according to specific function. No more than nine barges are estimated to be present in North Portland Harbor at any one time during the construction period.

Number, Area, and Duration of Temporary Structures

The number, area, and duration of temporary work platforms, support piles, mooring piles, and barges in water are summarized in Table 3-14.

Table 3-14. Summary of Temporary Overwater Structures in North Portland Harbor

Type of Structure	Structures	Total Area in Water (piles) (sq. ft.)	Total Area Over Water (sq. ft.)	Duration to Install (days/platform)[a]	Duration Present in Water (days)
Work bridges	9	2,790	29,640	12	20 - 42
Oscillator support platforms	31	900	27,900	2	10 - 34
Barge moorings	N/A	679	N/A	N/A	30
Barges (at one time)	Up to 9	N/A	105,000	N/A	10 - 34
Total	**Up to 49**	**4,369**	**162,540**	**---**	**---**

a Assumes one crew.

Installation of Temporary Piles

As with the mainstem Columbia River bridges, temporary piles will be required to support in-water work bridges or to moor barges during construction of the North Portland Harbor bridges. Unlike the Columbia River Bridges, cofferdams are not necessary.

Piles used for the temporary work bridges and the oscillator support platforms must be load bearing. They will first be vibrated to refusal, and then proofed with an impact hammer to confirm load-bearing capacity. An average of 3 load-bearing piles could be installed per day using vibratory installation to set the piles, with one impact driver to proof. Rates of installation will be determined by the type of installation equipment, substrate, and required load-bearing capacity of each pile.

Temporary mooring piles will be installed and removed throughout the construction process. Installation of these mooring piles could occur year-round and at any time of the day. These piles will be installed using vibratory methods only.

In general, temporary piles will extend only into the alluvium to an estimated depth of 70 to 120 feet. Standard pipe lengths are 80 to 90 feet, so some piles may need to be welded to achieve the lengths required to drive them to these depths.

Estimated pile installation specifications are provided in Table 3-15. Estimates of required number of strikes per pile and total strikes are the same as for the Columbia River (Section 3.5.2.4). However, only one impact driver will be used. Exposure factors based on daily pile strikes, timing, and duration of piles strike activities, days of pile driving within a week, and size of pile, among other factors were used to estimate the potential exposure to fish that are within or pass through the project area. Impact driving within North Portland Harbor is analyzed in conjunction with impact driving activities in the mainstem Columbia River to calculate the overall exposure factor for fish that occur in the project area.

Impact pile driving is proposed to occur only during a 31-week period from approximately September 15 to April 15 or other period approved by NMFS, ODFW, and WDFW. No impact pile driving will occur outside of the approved dates. Figure 6-20 provides an estimated pile installation schedule for North Portland Harbor.

Table 3-15. Pile-Strike Summary for Construction in North Portland Harbor

Pile Size	Estimated Piles Installed per Day	Estimated Strikes per Pile	Estimated Maximum Strikes per Day	Hours of Pile Driving/12-hr Daily Pile Driving Work Period
Temporary Work Bridge				
18"– 24"	3	300	900	0.165
Oscillator Support Platforms				
36" – 48"	3	300	900	0.165

As in the Columbia River mainstem, a noise attenuation device will be for all impact pile strikes, with the exception of a period of up to 2.5 to 5 minutes per week. This period allows time to test the effectiveness of the attenuation system and to shut down impact pile driving in the event of an attenuation device failure. Single strike and cumulative sound exposure levels will be monitored to ensure they do not exceed thresholds detailed in the hydroacoustic minimization measure (Section 7.1.5). In addition, each 24-hour day will include 12 consecutive hours of no impact pile driving to allow for migrating fish to pass through the area of effect (Section 6 and Appendix K) and to allow non-migrating fish time to recover from hydroacoustic impacts.

3.5.3.5 Bent Construction

In-water drilled shaft construction for the North Portland Harbor is described in Section 3.5.3.1.

3.5.3.6 Debris Removal

Debris from previous structures, including foundations from the 1917 and 1953 bridges, may be present at some locations where drilled shafts will be installed. This debris is likely to consist of large rock or old concrete. Because casings cannot advance through this type of material, it must be removed. Removal will consist of capturing the debris in a clamshell bucket. Capture of sediment will be limited. Debris will be placed in an upland location, and disposed of at a landfill if appropriate. Debris removal activities would be limited to the designated in-water work window of November 1 through February 28. Removal activities will take no more than 7 days over the course of construction.

Before debris removal begins, divers will pinpoint the location of the material. Debris removal will only occur in the precise locations where material overlaps with the footprint of the new shafts, greatly minimizing the areal extent of the activity. The amount of material in this location is unknown; however, assuming a worst-case scenario (that the area of the material is the same as the same as the footprint of the drilled shafts), the project will remove debris in no more than 31 locations over an area of roughly 2,433 sq. ft. No more than 90 cubic yards of material will be removed.

If any items are found during excavation that contain potential contaminants (e.g., buried drums, car bodies containing petroleum products, etc.) activities to control and clean up contaminants will be implemented in accordance with the Spill Prevention, Control and Countermeasures (SPCC) plan as described in Section 7.1.2.

Duration of Permanent Shaft Installation

Installation of each drilled shaft is estimated to take approximately 10 days. However, the total duration of this activity could vary considerably depending on the type of equipment used, the quantity of available equipment, and on-site soil conditions. The total duration of drilled shaft installation will be approximately 18 months.

Quantity of Permanent Shafts

The number and area of permanent shafts are summarized in Table 3-16 for bridges over North Portland Harbor. The approximate water depth at the location of each bent is also listed. Each bridge will have five to seven spans, each a maximum of 255 feet long.

Table 3-16. Number and Area of Permanent Shafts Required for North Portland Harbor Bridges

Bridge Type	Number of Bents	Number of Shafts/Bent	New Shafts /Bridge	Total Area of New Shafts (sq. ft.)[a]
Northbound CD	4	Varies 1-2	5	393
I-5 Widening	6	Varies 1-2	8	628
Southbound CD	4	Varies 1-2	5	393
LRT Bridge	5	Varies 2-3	12	942
Total	**20**	**--**	**30**	**2,356**

a 10-foot-diameter shafts.

Shaft Caps

No shaft caps are proposed for the North Portland Harbor bridges.

3.5.3.7 Column Construction

Columns will be constructed of cast-in-place reinforced concrete. Construction of cast-in-place columns is anticipated to occur from December 2013 through September 2015 and will require cranes, work barges, and material barges continuously throughout this period.

3.5.3.8 Superstructure

The superstructure will consist of girders and a deck. Girders will be constructed of structural steel, cast-in-place concrete, or precast concrete. Precast girders may be fabricated at a casting yard (Section 3.11). A cast-in-place concrete deck will be placed on the girders. This element of project construction will require cranes, work barges, and material barges in the river continuously from approximately December 2013 through September 2015.

3.6 DEMOLITION OF EXISTING COLUMBIA RIVER BRIDGES

The existing Columbia River bridges will be demolished after the new Columbia River bridges have been constructed and after associated interchanges are operating.

3.6.1 Proposed Bridge Demolition Methods

The existing Columbia River bridges will be demolished in two stages: 1) superstructure deconstruction and 2) substructure deconstruction.

3.6.1.1 Columbia River Bridges Superstructure Removal

Demolition of the superstructure will begin with removal of the counterweights. The lift span will be locked into place and the counterweights will be cut into pieces and transferred off-site via truck or barge. Next, the lift towers will be cut into manageable pieces and loaded onto barges by a crane. Prior to removal of the trusses, the deck will be removed by cutting it into manageable pieces; these pieces will be transported by barge or truck or by using a breaker, in which case debris will be caught on a barge or other containment system below the work area. After demolition of the concrete deck, trusses will be lifted off of their bearings and onto barges and transferred to a shoreline dismantling site.

The existing Columbia River bridge structures comprise 11 pairs of steel through-truss spans with reinforced concrete decks, including one pair of movable spans over the primary navigation channel and one pair of 531-foot long span trusses. The remaining nine pairs of trusses range from 265 feet to 275 feet in length. In addition to the trusses, there are reinforced concrete approach spans (over land) on either end of the bridges.

Table 3-17 describes the approximate area of the overwater portions of the existing bridges.

Table 3-17. Approximate Area of Existing Columbia River Bridges

	Northbound	Southbound
Steel Trusses	168,096 sq. ft.	176,943 sq. ft.
Reinforced Concrete Approach Structure	18,250 sq. ft.	18,950 sq. ft.
Total Structure Area	**186,346 sq. ft.**	**195,893 sq. ft.**

3.6.1.2 Columbia River Bridge Pier Removal

Nine sets of the 11 existing Columbia River bridge piers are below the OHW level and are supported on a total of approximately 1,800 driven timber piles. Demolition methods have not been finalized; however, the final design will consider factors such as pier depth, safety, phasing constraints, and impacts to aquatic species. Demolition of the concrete piers and timber piling foundations will be accomplished using one of two methods:

1. After removal of the trusses, a cofferdam will be installed at each of the nine in-water bridge piers to contain demolition activities. Cofferdams will not be dewatered. The piers and the piers will be broken up and removed from within the cofferdam. Timber piles that pose a navigation hazard will then be extracted or cut off below the mud line.
2. A diamond wire/wire saw (Figure 3-15) will be used to cut the piers into manageable chunks that will be transported offsite. Cofferdams will not be used. Timber piles will then be extracted or cut off below the mud line.

With either method, the pieces of the piers will be removed via barge.

Although ODOT maintenance personnel regularly inspect the existing bridge, the timber piles located underneath the existing piers are inaccessible and have not been inspected. Therefore, it is unknown whether these timber piles have been treated with creosote, but given their age and intended purpose, it is assumed that they have been so treated. Only piles that could pose a navigation hazard will be removed or cut off below mud line. These piles include those that are present in the proposed navigation channels and any that extend above the surface of the river bed. Piles will either be removed (using a vibratory extractor, direct pull, or clam shell dredge) or cut off below the mud line using an underwater saw. The exact number of piles to be removed is unknown.

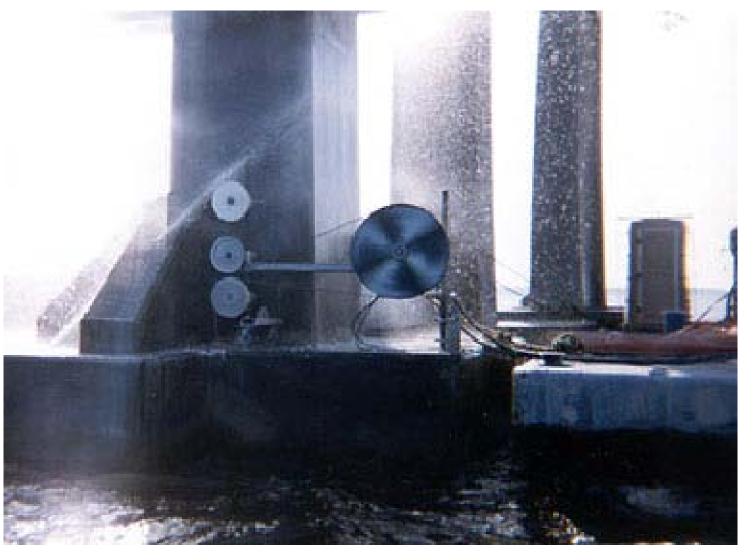


Figure 3-15. Wire/Diamond Saw

3.6.1.3 Columbia River Bridge Demolition Sequencing

A conceptual demolition sequence was determined based on the amount of equipment likely available to build the project and the physical space the equipment requires at each pier. The sequence is provided in Appendix A, Figures 12 through 16. The actual construction sequence will be determined by the contractor once a construction contract is awarded.

3.6.1.4 Columbia River Bridge Demolition Timeline

Demolition will occur after the new Columbia River replacement bridges are built. Demolition activities will take approximately 18 months from approximately September 2018 through March 2020.

3.6.2 Use of Temporary Cofferdams and Piles During Bridge Demolition

Temporary cofferdams will be required to isolate work activities, and temporary piles will be installed to anchor work and material barges during demolition the spans and in-water piers.

3.6.2.1 Cofferdams

If the diamond wire/wire saw is not used, a temporary cofferdam consisting of interlocking sections of sheet piles will be used to isolate demolition activities at each of the nine in-water piers. Table 3-18 describes the estimated dimensions, area, and number of temporary cofferdams that will be used during bridge demolition.

Table 3-18. Approximate Cofferdam Specifications for Columbia River Bridge Demolition

Length	Width	Height	Area per Cofferdam (sq. ft.)	Number of Cofferdams	Total Area of Cofferdams (sq. ft.)
150	50	30	7,500	9	67,500

Sheet piles for cofferdams will be installed with a vibratory hammer or a press-in method. Table 3-19 describes the estimated number of sheet piles and duration for cofferdam installation as well as the total duration any one cofferdam will be present in-water. Up to three cofferdams will be in place at any given time. Sheet piles will be removed using a vibratory hammer or direct pull.

Cofferdams will be installed in a manner that minimizes fish entrapment. Sheet piles will be installed from upstream to downstream, lowering the sheet piles slowly until contact with the substrate. When cofferdams are used, fish salvage must be conducted according to protocol approved by ODFW, WDFW, and NMFS (see Appendix E).

Table 3-19. Demolition Summary for Cofferdams in the Columbia River

Number of Cofferdams	Number of Sheet Piles/ Cofferdam	Total Number Sheet Piles	Duration to Install Sheet Pile (#/Day)	Duration to Install One Cofferdam (days)	Duration Present in Water (days)	Duration to Remove One Cofferdam (days)
9	200	1,800	6	11	20	10

Barges

Barges will be used as platforms to perform the demolition and to haul materials and equipment to and from the work site (see Appendix A, Figures 8-10).

Several types and sizes of barges are anticipated to be used for bridge demolition. The type and size of each barge will depend on how the barge is used. Up to six stationary or moving barges are expected to be present at any one time during bridge demolition. Number of barges and barge area for each phase of demolition are summarized in Table 3-20.

3.6.2.2 Temporary Pipe Piles

Demolition is currently anticipated to occur from barges. Over 300 18- to 24-inch steel pipe piles (each approximately 70 feet long) will be used to anchor and support the work and material barges necessary for demolition. Table 3-20 summarizes temporary pile use during bridge demolition.

Table 3-20. Summary of Barges and Temporary Piles Used in Bridge Demolition

Application	Locations	Barges/ Location	Area of Barges[a] (sq. ft.)	Piles/ Barge	Piles	Area of Piles (sq. ft.)	Duration in Water (days/ location)
Span Removal	9	4-6	18,000	4	160	503	30
Pier Demolition	9	4	10,500	4	144	452	30
Total	**---**	**---**	**28,500**	**---**	**304**	**995**	**---**

a Cumulative at any one time.

Installation and Removal of Temporary Pipe Piles

All temporary piles will be installed using a vibratory hammer or push-in method. They will be extracted using vibratory methods or direct pull. Piles will be installed and removed continuously throughout the demolition process.

3.6.3 Equipment Necessary for Bridge Demolition

Equipment required for bridge demolition includes barge-mounted cranes/hammers or hydraulic rams. Vibratory hammers may be used to install and remove sheet piles for cofferdams and pipe piles for barge moorings. New permanent piles will not be required for demolition of the Columbia River bridges.

3.6.4 Proposed Bridge Construction and Demolition Minimization Measures

Throughout construction of the bridges over the Columbia River and North Portland Harbor and demolition of the existing Columbia River bridges, impact minimization measures will be used in accordance with regulations, permits, and state department of transportation specifications. These measures include methods to prevent pollutants from entering the water, salvage fish during isolation activities, utilize a noise attenuation device during impact pile driving, and monitor in-water noise, as well as monitoring and shutdown procedures to prevent injury to Steller sea lions during impact pile driving. Section 7 of this document presents detailed measures to avoid and/or minimize impacts from bridge construction and demolition activities.