Memorandum

November 7, 2012

TO: Interested Parties

FROM: Kris Strickler, Oregon Project Director
Nancy Boyd, Washington Project Director

SUBJECT: Columbia River Crossing Navigation Impact Report

The Columbia River Crossing Navigation Impact Report contains the results of a comprehensive analysis conducted in 2012 to inform decisions related to the height and navigational clearance for the replacement Interstate 5 bridge across the Columbia River. The report contains findings from several distinct research efforts on river use, vessel size, economic impacts and the feasibility of options to avoid, minimize or mitigate impacts to current and future river navigation. The centerpiece of the report is the result of a vessel impact analysis which identifies the number of impacted users along with the community, environmental and cost effects of bridge heights from 95 to 125 feet.

The report does not include a recommendation for a particular bridge height. The information and data contained can be used to understand the advantages and disadvantages of the bridge height options studied and inform a balanced decision. The selected bridge height must balance the interests of river users, freight mobility, needs for flight paths over the bridge to Portland International Airport and Pearson Airfield, connections to downtown Vancouver, interstate safety and efficiency, and cost and schedule of the CRC project.

A General Bridge Permit, issued by the U.S. Coast Guard, is one of the required elements to begin construction of the replacement bridge in late 2014. In reviewing a permit application, Coast Guard decision makers will consider their mission, which calls for meeting the reasonable needs of navigation and employing a balanced approach to the total transportation systems on land and water.

The Navigation Impact Report findings and continuing consultation with the affected parties will be used by the states of Oregon and Washington to finalize a bridge height in December 2012 in preparation to submit a General Bridge Permit application to the U.S. Coast Guard in January 2013.

Attachment

cc: Project Controls

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INTERSTATE 5 COLUMBIA RIVER CROSSING

Navigation Impact Report

November 2012

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ADA	Americans with Disabilities Act
CRC	Columbia River Crossing
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
LPA	Locally Preferred Alternative
NPH	North Portland Harbor
ODOT	Oregon Department of Transportation
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
WSDOT	Washington State Department of Transportation

1. Executive Summary

As one of the largest rivers in North America, the Columbia River is among the defining geographic features of the Pacific Northwest. It serves as an important transportation corridor and its resources have provided the economic and cultural foundations of Native American and western settlements.

Through the Portland-Vancouver metropolitan area, the Columbia River is crossed by three bridges, including the Interstate 5 (I-5) crossing, the Interstate 205 (I-205) crossing, and the BNSF Vancouver railroad bridge. Like the river, the I-5 corridor is a major regional and national resource. It is the principal north-south corridor for the movement of goods and services on the west coast of the United States from Canada to Mexico. Within the metropolitan area, it provides access to major economic centers such as the Ports of Portland and Vancouver and commercial and business districts throughout the region.

The Columbia River Crossing is a multimodal project to improve I-5 corridor mobility by addressing present and future travel demand and mobility needs in the vicinity of the river. It proposes to extend light rail transit across the river, improve interchanges in Washington and Oregon and replace the existing I-5 lift span bridges over the Columbia River with new, mid-level fixed span bridges.

1.1 Purpose of this Report

The purpose of this report is to further define how construction and operation of the proposed new bridges could affect current and future river navigation needs, and to identify how various bridge options could avoid or minimize such impacts. This report describes the physical features of the Columbia/Snake River system, the current and projected future navigation needs, alternative bridge heights considered (including evaluating avoidance and minimization options), potential navigation impacts for each alternative height, and potential mitigation strategies to further minimize impacts to navigation.

This report provides detailed consideration of fixed span bridge options, with vertical clearances ranging from 95 to 125 feet above the Columbia River Datum (CRD). These heights are considered mid-level bridges as defined in the CRC Record of Decision (ROD) and Environmental Impact Statement (EIS). In addition, while higher bridge heights were considered under the National Environmental Policy Act (NEPA) process but rejected as not meeting the project's purpose and need or as otherwise unreasonable, to better evaluate the impacts of the mid-level bridge height this report discusses several higher clearance bridge options, ranging from 135 to 178 feet above CRD and including fixed span and lift span configurations. High level bridges were eliminated from further consideration in the DEIS, as discussed in Chapter 3 below. Nonetheless, discussion of these higher bridge heights is included in this report in order to demonstrate the range of possible impacts to navigation. Each bridge height above 95 feet would further minimize impacts to navigation compared to the 95-foot bridge described in the ROD. The bridge options allowing 178 feet of vertical clearance would avoid any additional adverse impacts to navigation, relative to existing conditions, but would other adverse impacts as discussed in Section 7.3.2.

The existing bridge lift has a maximum vertical clearance of 178 feet above CRD. All of the vertical clearance options evaluated in this report are within the range of options that were considered during the NEPA process for the CRC project. The analysis in this report addresses a request from the U.S. Coast Guard (USCG) for an updated vessel and user impact analysis in response to new river user information received in 2011 and concerns regarding the vessel passage impacts from the 95-foot-high bridge that was evaluated in the Final EIS and described in the ROD.

Information and findings in this report will help inform the project's application for a General Bridge Permit from the USCG. The USCG has statutory authority to approve the location and clearances for all bridges over navigable waterways and "the [a]dministration of the alteration of unreasonably obstructive bridges".[1] In evaluating what is an unreasonably obstructive bridge, the USCG's Bridge Administration Manual[2] (hereinafter the Manual) is instructive. The Manual starts generally by stating that "[w]hile the public right of navigation is paramount to land transportation, it is not absolute. This right may be diminished to benefit land transportation, provided that the reasonable needs of navigation are not impaired. (Chapter 1 A.1.b) The Manual goes on to state that "[we] must remember that the bridge statutes and the subsequent court interpretations require bridges provide for the reasonable needs of navigation, not for all the needs of navigation" (Chapter 1 B.2) and also that "as the nation's land (highway-rail) transportation system expands, its dependence on and importance to the national economy, defense, and recreation grows at least equal to that of the water-mode transportation system." (Chapter 1 B.3)

Showing this balanced approach to evaluating what is an unreasonable obstruction to navigation, which implies there is a reasonable obstruction, the Manual states "[w]hen considering bridge actions, [USCG] must work to promote the overall goals of the Department of Homeland Security (DHS). This must be done in a balanced manner to accommodate, to the greatest practical extent, the needs of all the surface transportation modes -- highway, rail, pipeline and marine." (Chapter 1 B.4). Likewise, land transportation needs are explicitly cited as well "[t]o ensure that proposed bridge projects meet the reasonable needs of navigation, the Coast Guard must promote and expedite projects that facilitate national and international commerce and provide for the reasonable needs of present and prospective land and marine transportation." (Chapter 1 B.5)

Lastly, the Manual says "[i]t is the Commandant's policy, when considering bridge actions, to work toward promoting the overall goals of the Department of Homeland Security in a balanced manner in order to accommodate, to the greatest extent practicable, the needs of all transportation modes. However, the safety of navigation is a paramount consideration that cannot be compromised when addressing bridge program issues." (Chapter 2 E.1)

Based upon this language from the USCG's Bridge Manual, the CRC's application for a General Bridge Permit must demonstrate that the reasonable needs of navigation would not be impaired and safety would not be compromised, but also must be aware of the project's purpose which has

[1] Source: 33 CFR 114.01(2).
[2] US Coast Guard Bridge Administration Manual, March 26, 2004. Washington, D.C.

demonstrated substantial proposed benefits to land-based modes of transportation, and must provide the analyses and documentation needed for the USCG to determine that the reasonable needs of current and future marine navigation are addressed.

Given the Manual's explicit guidance that there is a requirement to consider land transportation needs, and therefore to help inform the process of determining a balanced solution, this report provides information on the navigational effects of each bridge height evaluated as well as the impacts to surface transportation and other factors of each bridge height. The non-navigation factors to consider include the effects on highway user safety, traffic performance and operations, local street connectivity, transit operations and alignment, transit station location, aviation airspace intrusion, and cost.

This report does not recommend a particular bridge height. It provides findings that can be used to understand the advantages and disadvantages of the bridge height options studied and inform a balanced decision.

1.2 The River and its Users

The Columbia River's deep draft navigation system provides for a 43-foot-deep by 600-foot-wide channel from inside the Columbia Bar upriver to ports on both the Washington and Oregon sides of the river. The upriver end of this section of the channel, known as the Lower Columbia, is just downriver from the Interstate 5 bridges.

Three bridges cross the main channel of the Columbia River in the project area: the northbound and southbound structures of the I-5 bridges (proposed to be replaced by the CRC project) and the BNSF Railroad Bridge located less than one mile downriver (west). The I-5 bridges are in the shallow-draft section of the system and the BNSF bridge is in the deep-draft section.

The shallow-draft system begins just downriver from the I-5 bridges and extends through the bridge area upriver to The Dalles lock and dam. The shallow-draft system has a controlling depth of approximately 15 feet. Just east of The Dalles is a BNSF railroad bridge at Celilo Falls with a vertical clearance of 79 feet, which is notably less than the heights proposed for the new I-5 Columbia River Crossing.

Between the I-5 bridges and the Celilo Falls BNSF railroad bridge 95 miles to the east, many shoreline land uses are dependent on the Columbia River. In general, the Columbia River shoreline is identified by local jurisdictions as a resource to be leveraged for river-dependent uses that are more in line with recreational, environmental, habitat or economical purposes than with industrial marine, water-dependent uses. The intrinsic value of the Columbia River is largely in its natural beauty, especially within the National Scenic Area. The most significant land use is the 85-mile long Columbia River Gorge National Scenic Area which protects the natural beauty of the gorge and severely limits industrial development outside of existing incorporated communities. Except for the Columbia Business Center in Vancouver, most of the industrial zoned land will continue to support existing uses and will be limited to businesses that would not be height constrained (for example, lumber or recreational sailboat manufacturing), as discussed in Section 7.4.

Throughout this report, river water levels are expressed relative to the Columbia River Datum (CRD). The CRD is a fixed datum, or reference elevation, established by the Army Corps of Engineers in 1911 for use in the Columbia River.

Vessels currently using the river in the vicinity of the project include tugs and barges, recreational sailboats and powerboats, marine contractor barges with construction cranes and materials, cruise and passenger boats, dredges, government vessels, vessels transporting shipments of marine industrial businesses and fabricators and others. Section 6.2 includes illustrations of various types of vessels.

On average, about 2,600 commercial vessel trips occur each year in this section of the Columbia River, based on logs of the U.S. Army Corps of Engineers over the last 12 years. In addition, more than 185,000 recreational activity days per year occurred on average in the Columbia River in Multnomah County, according to the Oregon State Marine Board. Of the recreational users, nearly 20,000 activity days were from sailboats.

Under the I-5 bridges, vessels pass through one of three channels: the primary channel, the barge channel and the alternate barge channel. The primary channel lies under the bridges' lift spans and has a horizontal clearance of 263 feet and a vertical clearance of 39 feet above 0 CRD in the closed position and 178 feet CRD in the raised position.

The highest clearance of these alternate channels provides a vertical clearance of 72 feet above CRD, or 56 feet above a 16-foot CRD river stage. Typically vessels requiring bridge openings are either too tall to pass under the alternate channel spans, or because the location of the primary channel provides a safer line for navigating between the I-5 bridges and the bridge opening in the BNSF bridge just downriver (the primary channel under the I-5 bridges lines up with the opening in the BNSF bridge just downriver, while the alternate channels under the I-5 bridges are located toward the center and south bank of the river thus requiring vessels to make an S-curve maneuver between the I-5 bridges and the BNSF bridge opening).

The existing I-5 bridges opened for vessel traffic an average of 289 times per year over the past 25 years. Over the past five years, the annual average was 209 lifts for vessel traffic and 459 average total lifts when maintenance lifts are included. For those vessels that requested a bridge lift during that period, tugs and barges accounted for half of all openings, followed by sailboats at 22 percent, and construction equipment at 17 percent. Each of the remaining vessel types accounted for between one and four percent. These data are discussed further in Chapter 6 and presented in Appendix E.

I-5 bridge lift records are kept only for vessels that require a lift, and therefore there is no count of the number of vessels that pass without a lift. However, data on vessel passage at other locations on the river provide an indication of the small share of vessels that actually request or require a lift. Most vessels do not require an opening of the lift span because they are either low enough to pass through the main channel while the lift span is in the lowered position or they can use one of the two alternate channels that pass under the I-5 bridges. For example, data from the locks at Bonneville dam indicate that from 2000 to 2011, less than four percent of the commercial vessels transiting through the locks to downstream of the I-5 bridges required a bridge lift. Using data from the Oregon State Marine Board, collected during a similar time period, indicate that less than 0.4 percent of the recorded sailboat activity days in the vicinity of the I-5 Bridge required a bridge lift. Similar data are not available for other vessel classifications.

Vertical constraints on vessels are a determined largely by vessel height, bridge height and river water levels. Because river water level fluctuates daily and over the course of the year, vertical clearance under the bridges also fluctuates. Analysis of the water level data collected at the I-5 bridges between 1972 and 2012 indicate the following:

- The highest average daily high occurs in early May and is at approximately 10 feet above CRD.
- The lowest average daily low occurs in early September and is at approximately 2 feet above CRD.
- The "ordinary high water" level, which is the river level that was exceeded less than two percent of the days over the 40 year data period, is at 16 feet above CRD.

1.3 Findings

The core analysis for this report was the evaluation of how different vessels and vessel classes would be impacted by each of the bridge height options studied. This analysis included acquiring data on the vessels themselves and on 40 years of river water level data and 25 years of bridge lift data (see Chapters 5 and 6). It also required establishing analytical assumptions, through discussions with the US Coast Guard, for determining an "impact", as described above.

1.3.1 Summary of Vessel Impacts

On average, about 2,600 commercial vessel trips occur each year, and more than 185,000 recreational activity days per year occurred in the Columbia River in Multnomah County. At the lowest mid-level bridge height studied (95 feet), 41 vessels would be restricted from passing a portion of the year, and 12 other vessels/users would not be able to pass at any time of year without mitigation. All other vessels would pass unrestricted. As discussed in Chapter 7, higher mid-level bridges, studied in 5-foot increments through 125 feet, were evaluated as potential measures to further minimize navigation impacts. At the highest mid-level bridge height studied (125 feet), just three vessels/users would be restricted from passing a portion of the year, and five other vessels/shipments, including three that do not yet exist but are projected to be built/fabricated, would not be able to pass at any time of year without mitigation. All other vessels would pass unrestricted.

All of the bridge heights discussed in this report, including the maximum vertical clearance (178 feet CRD) with the existing lift span, would pose vertical clearance constraints on either existing or projected future vessels or shipments. As expected, this study found that as the bridge height decreased, the number of vessels that would be constrained by vertical clearance issues increased. Some of the incremental vessel clearance changes were small and some were substantial. For example, when increasing the bridge height from 95 feet to 105 feet, 16 additional vessels could pass all year round under the assumed conditions (defined below), whereas when increasing from 120 to 125 feet, for example, just one additional vessel could pass year round under the assumed worst case conditions. The incremental impacts of each height are discussed in Chapter 7.

The number, type, name and characteristics of each vessel that has been identified as impacted under the assumed conditions, for each bridge height studied, are detailed in Chapter 7 and the appendices. The number of vessels, by vessel class, for each bridge height, is summarized below in Exhibit 1.3-1. These are based on the assumed conditions of a 16-foot CRD river level and a 10-foot air gap. The impacts are based on “pre-mitigation” effects. Potential mitigation to reduce the impacts is discussed in Chapter 9.

Briefly, and as discussed in Chapter 7 and shown in Exhibit 1.3-1 below, new bridges with a 178-foot vertical clearance (whether under a fixed span or a lift span) would impact one possible future shipment by a marine fabricator (Greenberry Industries). A bridge height of 135 feet would constrain five additional users, including one possible future sailboat (from Schooner Creek Boat Works), the two largest crane barges (the *DB Taylor* and the *DB Freedom*), and the possible future shipments of two marine industries/fabricators (from Thompson Metal Fab and Oregon Iron Works) for a total of six impacted users under the assumed conditions. For the 125-foot bridge height, two additional users would be constrained – one marine contractor vessel (the dredge *Oregon*) and a possible shipment by another marine contractor (SDS Lumber), for a total of eight impacted users. For the 120-foot bridge height, one additional crane barge (*Derrick No. 24*) would be unable to pass under this bridge for a total of nine impacted users. A 115-foot bridge would impact all of the above plus a sailboat (*Make it So*), two marine contractor vessels (the *DB General* and *DB 4100*), and a federally owned dredge boat (the *Yaquina*) for a total of 13 users impacted under the assumed conditions. A 110-foot bridge would impact all of the above plus another sailboat, five more marine contractor vessels, and a passenger cruise boat for a total of 20 impacted users. A 105-foot bridge would impact all of the above plus another sailboat and six additional marine contractor vessels for a total of 27 impacted users. A 100-foot bridge would impact all of the above plus 14 additional marine contractor vessels, another federally owned dredge boat, and the possible future shipment of a fabricator/marine industrial company, for a total of 43 impacted users. A 95-foot bridge would impact all of the above plus four additional sailboats, four additional marine contractor vessels, a U.S. Navy vessel, and another cruise passenger vessel for a total of 53 impacted users. These impacts are based on the assumed conditions for river level and air gap, and are prior to any of the mitigation measures described in Chapter 9.

Exhibit 1.3-1. Number of Vessels Impacted at 16 feet CRD River Stage and 10-foot Air Gap

	Existing Vessels					Anticipated Vessels			
Bridge Height	**MF**	**MC**	**F**	**P**	**S**	**MF**	**MC**	**S**	**Total**
178 ft						1			**1**
135 ft	2	2				1		1	**6**
125 ft	2	3				1	1	1	**8**
120 ft	2	4				1	1	1	**9**
115 ft	2	6	1		1	1	1	1	**13**
110 ft	2	11	1	1	2	1	1	1	**20**
105 ft	2	17	1	2	2	1	1	1	**27**
100 ft	2	31	2	2	2	2	1	1	**43**
95 ft	2	35	3	3	6	2	1	1	**53**

Notes:

Assumed Conditions are 16 feet CRD river stage and a 10-foot air gap.

MF = Marine Industry/Fabricator, MC = Marine Contractor, F = Federal, P = Passenger/Cruise, S = Sailboat.

As noted, these impacts are based on worst case assumptions regarding river level and air gap. While the impacted vessels would not have unrestricted, year-round access under a given bridge height, many of those impacted vessels would be able to pass under that height, and lower bridge heights, for most or at least part of the year. This and other factors are important when considering the reasonable needs of navigation.

It is also worth noting that the identified navigation impacts all relate to restricting the frequency of passage. They don't adversely affect safety. They impact the passage of a very small portion of marine traffic. Of those impacted a share could not pass for some days of the year and a smaller portion could not pass at any time, without mitigation. None of the identified impacts would compromise navigation safety. This is an important point for permitting considerations, as described above. The US Coast Guard Bridge Administration Manual states that "the safety of navigation is a paramount consideration that cannot be compromised when addressing bridge program issues." (Chapter 2 E.1) Navigation safety was an important factor when developing and screening alternatives during the project's NEPA process. As discussed in the ROD, under existing conditions "[m]arine vessels traveling this section of the Columbia River must navigate under one of the fixed spans or through the lift span of the I-5 bridges, and must also navigate through the swing span of the Burlington Northern Santa Fe (BNSF) railroad bridge one mile downstream. Navigation safety for these vessels, especially when traveling downstream (with the current), would be substantially improved with a replacement river crossing…"[3] While navigation safety was not part of the basic purpose and need for the project, navigation safety would benefit from the project as defined in the ROD.

1.3.2 Meeting the Reasonable Needs of Navigation

Determining the bridge height that provides for reasonable navigation needs will include comparing how the incremental minimization of vessel impacts compared to the incremental increases in other impacts and costs. Each incremental rise in the bridge height was found to provide some added vertical clearance advantage (minimization) for at least some vessels, but was also found to create incrementally higher disadvantages to surface transportation and other factors. Weighing the specific advantages and disadvantages will be critical in determining the appropriate balance and therefore is relevant to the question of what is a *reasonable* impact to navigation. For example, understanding the navigation impacts at each bridge height requires more than just comparing the number of vessels that would be impacted under the assumed conditions. Other factors to consider in determining reasonable navigation needs include the following.

Do all impacted vessels need to pass under the bridge 98 percent of the days in a year? No, many do not. The basic impact assessment in this report assumed certain conditions: a vessel was considered "impacted" if it was too tall, with a 10-foot air gap, to pass under the bridge when the river level is above 16 feet CRD (the river level is below 16 feet CRD for more than 98 percent of the days per year). However, the majority of vessel owners reported needing substantially less frequent passage than this, such that many vessels that have been identified as impacted would be able to pass during some or even most days of the year. Exhibit 1.3-2 summarizes impacts based on slightly less conservative conditions than the assumed water level and air gap used in the worst case impact analysis. The impacts in Exhibit 1.3-2 are based on an air gap of five feet

[3] I-5 Columbia River Crossing Record of Decision (page 11). http://www.columbiarivercrossing.org/FileLibrary/ROD/CRC_ROD.pdf

and a river level of 8.65 feet CRD. Daily high river levels were below this stage for more than 80 percent of the days over the last 40 years, and more than 50 percent of the days during the two highest water months of the year (May and June). Nearly all vessel owners whose vessels would be impacted by a 95-foot bridge under the assumed conditions reported that their vessels transit under the existing I-5 bridges much less frequently than this (about 90% of the owners indicated that their vessels transit two times or less per month).[4] Exhibit 1.3-2 shows that with slightly less conservative assumptions than were used in the basic impact analysis, the number of impacted vessels drops substantially. The range drops from between 1 and 53 vessels to between 1 and 22 vessels, before mitigation. Of the vessels considered "impacted" under these less conservative assumptions, many (the number varies by bridge height) would still be able to pass under the given bridge height, but for fewer than 80 percent of the days per year. Still other vessels would be restricted year round. Mitigation could further reduce these impacts.

Exhibit 1.3-2. Number of Vessels Impacted at 8.65 feet CRD River Stage and 5-foot Air Gap

	Existing Vessels					Anticipated Vessels			
Bridge Height	MF	MC	F	P	S	MF	MC	S	Total
178 ft						1			**1**
135 ft	2	1				1		1	**5**
125 ft	2	2				1		1	**6**
120 ft	2	2				1		1	**6**
115 ft	2	3				1		1	**7**
110 ft	2	4				1	1	1	**9**
105 ft	2	6	1			1	1	1	**12**
100 ft	2	9	1		1	1	1	1	**16**
95 ft	2	13	1	1	2	1	1	1	**22**

Notes:

"Other" Assumed Conditions are 8.65 feet CRD river stage and a 5-foot air gap

MF = Marine Industry/Fabricator, MC = Marine Contractor, F = Federal, P = Passenger/Cruise, S = Sailboat.

Is it reasonable for some impacted vessels to transit with less than a 10-foot air gap? The impact analysis assumed a 10-foot air gap, but most vessels would not need this much gap. Allowing for less air gap would decrease the number of vessels impacted and increase the number of days per year that those vessels could transit. Exhibit 1.3-2 shows how many fewer vessels would be impacted with a 5-foot air gap and at the 8.65-foot river stage.

Do the impacted river users have other reasonable options to accommodate their navigation needs? All of the marine contractor vessels that would be impacted are owned by river users that also own other vessels that can perform the same function and have lower vertical clearance requirements. When river levels do not allow passage of the impacted barges and cranes, these contractors may be able to use their other equipment and vessels to maintain year round access to

[4] Source: Appendix B-1

construction sites that can be reached only by transiting under the bridges, as discussed in Section 7.2. This consideration could minimize impacts for some vessel owners.

Is it reasonable to construct a higher bridge to accommodate vessels that may never pass through this section of the Columbia River? Some vessels will need to be able to pass year round; others pass through less frequently but are reasonably foreseeable; still other identified vessels have not navigated through the I-5 crossing in many years and may not need to in the future. Potential examples include the dredge *Oregon* that, under the assumed conditions, would be impacted by bridges 125 feet and lower and the *Derrick No. 24* that would be impacted by bridges 120 feet and lower. The *Oregon* has transited six times in the last 30 years and the *Derrick No. 24* has not transited in the last ten years. This is another example of how the impact numbers presented represent worst case assumptions.

Will a bridge height lower than the current lift span have a substantial adverse effect on upriver, shoreline land use in the future? Between the I-5 bridges and the Celilo Falls BNSF railroad bridge 95 miles to the east, many shoreline land uses are dependent on the Columbia River. In general, the Columbia River shoreline is identified by local jurisdictions as a resource to be leveraged for river-dependent uses that are more in line with recreational, environmental, habitat or economical purposes than with industrial marine, water-dependent uses. The majority of significant land uses in that section are governed by the laws applicable to the 85-mile long Columbia River Gorge National Scenic Area which protects the natural beauty of the gorge and severely limits industrial development outside of existing incorporated communities. Except for the Columbia Business Center in Vancouver, most of the industrial zoned land will continue to support existing uses and will be limited to businesses that would not be height constrained (for example, lumber or recreational sailboat manufacturing), as discussed in Section 7.4.

Can mitigation for individual vessels provide for reasonable navigation needs under the studied bridge heights? Chapter 9 discusses many different measures that could allow nearly all current river users that would be impacted under the assumed conditions to pass under lower bridge heights. Mitigation for individual vessels will be determined when a bridge height is selected. Examples of mitigation options include the following:

- Partial disassembly: For vessels that would have an infrequent need to transit under the bridge, partial disassembly of the tallest elements of the vessel or equipment would allow them to pass under. This could apply to barge dredges, construction cranes, and tall sailboats. It may also be possible for marine industry and fabricator shipments.
- Permanently modify the tallest elements of a vessel: This measure could be applied to several impacted vessels. For vessels that have antenna and other equipment on a mast structure that would allow modification without unduly diminishing operations or performance, the mast structure can be reconstructed with a hinge. The hinge could be opened in order to reduce the effective air draft while passing under the bridge.

Applying these considerations to the results of the vessel impact analysis demonstrates how they provide a more thorough understanding of vessel passage impacts. For example, the 125-foot bridge has been identified as impacting four marine contractor vessels because they could not pass under the bridge under the assumed conditions. However, at least two of these vessels could pass under the bridge for most of the days of the year without any mitigating measures. When taking into account the seasonal variations in the river stages, and a less conservative air gap, two of the impacted vessels (the dredge Oregon and the future SDS lumber shipment) would be able to pass under a 125-foot bridge for at least 80 percent of the days of the year, and at least 50 percent of the days in the two highest water months. They would be able to pass under a 110-foot bridge between 40 and 95 percent of the days for most months of the year and between at least 30 and 35 percent of the days during the two highest water months. The other two impacted marine contractor vessels (*DB Freedom* and *DB Taylor*) would likely require mitigation to transit under the bridge. The owners of each of these vessels own other vessels that could perform similar functions and have lower vertical clearance requirements; if the bridge restricts passage of their tallest vessels, they may be able to use their other vessels for work upriver. Other mitigation could include lowering or removing the spuds (on the *DB Freedom*) or removing the boom or modifying the gantry on the *DB Taylor*. Any vessel-specific mitigation determinations would be made through coordination with vessel owners. Mitigation options are discussed in Chapter 9.

These and other considerations will be important for determining the bridge height that would provide for the reasonable needs of navigation for the individual vessels and vessel classes impacted. Such a determination would also be influenced by weighing these considerations against the adverse impacts and costs associated with the incremental increases in bridge height.

1.3.3 Other Factors to Consider

This report also compares how the incremental improvements in vessel clearance compare to the incremental increases in adverse impacts to surface transportation, other resources and costs, as the suggested balancing test the USCG's Bridge Administration Manual allows: "[w]hen considering bridge actions, [USCG] must work to promote the overall goals of the Department of Homeland Security (DHS). This must be done in a balanced manner to accommodate, to the greatest practical extent, the needs of all the surface transportation modes -- highway, rail, pipeline and marine." (Chapter 1 B.4). This analysis found that each incremental increase in bridge height would result in incremental increases in impacts to surface transportation, aviation safety, and cost. Except for the low-level bridge with a lift span and the 95-foot fixed span bridge, all other bridge alternatives considered would increase freeway grades above those developed for the 95-foot design height. The increases in grades would all be within acceptable limits but would impact traffic operations and safety (the steeper grade with a 125 foot bridge, compared to a 95-foot bridge, would increase the number of predicted truck-related crashes by over 200 percent[5]. Increases in bridge height will also result in lengthening the on-ramp to I-5 from Hayden Island, which will affect traffic operations on the bridge. Additional analysis is required to address the change in operations. Increases in bridge height may also affect the planned on-ramp from 6th Street to I-5 southbound in Vancouver. For a bridge height of 120 or 125 feet, it becomes challenging and more expensive to keep the on-ramp operational. For bridges higher than 125 feet, the on-ramp could not be constructed, and alternative routing to I-5 would be required.

Increased bridge heights will affect the grade for the light rail transit alignment as it enters downtown Vancouver, which would have a minor impact on transit schedules. At 120 feet the

[5] Based on applying the Speed Reduction Crash Curves, from *A Policy on Geometric Design of Highways and Streets*, page 3-120, American Association of State Highway Transportation Officials.

transit grade would be raised to a point that could significantly impact operations on 5th Street, which may require substantial changes to traffic access and circulation patterns downtown.

Potential intrusion into FAA airspace for Pearson Airpark was also evaluated. At bridge heights of 115 feet and above there are one or more locations on the bridge and SR 14 interchange where sign structures and lighting would penetrate the protected airspace and create both safety concerns for air travel and financial liability for the bridge owners. The lift span bridge options would cause even greater intrusions into the airspace.

As shown in the following table, raising the bridge height from 95 feet up to110 feet would add a relatively small cost ($36 million) to the project, whereas raising it from 110 feet up to 120 feet would more than quadruple the cost increase ($176 million) over the 95-foot bridge. Weighing the tradeoffs will be part of determining the appropriate balance of navigation clearance versus surface transportation impacts and costs.

This report also evaluates the projected regional economic benefits that would result from the project's improvements in transportation operations. These project-related economic benefits are a summary of landside traveler savings, marine navigation savings, and the economic effects of improved market access and connectivity. These improvements were estimated to add $4 to $6 billion to the gross regional product by 2050 for the preferred alternative, compared to No-build, as described in Chapter 4.

Exhibit 1.3-3. Bridge Height Change Costs (2011 estimate)

Bridge Height Above 0 CRD (ft)	Incremental Cost ($ millions)[a]
95	-
100	$13
105	$22
110	$36
115	$91
120	$176
125	$171

a Estimate of additional costs above the LPA cost of a 95-ft. bridge, at a 60% confidence level that the actual cost will be at or below the cost estimate.

1.4 Reader's Guide to this Report

Information can be found in the following chapters and appendices of this report:

- Chapter 2 includes the basic purpose and need for the CRC project.
- Chapter 3 includes a description of the CRC project from the Record of Decision, a description of previous analysis of various bridge heights that were dropped from further consideration, an explanation of the process and input that led to the mid-level bridge as part of the preferred alternative, and the reasons for studying additional mid-level bridge heights at this time.
- Chapter 4 provides an economic benefit analysis for the project.

- Chapter 5 provides an overview of the Columbia River as a navigation route and interprets 40 years of river water level data (further detail is in Appendices D and F).
- Chapter 6 provides results of an updated river user survey and an analysis of bridge lift data, (further detail is in Appendices B, C, E and J.
- Chapter 7 evaluates how the different bridge heights studied would affect river users. Each incrementally higher bridge further minimizes impacts to vertical navigation clearance. Avoidance alternatives are also considered. This chapter also evaluates how the different bridge heights would affect surface transportation, costs and other resources, as well as an analysis of how future land uses and possible future river users might be affected by the proposed bridge (further detail is in Appendices A, G, H and I).
- Chapter 8 identifies temporary navigation impacts that would occur during construction.
- Chapter 9 identifies potential measures to minimize or mitigate unavoidable long term and short term impacts.

1.5 Next Steps

Information from this report will be used to assist federal and state agencies participating in developing and permitting the project to evaluate the alternative bridge heights considered, leading to the submittal of a General Bridge Permit application to USCG.

2. Purpose and Need for the I-5 Columbia River Crossing Project

The Purpose and Need statement developed by the lead agencies, project sponsors, and CRC Task Force is provided below, and as described in the CRC EIS and Record of Decision (ROD).

2.1 Project Purpose

The purpose of the proposed action is to improve I-5 corridor mobility by addressing present and future travel demand and mobility needs in the CRC Bridge Influence Area (BIA). The BIA extends from approximately Columbia Boulevard in the south to SR 500 in the north. Relative to the No-Build Alternative, the proposed action is intended to achieve the following objectives: a) improve travel safety and traffic operations on the I-5 crossing's bridges and associated interchanges; b) improve connectivity, reliability, travel times, and operations of public transportation modal alternatives in the BIA; c) improve highway freight mobility and address interstate travel and commerce needs in the BIA; and d) improve the I-5 river crossing's structural integrity (seismic stability).

2.2 Project Need

The specific needs to be addressed by the proposed action include:

- **Growing travel demand and congestion:** Existing travel demand exceeds capacity in the I-5 Columbia River crossing and associated interchanges. This corridor experiences heavy congestion and delay lasting 4 to 6 hours daily during the morning and afternoon peak travel periods and when traffic accidents, vehicle breakdowns, or bridge lifts occur. Due to excess travel demand and congestion in the I-5 bridge corridor, many trips take the longer, alternative I-205 route across the river. Spillover traffic from I-5 onto parallel arterials such as Martin Luther King Jr. Boulevard and Interstate Avenue increases local congestion. In 2005, the two crossings carried 280,000 vehicle trips across the Columbia River daily. Daily traffic demand over the I-5 crossing is projected to increase by more than 35 percent during the next 20 years, with stop-and-go conditions increasing to approximately 15 hours daily if no improvements are made.
- **Impaired freight movement:** I-5 is part of the National Truck Network, and the most important freight highway on the West Coast, linking international, national and regional markets in Canada, Mexico and the Pacific Rim with destinations throughout the western United States. In the center of the project area, I-5 intersects with the Columbia River's deep water shipping and barging as well as two river-level transcontinental rail lines. The I-5 crossing provides direct and important highway connections to the Port of Vancouver and Port of Portland facilities located on the Columbia River as well as the majority of the area's freight consolidation facilities and distribution terminals. Freight volumes moved by truck to and from the area are

projected to more than double over the next 25 years. Vehicle-hours of delay on truck routes in the Portland-Vancouver area are projected to increase by more than 90 percent over the next 20 years. Growing demand and congestion will result in increased delay, costs and uncertainty for all businesses that rely on this corridor for freight movement.

- **Limited public transportation operation, connectivity, and reliability:** Due to limited public transportation options, a number of transportation markets are not well served. The key transit markets include trips between the Portland Central City and the city of Vancouver and Clark County, trips between north/northeast Portland and the city of Vancouver and Clark County, and trips connecting the city of Vancouver and Clark County with the regional transit system in Oregon. Current congestion in the corridor adversely impacts public transportation service reliability and travel speed. Southbound bus travel times across the bridge are currently up to three times longer during parts of the a.m. peak compared to off-peak. Travel times for public transit using general purpose lanes on I-5 in the BIA are expected to increase substantially by 2030.
- **Safety and vulnerability to incidents:** The I-5 river crossing and its approach sections experience crash rates more than twice the statewide averages for comparable facilities. Incident evaluations generally attribute these crashes to traffic congestion and weaving movements associated with closely spaced interchanges and short merge distances. Without breakdown lanes or shoulders, even minor traffic accidents or stalls cause severe delay or more serious accidents.
- **Substandard bicycle and pedestrian facilities:** The bike/pedestrian lanes on the I-5 Columbia River bridges are about 3.5 to 4 feet wide, narrower than the 10-foot standard, and are located extremely close to traffic lanes, thus impacting safety for pedestrians and bicyclists. Direct pedestrian and bicycle connectivity are poor in the BIA.
- **Seismic vulnerability:** The existing I-5 bridges are located in a seismically active zone. They do not meet current seismic standards and are vulnerable to failure in an earthquake.

3. Description of Proposed Project and Heights Considered

3.1 Project as Approved by Record of Decision

The CRC ROD describes a project which, in summary, provides transportation improvements throughout the 5-mile project corridor, including:

- A new river crossing over the Columbia River and I-5 highway improvements. Improvements to seven interchanges, from south to north: Victory Boulevard, Marine Drive, Hayden Island, SR-14, Mill Plain, Fourth Plain and SR 500. Related enhancements to the local street network.
- Improvements to the existing I-5 mainline bridge over North Portland Harbor; three new structures over this waterway associated with I-5; and one new multimodal bridge carrying light rail transit, local traffic, pedestrians and bicyclists.
- A variety of bicycle and pedestrian improvements throughout the project corridor. A multi-use path connecting to the existing system. The path would allow users to travel from north Portland, over Hayden Island and the Columbia River into downtown Vancouver.
- Extension of light rail transit from the Expo Center in Portland to Clark College in Vancouver and associated transit improvements. Transit stations would be built on Hayden Island, in downtown Vancouver, and at a terminus near Clark College. Three park and rides are to be built: Columbia (near the SR 14 interchange), Mill (in uptown Vancouver) and Clark (near Clark College). Improvements would be made to the tracks on the Steel Bridge. Also, bus route changes and the expansion of the Ruby Junction light rail transit maintenance facility.
- Transportation demand and system management measures to be implemented with the project, including the use of tolls, subject to the authority of the Washington and Oregon Transportation Commissions.[6]

The CRC Project (Project) will construct new bridges over the main channel of the Columbia River and new structures across North Portland Harbor, along with improvements to the existing I-5 bridges across North Portland Harbor. These improvements, as described in the CRC ROD and FEIS, are described below.

3.1.1 Main Span Crossing of the Columbia River

The parallel bridges that form the existing I-5 crossing over the Columbia River will be replaced by two new parallel bridges. The eastern structure will accommodate northbound highway traffic on the bridge deck, with a bicycle and pedestrian path underneath; the western structure will carry southbound traffic on the bridge deck, with a two-way light rail guideway below. Whereas the existing bridges have only three lanes each, with virtually no shoulders, each of the new

[6] Source; I-5 Columbia River Crossing Record of Decision, December 2011 (pages 1-2); http://www.columbiarivercrossing.org/FileLibrary/ROD/CRC_ROD.pdf

bridges will be wide enough to accommodate three through lanes and two add/drop lanes. Lanes and shoulders will be built to full Washington State Department of Transportation (WSDOT) and Oregon Department of Transportation (ODOT) design standards.

Vertical and Horizontal Clearance

The top deck of the new mid-level bridge, as selected in the ROD, will range in elevation from approximately 100 to 140 feet over the Columbia River. The available vertical clearance of the primary channel will be a mid-level bridge with a minimum of 95 feet above zero Columbia River Datum (CRD), over a 300-foot width span. To provide a 300-foot navigation clearance between bridge piers requires bridge spans greater than 400 feet. The design includes spans of 465 feet. Unlike the existing bridges over the Columbia River, the new structures will not include lift spans.

Pier Locations

The existing bridges over the Columbia River have nine pier sets. Each of the new bridges will be built on six pairs of in-water piers plus two pairs of piers on land. Each of these pier sets will be supported by a foundation of approximately sixteen 10-foot-diameter drilled shafts. Each group of shafts will be tied together with a concrete cap measuring approximately 75 feet by 75 feet at the water line. Slender columns will rise from the shaft caps and connect to the superstructure of the bridges. During final design, project staff will further explore the potential for reducing the diameter of the new in-water piers.

3.1.2 North Portland Harbor Bridges

The existing highway structures over North Portland Harbor will not be replaced; instead, they will be retained and will accommodate all mainline I-5 traffic. Four new, narrower parallel structures will be built across the waterway: three on the west side and one on the east side of the existing North Portland Harbor bridge. The Project will not widen or seismically upgrade the existing North Portland Harbor bridge.

Three of the new structures will carry on- and off-ramps to mainline I-5. Two structures west of the existing bridge will carry traffic merging onto I-5 southbound from Hayden Island or exiting off of I-5 southbound to Marine Drive. The new structure on the east side of I-5 will serve as an on-ramp for traffic merging onto I-5 northbound from Marine Drive and Martin Luther King Jr. Boulevard and will carry the multi-use path underneath the bridge deck.

The fourth new structure will be built slightly farther west and will include a two-lane local multimodal bridge for local traffic to and from Hayden Island, light rail transit, and will include bicycle lanes and sidewalks. The length of each new structure will be between 800 and 1,000 feet, depending on its location and the angle relative to the channel. Span lengths will vary by bridge, and the existing navigation channel will be preserved. All of the new structures will have at least as much vertical clearance over the river as do the existing North Portland Harbor bridges.

3.2 Main Span Bridge Heights Considered during CRC NEPA Process

Elements of the CRC Project have been proposed and studied since the early 1990s. In 2002, the I-5 Transportation and Trade Partnership[7] produced an evaluation of multiple highway, transit, and river crossing improvements in this corridor and other parts of I-5. This process gathered public and stakeholder input on issues and potential solutions for transportation problems in the I-5 corridor, and recommended that the region move forward with a number of specific projects, including the I-5 Columbia River Crossing.

After FTA and FHWA issued a Notice of Intent to prepare an EIS in September 2005, the Project again began working closely with the public, stakeholders, and local jurisdictions to develop the Project's Purpose and Need. Following the adoption of the Project Purpose and Need, the Project developed an Evaluation Framework[8] that is based on the Purpose and Need and set forth the criteria by which project components would be evaluated and screened for further consideration. The Project began soliciting ideas and identifying possible transportation components (for example, various transit technologies and river crossing types and locations) and over 70 such components were identified. With public and agency input, the Project performed two rounds of evaluation and screening, as well as conducted additional evaluation and research, to narrow these options and assemble these components into 12 alternative packages. The Project then analyzed how well each alternative would address the criteria from the Evaluation Framework. In January 2007, the Project launched an intensive public involvement effort to present the results of this evaluation and invite comments on which alternatives should move forward into the DEIS.

During the Project's early NEPA analysis and community outreach, a variety of bridge types and heights were considered. Bridge heights were evaluated in relationship to impacts on river users; traffic safety; airspace; transit; downtown Vancouver, Washington; Hayden Island, Oregon; and to the overall footprint. Local communities and the states recognized the need to balance these sometimes competing interests as potential solutions were evaluated. The bi-state CRC Task Force- considered the need for the following[9]:

- Improved navigational safety and access
- Observing Federal Aviation Administration requirements that obstructions should be avoided for the safe operation of aircraft
- Replacement of substandard features and improved sightlines for safety on the interstate
- Improved interstate traffic and freight mobility
- Grades that would accommodate transit
- Bridge landings that are compatible with local land use and community plans

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[7] Source: Portland-Vancouver (City of Portland, Oregon and City of Vancouver, Washington). 2002. Portland-Vancouver I-5 Transportation and Trade Partnership. Final Strategic Plan. Portland OR and Vancouver, WA. June 2002.
[8] Source: CRC (Columbia River Crossing). 2006a. Evaluation Framework. Task Force. Available at <http://www.columbiarivercrossing.org/FileLibrary/GeneralProjectDocs/ScreeningEvaluationFramework.pdf>. Accessed May 20, 2011.
[9] Source: With the exception of "local land use plans" all of the considerations were included in the Step A Screening Report. The local land use aspect was considered in the Step B Screening Report. Both are included in attachments to the Development of Range of Alternatives memo. Citation from FEIS to Development of Range of Alternative memo: CRC. 2007a. Development of the Range of Alternatives (Technical Memorandum). June 2007.

- Improved bicycle and pedestrian access
- Safer connections to the adjacent state highway system

In 2006, a long list of project "components" – including multiple transit modes, various bridge heights, various highway configurations, and other options – were evaluated to determine which should advance into further alternatives analysis. For the purposes of the analyses at that time, three representative bridge heights were evaluated for the main span: low with a movable span (around 65 feet), mid (95 to 110 feet), and high (around 130 feet). Based on study results and input, the bi-state task force recommended the following:

1. Removing the low level, movable span bridge components from consideration due to negative effects to highway mobility, highway safety, freight movement, maintenance costs and the lack of a significant difference in community impacts when compared to a higher mid-level fixed span bridge.
2. Removing four high-level bridge components (greater than 130 feet) because of safety concerns with Pearson Airfield and 2004 findings that all known commercial and recreational vessels could be accommodated at 125 feet.
3. Advancing the mid-range height component based on the 2004 boat survey findings that a fixed span of 80 feet would accommodate all but six known vessels.

Also in 2006, the U.S. Coast Guard (USCG) accepted "cooperating agency" status and provided critical guidance to the project including offering a public hearing for review and comment of a mid-level replacement bridge. At the September 2006 USCG public hearing, 17 people testified: one construction barge owner requested a bridge with a "high" level of navigation clearance and one fabricator requested 100 feet.

During this same period, the Federal Aviation Administration reported it had "no objections" to the mid-level bridge height provided for the agency's consideration[10].

The bi-state task force moved the mid-level bridge component forward within different multimodal alternatives for technical analysis in the draft EIS (DEIS). About 1,600 public and agency comments were received on the DEIS in 2008. Of the comments stating a preference on the bridge element, the majority favored a replacement (mid-level bridge) as compared to no action or a supplemental bridge. Of the 1024 comments expressing an opinion on the replacement bridge, 66% were favorable and 34% were unfavorable. Only 346 comments expressed an opinion on the supplemental bridge, with 48% favorable and 52% unfavorable."

Based on the technical analysis in the DEIS and public and agency comment, the bi-state task force and six boards and councils of each local sponsor agency unanimously recommended a replacement bridge at mid-range height with an extension of light rail to Clark College in Vancouver for the Locally Preferred Alternative (LPA). The development and refinement of the LPA was informed by public input – over 29,000 public contacts at more than 1,000 public events.

In early 2011, the Oregon and Washington governors initiated a 3-month bridge type review process and ultimately identified a composite deck truss design for the replacement river

[10] Source: Letter dated June 14, 2005 to Lynn Rust from Don Larson, Airport Planner, FTA.

crossing structures. More than 250 people and organizations provided comment. Of those, 12 provided comments on vertical navigational clearance or highway grade. Only one (a private citizen) said the mid-level height would potentially impede river navigation. The other 11 suggested that a higher bridge could impact aviation and bicycle and pedestrian mobility. The USCG did not submit comments at that time.

During 2011, approximately three years after the DEIS was issued, the USCG forwarded an amended height request from an existing river user, and a new river user was also identified with concerns about the bridge height. In September 2011, the FEIS was published and available for review and comment. During this time, the USCG expressed written concern with the proposed 95-foot bridge height based on comments received from river users and notified the project that 125 feet clearance would be given serious consideration during their review.

The USCG also asked that the river user survey be updated and that alternatives be considered to address any new information resulting from the updated survey. This led to the Project further analyzing, as documented in this report, the potential for the main span to be constructed with a vertical clearance higher than 95 feet. The costs, benefits and impacts of a crossing with a higher vertical clearance. are provided in Chapters 7 and 8 of this report.

3.3 Other Main Span Bridge Heights Considered for General Bridge Permit Application

In addition to the detailed evaluation of mid-level, fixed span bridges, this report also discusses four other bridge height options, including:

- The existing lift span with a maximum vertical clearance of 178 feet above zero CRD
- A high level fixed span bridge with the same maximum vertical clearance (178 feet) as the existing lift span
- A mid-level bridge with a lift span with the same vertical clearance (178 feet) as the existing lift span, and
- A high level fixed span of approximately 135 feet maximum vertical clearance.

Although high level bridge options were eliminated from consideration during the NEPA process[11] (as discussed in Section 7.3 below) the 178 foot options are included for comparison in this report because they equal the maximum clearance allowed when the lift span is opened for the existing bridges, and because they represent the high end of the high-level bridge range. The 135 foot fixed span option is included for study because it is the highest level, fixed span bridge that would not significantly affect the existing North Portland Harbor bridge (a higher bridge would likely require that the NPH bridge be rebuilt), the "Land Bridge" over SR14 (an important cultural and biking/walking connection between the Vancouver Historic Reserve and the waterfront) and the future "Community Connector" in the vicinity of Evergreen Boulevard.

[11] CRC. 2007a. Development of the Range of Alternatives (Technical Memorandum). June 2007.

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4. Economic Benefits of Project

The selection of the Columbia River Crossing **(**CRC) preferred alternative in the ROD is the result of extensive analyses considering how to meet the project's Purpose and Need while balancing the sometimes competing needs of various user groups (including auto, truck and bus highway users, light rail transit users, freight rail, marine transportation, aviation and bicyclists and pedestrians) and environmental and community benefits and impacts. For example, alternatives that lower the bridge height reduce potential impacts to aircraft but increase the number of potentially impacted river users. In considering those trade-offs between users, it's important to also consider the very significant economic benefits of the project to the region, the West Coast, and the United States. Those benefits derive from reduced congestion and decreased travel times, improved safety for motorists, and improved safety and efficiency for marine navigation. Those direct benefits to transportation system users in turn will result in economic benefits to the region by improving access to job opportunities throughout the region, reducing business costs, and improving access to goods and services both domestically and internationally. This chapter provides a brief overview of those benefits. It is worth noting that this analysis estimates the economic impacts associated with the project's operational benefits for all users, whereas the FEIS included estimates of economic impacts that would result from construction-related activities.

4.1 Methodology

The economic benefits of the CRC project have been estimated by utilizing the Transportation Economic Development Impact System (TREDIS) model to provide the overall economic benefits of the preferred alternative versus the No-Build Alternative. The TREDIS model has been widely and successfully used in many previous Portland regional, Oregon state and national studies. Inputs to the model were derived from information in the CRC FEIS documents. The TREDIS model estimates traveler benefits and any added benefits from the impacts of investments on improved market access and improved connectivity. It has been used to compare what happens to the future economies of the region, the rest of Washington, the rest of Oregon, and California under the preferred alternative versus the No-Build Alternative. Its findings can be found as an appendix to the Economic Benefits Report, published October 31, 2012 and is available on the CRC website.

4.2 Summary of Project Economic Benefits

Project-related economic benefits are a summary of landside traveler savings, marine navigation savings, and the economic effects of improved market access and connectivity. The net present value to the economy of the preferred alternative versus the No-Build Alternative is estimated in the TREDIS model by comparing the time streams of costs and benefits for each option, using a discount rate for future years.

The most general measure of economic benefits is the net change that a project brings about in the overall magnitude of the economy, which is expressed in terms of gross regional product (or for the nation as gross national product).The discounted net present value of the greater net gross regional product for the Portland-Vancouver region plus the rest of the West Coast with the preferred alternative versus the No-Build Alternative is highly positive, indicating that the preferred alternative is a very desirable long-term investment. Net added gross regional product to 2050 would be over $4 billion if a 5 percent discount rate is used and over $6 billion if a 3 percent discount rate is used. In terms of a benefit to cost ratio for the project, this added gross regional product from the preferred alternative is equivalent to a more than 2 to 1 to an almost 3 to 1 ratio of benefits to costs. The preferred alternative also has highly positive impacts on other economic measures such as jobs and wages, as discussed below. The preferred alternative is thus a highly justified investment in terms of its economic results.

TREDIS also produces additional economic measures for future years. The combined net economic impacts of the traveler savings and the market access and connectivity impacts of the preferred alternative will also result in the addition of 4,200 jobs and $231 million in additional wages in 2030 under the preferred alternative compared to the No-Build Alternative. All net benefits are the net total increases after taking into account the costs of the project itself.

Traveler savings and market access impacts are described in more detail in the following paragraphs. In addition, the benefits derived from reducing a risk of catastrophic loss of a bridge are also discussed.

4.3 Landside Traveler Savings

By 2030, the estimated annual traveler landside savings due to the preferred alternative versus the No-Build Alternative will exceed $435 million per year. These savings accrue to highway, transit, and marine users.

Landside transportation benefits include substantial savings in highway travel times and transit travel times, with about 6.8 million hours per year in auto and truck delay savings on the facility itself for automobile and truck users for the preferred alternative versus the No-Build Alternative, both from less congestion delay during peak periods and due to fewer bridge closures during off-peak periods. There is also substantially less daily congestion on other highway facilities. The diversion of travelers to transit with the much better transit service under the preferred alternative also provides substantial portions of these savings.

Landside transportation benefits also include the savings in accident costs which will be achieved by the preferred alternative compared with the No-Build Alternative, with 510 to 540 fewer crashes per year, with resulting dollar savings in accident costs. Landside transportation benefits also include lower vehicle miles traveled and lower vehicle operating costs for autos and trucks.

4.4 Marine Navigation Benefits and Costs

Transportation benefits to the marine industry also accrue because elimination of bridge closures will provide greater flexibility for marine traffic to achieve future efficiencies due to the removal of constraints on daytime travel. Although closures are relatively few, marine productivity savings could be achieved and are estimated very conservatively at about $137,000 per year.

As discussed in subsequent chapters of this report, potential impacts to marine navigation have been considered for a range of bridge heights. A bridge height selected to be included in the General Bridge Permit application to the U.S. Coast Guard may result in some foreseeable impacts to river users, such as negative economic impacts to those users. Once a bridge height is recommended pursuant to the bridge permit application, mitigation efforts will be focused on addressing negative impacts for impacted river users.

4.5 Economic Benefits due to Improved Market Access

In addition to the direct transportation benefits, there are further significant benefits resulting from the impacts of the preferred alternative on freight and personal travel access and connectivity.

Because the daily duration of congestion decreases with the project, the number of trucks operating during periods of congestion will drop very substantially under the preferred alternative, by 60 percent or more, preserving and enhancing the key freight industries, such as lumber and wood, food and farm products, distribution, transportation and equipment, and high-tech products, which are highly dependent on the level of service on the CRC.

Person throughput (the number of people that can cross the bridge over a specified time period) will be enhanced. Person throughput for the corridor will be enhanced by one-third during the AM peak period and by 40 percent during the PM peak period, due largely to the greater multimodal person capacity. This enhanced throughput will also enhance the economic competitiveness of the region and the states by enhancing market access and connectivity.

The preferred alternative improves labor and business market access and improves connections, stimulating additional economic activity. Matching employees and their unique skills to employer needs, enhancing supplier connections, supply chain coordination, and overall knowledge sharing are the results of improved market access and connectivity. These market access and connectivity benefits under the preferred alternative generate 1,700 (out of 4,200) additional jobs and $111 million (out of $231 million) in added wages in 2030, with the Portland Metro area receiving the majority of these benefits.

4.6 Eliminating the Risk of Catastrophic Loss of the Existing Bridges

An equally important potential economic benefit of the preferred alternative is that its implementation will avoid the risk of an economic catastrophe. The current structures are nearly 100 years old and nearly 60 years old and are not designed to meet current seismic standards. In a major earthquake, one or both structures could be rendered inoperable. The failure of one or both I-5 structures would have disastrous economic consequences until replacement facilities could be built on an emergency basis. Other regions have chosen not to take these risks.

The No-Build Alternative actually includes the probability that the project would have to be implemented on an emergency basis at some time. Under those circumstances, it would be implemented in a manner that avoided the future risk of structural or seismic failure meaning that something similar to or identical to the preferred alternative would be implemented. The No-Build Alternative thus includes the risk of a very major economic disaster lasting at least several years until emergency construction could be completed, followed by a similar but later future with the preferred alternative finally being implemented.

5. The Columbia/Snake River System and Water Levels

This chapter describes the characteristics of the Columbia River and Snake River system, including river water levels, that are relevant to consideration of navigation needs at the I-5 crossing.

5.1 Description of Columbia/Snake River System

The Columbia/Snake River System begins at the mouth of the Columbia River and extends to Lewiston, Idaho, at the confluence of the Snake and Clearwater Rivers, approximately 465 miles upriver from Astoria, as shown in the map in Exhibit 5.1-1.

The deep draft navigation system provides for a 43-foot-deep by 600-foot-wide channel from inside the Columbia Bar to Portland, Oregon, and Vancouver, Washington, on the Columbia River: a distance of approximately 105 miles. This section of the channel, known as the Lower Columbia, provides deep-water access to facilities at the Washington ports of Longview, Kalama, Woodland and Vancouver and to the Oregon ports of Astoria, St. Helens and Portland, as well as to industrial plants located in this area. Approximately 40 million metric tons of cargo passed via the mouth of the Columbia River in 2011 (including both inbound and outbound directions).

The shallow-draft navigation system begins just upriver of Vancouver. The BNSF Rail Bridge (at river mile 105.6) and the Columbia River Bridge (at river mile 106.5) are located at the beginning of the shallow-draft section of the river. The first section of the shallow-draft system (from Vancouver to The Dalles lock and dam) has a controlling depth of approximately 15 feet. The controlling depth for the rest of the shallow draft system (from The Dalles to Lewiston, Idaho) is 14 feet. The section of the river from Vancouver to The Dalles handled approximately 7.0 million tons in 2010. More than 90 percent of this cargo passed through the locks at Bonneville, moving mainly from upriver ports to downriver ports (primarily grain moving down river and petroleum products moving upriver).

The BNSF bridge at Celilo Falls is located at river mile 201.2, which is approximately 10 miles upriver from The Dalles lock and dam (river mile 191.5). The BNSF Bridge has a fixed height of 79 feet above the normal pool elevation behind the The Dalles dam when open and represents the next lowest height restriction in comparison with the options under consideration for the proposed I-5 bridges. This means that the height constraint imposed by the CRC fixed bridge options potentially affects river traffic vertical clearance for a distance of approximately 95 miles or 20 percent of the river system. Normal pool elevation is the height in feet above sea level at which a section of the river is to be maintained behind a dam. The water level can vary with river flow, flood control, fisheries management, and power generation requirements.

Exhibit 5.1-1
Columbia-Snake River System Map

Columbia River CROSSING

Plans are currently underway for a fixed height bridge for the SR 35 bridge located at Hood River (river mile 106.5). The existing SR 35 bridge has an open height of 148 feet above the normal pool elevation behind the Bonneville dam, while the proposed replacement would be a fixed bridge with a height of 80 feet above normal pool elevation. If this occurs, the length of the river segment with potential vertical clearance effects from the CRC fixed bridge options would consist of 63.3 river miles, about 14 percent of the Columbia/Snake River system.

See Appendix D for details on the navigation clearances for all bridges, cables, and locks across the Columbia River (from the mouth to Richland, WA), and across the Snake River (from the mouth to Lewiston, ID).

5.2 Main Channel of the Columbia River in the Project Area

The I-5 CRC project crosses both the main channel of the Columbia River as well as North Portland Harbor—a side channel of the Columbia that separates Hayden Island from the Oregon mainland. The following discussion identifies the navigational characteristics of these two navigable waters in the immediate project area.

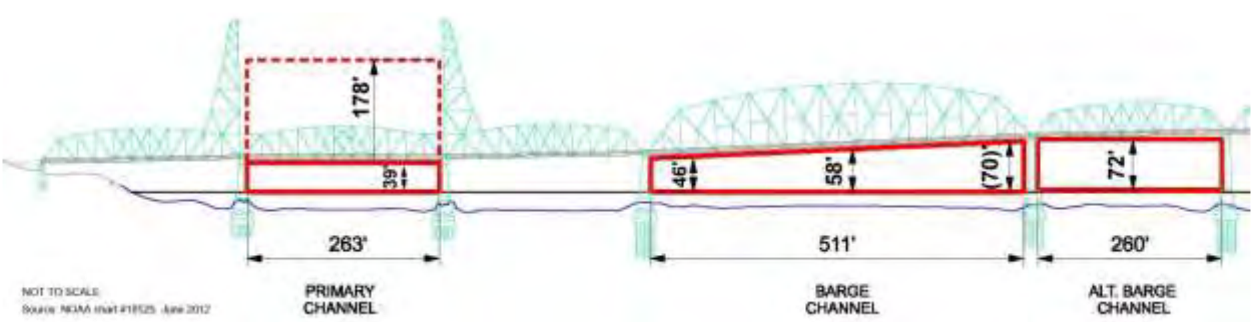
5.2.1 Existing Conditions at the I-5 Bridge

There are three bridges crossing the main channel of the Columbia River in the project area: the northbound and southbound structures of the I-5 bridges and the BNSF Railroad Bridge.

Under the I-5bridges, vessels pass through one of three channels: the primary channel, the barge channel and the alternate barge channel (see Exhibit 5.2-1).

The primary channel lies under the bridges' lift spans and has a horizontal clearance of 263 feet and a vertical clearance of 39 feet above 0 CRD in the closed position and 178 feet in the raised position. The barge channel lies under the wide spans of the bridges and has a horizontal clearance of 511 feet and a vertical clearance ranging from 46 feet to 70 feet above 0 CRD. The alternate barge channel occupies the span directly to the south of the wide span and has a horizontal clearance of 260 feet and a vertical clearance of 72 feet.

Exhibit 5.2-1. Existing Columbia River Navigation Clearances



The third bridge in the project area—the BNSF Railroad Bridge—is located approximately one mile downstream (westerly) from the I-5 bridges and accommodates vessels with heights in excess of 35 feet using a 200-foot-wide movable swing span. The swing span is aligned with the bridges' lift spans.

The most direct vessel route through this river section is through the I-5 bridges' primary channel lift spans and through the BNSF Bridge's swing span. This route is relatively straight and is preferred during times of high velocity river flow. This route, designated the primary channel, is represented in Exhibit 5.2-2. Vessels requiring a vertical clearance in excess of 39 feet require the liftspan to open. However, bridge lifts are restricted during certain times, which can cause vessel travel delays. The Federal Code of Regulations stipulates that the span need not be raised Monday through Friday from 6:30 a.m. to 9 a.m. and from 2:30 p.m. to 6 p.m.[12]

Vessel operators can avoid bridge lift delays by opting to travel through the I-5 bridges' barge or alternate barge channels as vertical clearance allows. The use of these channels requires a more complex maneuver than does the route through the primary channel and requires the vessel to navigate an "S" curve path between the I-5 bridges and the BNSF Bridge in order to pass through the BNSF swing span. These routes are shown in Exhibit 5.2-2 and are designated as the barge channel route and the alternate barge channel route.

Exhibit 5.2-2. Existing Columbia River Navigation Channels

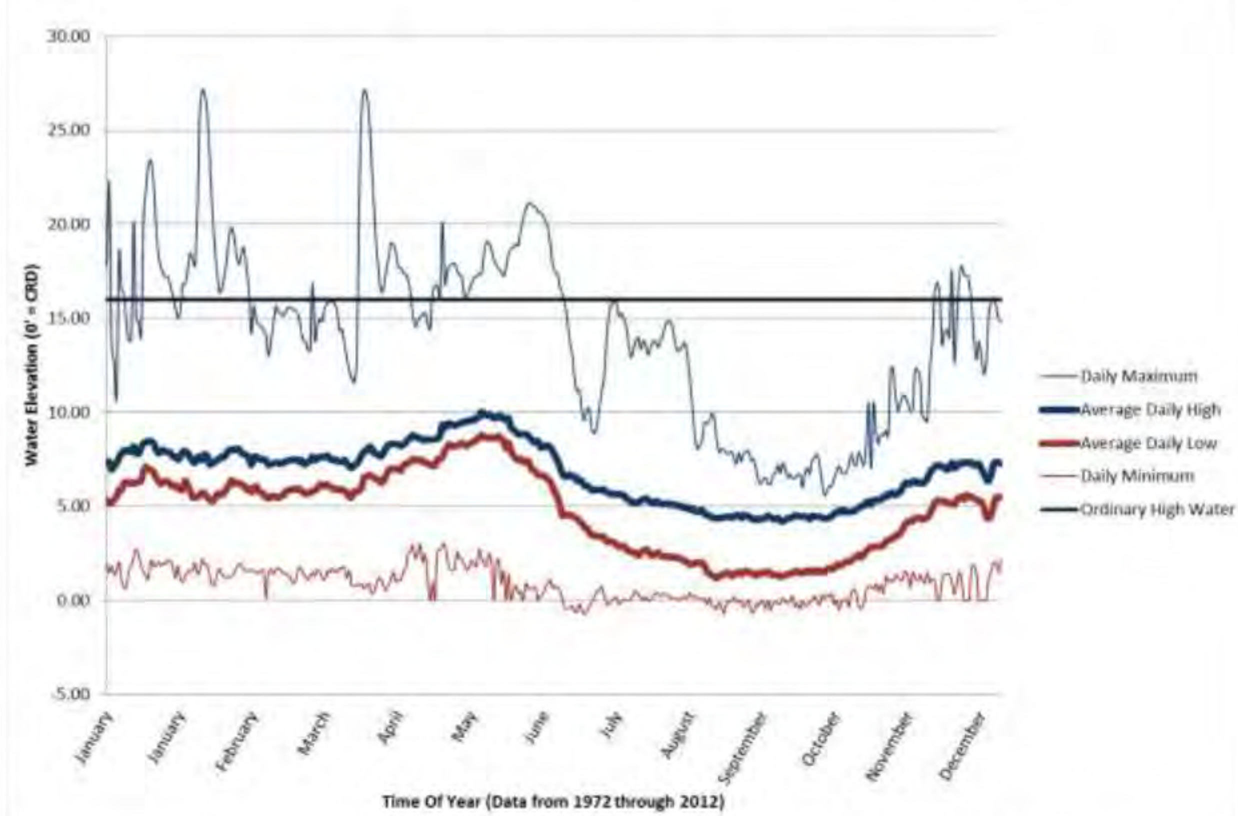
Information on the number and types of vessel trips through this portion of the Columbia River, as well as historic bridge lift data, can be found in Chapter 6.

5.2.2 River Water Levels at the I-5 Bridge

In addition to the bridges, multiple other factors affect navigability and navigation safety in the I-5 crossing area, as described in Section 7.1 of this report. One of the critical factors influencing vertical clearance is river water level, which fluctuates daily and over the course of the year. Exhibit 5.2-3 summarizes the variability in water levels for the Columbia River at the I- 5 bridges from 1972 through 2012. Included in the exhibit are daily maximum, daily minimum, average daily high, and average daily low. Appendix F contains the data used to develop this chart.

[12] 33 CFR 117.869: § 117.869. Columbia River.(a) The draws of the Interstate 5 Bridges, mile 106.5, between Portland, OR, and Vancouver, WA, shall open on signal except that the draws need not be opened for the passage of vessels from 6:30 a.m. to 9 a.m. and from 2:30 p.m. to 6 p.m. Monday through Friday except federal holidays.

Exhibit 5.2-3. Columbia River Water Elevation at the Interstate Bridges (1972-2012)



Note: The water level went above the ordinary high water mark (16' above CRD) less than 2% of the time (208 days / 14,388 days) between 1972 and 2012.

In general, the following river water level trends can be observed from the data collected over the past 40 years:

- The highest average daily high is at approximately 10 feet above CRD and occurs in early May.
- The lowest average daily low is at approximately 2 feet above CRD and occurs in early September.
- The ordinary high water level, which is the water level that was exceeded less than 2 percent of the time over the past 40 years, is 16 feet above CRD. This is used as the "analysis level" for identifying vessels that would be impacted by different vertical clearances, as discussed in Section 7.1.

River levels at the I-5 bridges are influenced primarily by variations in runoff. However, the river level is also tidally influenced between its mouth at the Pacific Ocean and the Bonneville Dam. The tidal influence is less at high river flow conditions and greater during low flow conditions. According to NOAA Chart 18526, the diurnal range of the tide during low river stages is 1.8 feet at Vancouver. The range becomes progressively smaller with higher stages of the river.

The CRC project team also considered how potential climate change could affect future Columbia River water levels, as described in Chapter 3 of the FEIS. This was based on reviewing research conducted by the University of Washington's Climate Change Impacts Group. Section 3.19 of the FEIS summarizes how the project might perform under potentially changing conditions predicted as a result of climate change. Based on the best available science, the effects of climate change in the project area that could be relevant to future Columbia River water levels and vessel clearance are projected as follows:

- Sea level rise in the Pacific Northwest will vary with regional rates of uplift, but would be similar to the global average increase of 1.6 feet by 2100, with a range of six inches to 3.1 feet.
- Warmer winter temperatures in the Columbia River Basin will result in lowered snowpack and higher winter base flows. Lower base flows are expected in the spring and summer months, and an increased likelihood of more intense storms may increase the chance of flooding.
- Average annual precipitation is likely to stay within the range of twentieth century variability; however there will be a shift in the amount and timing of seasonal precipitation, with a trend towards more winter precipitation.
- Seasonal shift in temperature and precipitation will likely impact base and peak flows and river water levels. Warmer, wetter winters will likely lead to higher winter base flows and river stages, while lower base flows and river stages will likely occur in spring and summer months.

There is uncertainty associated with these predictions, and the best available science does not provide specific predictions for how climate change impacts would change the daily or monthly average highs and lows at the bridge crossing. Further, while numerous studies have been performed on the effects of climate change on the Columbia River, they have focused on hydrology. No known studies have evaluated the potential changes to the stage of the Columbia River, which is affected by river management and discharge as well as tide in the lower Columbia.

However, based on existing data regarding how Pacific Ocean tidal changes affect river water levels at the bridges (see Section 7.1), it is reasonable to expect that if sea levels rise as predicted, there would be a minor increase (a fraction of 1.8 feet—the existing diurnal range of the tide during low river stages) in water levels at the bridge during low runoff periods and little to no effect during the higher runoff periods. As indicated above, the climate change predictions, if accurate, suggest that average spring flows, which are historically the highest of the year, will be lower in the future; that average winter flows will be higher (peak average flows could shift away from the spring and toward the winter season); and that average summer flows, historically the lowest of the year, will be even lower in the future.

Because the best available science provides no quantitative predictions of how daily or monthly average flows could change, it is difficult to translate the general climate change predictions into precise conclusions regarding future vessel clearances. However, given that the average annual precipitation is not expected to change, this suggests that average annual runoff would be similar and thus average annual river levels at the bridge would likely be similar to what they have been in the past 40 years. Sea level rise could have a minor effect on this during low runoff periods.

Given the predictions in seasonal precipitation changes, however, any effect of sea level rise could be counteracted by low flows being even lower in the future. The combination could result in slightly more vertical clearance during the spring and summer months compared to recent history, and slightly less during the winter months, at least during the days following storms or major precipitation events.

5.2.3 Columbia River Treaty

Since 1964, the Columbia River Treaty has provided a mandate for the United States and Canada to cooperatively plan and coordinate hydropower operations, share in downstream hydropower benefits, and manage flood storage in Canada for the benefit of the U.S. While the Treaty has no specific expiration date, either nation can terminate most of the Treaty provisions in 2024, with a minimum ten years written notice. Unless it is terminated, most of the provisions of the treaty would continue indefinitely, although the terms of the flood control agreement will change automatically in 2024. After that time, Canada will still be required to provide operations for flood control in the US, and the US would be required to increase reimbursement to Canada for its lost power generation and for the operating costs to provide the requested flood control. If the Treaty is terminated, the US will no longer be required to provide Canada with one half of the downstream power benefits realized in the US. At this time, discussions between the nations are ongoing regarding options for post-2024 management of power generation and flood control. Treaty review documents indicate that the nations want to first understand how continuing or terminating the treaty would affect power generation, flood control and ecosystem function, before assessing impacts in other areas such as fish and wildlife, recreation, cultural resources, irrigation, climate change, navigation and water supply.[13] As of October 2012, the treaty review had not evaluated potential effects on river levels or navigation. The project will monitor the results of the on-going negotiations and analysis for any indication of potential navigation impacts at the Interstate 5 crossing.

5.3 North Portland Harbor

North Portland Harbor can be characterized in two distinctive portions: the eastern portion, which contains moorages for floating homes and recreational vessels, and the western portion, which services Port of Portland marine terminal facilities.

5.3.1 North Portland Harbor - Eastern Portion

Two bridges span over North Portland Harbor in the eastern portion; the BNSF Bridge and the I-5 North Portland Harbor Bridge. The North Portland Harbor Bridge carries I-5 and connects Marine Drive with Hayden Island and points north. The CRC project proposes to construct additional bridges adjacent to the North Portland Harbor Bridge and therefore could affect navigation on that body of water.

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[13] Sources: US Army Corps of Engineers and NW Power and Conservation Council documents at:
http://www.crt2014-2024review.gov/Files/presentation-ColumbiaRiverTreaty-listeningsessions-Oct2011.pdf;
http://www.nwcouncil.org/history/columbiarivertreaty.asp;
http://www.nwd-wc.usace.army.mil/PB/PEB_08/docs/Entity/07Nov_HydrometAnnRep.doc

Although there is no federally authorized navigation channel on this portion of North Portland Harbor, the existing bridges and surroundings indicate what the existing constraints are on navigation. As previously mentioned, the eastern portion of North Portland Harbor contains moorages for floating homes and recreational vessels. The existing North Portland Harbor Bridge has fixed spans and provides one navigation channel with a navigation clearance of 215 feet wide with a height ranging from 35 feet to 40 feet. Existing clearance under the bridge and the surrounding moorages indicates that the dominant vessel type is recreational (requiring less than 40 feet of vertical clearance). The Project has committed that all of the structures proposed to be built by CRC over North Portland Harbor would meet or exceed the vertical clearance allowed beneath the existing North Portland Harbor Bridge.

Farther toward the west, vessels pass under the BNSF Railroad Bridge. Similar to the situation on the Columbia River, the BNSF Railroad Bridge over the North Portland Harbor is located approximately one mile downstream from the North Portland Harbor Bridge and accommodates vessels requiring more than 35 feet of vertical clearance through a movable swing span. According to NOAA Chart 18525, the swing span in North Portland Harbor provides 125 feet of horizontal navigational clearance.

5.3.2 North Portland Harbor - Western Portion

Vessels traveling the western portion of North Portland Harbor appear to be primarily associated with the Port of Portland marine terminal facility. These ships operate only downstream of the I-5 crossing. This facility receives ocean going vessels (large tankers and cargo ships) containing automobiles and shipping containers.

Vessel count information for North Portland Harbor is available through the US Army Corps of Engineers (USACE), some of which is presented in the Exhibit 5.3-1.

Exhibit 5.3-1. North Portland Harbor Vessel Count

North Portland Harbor		2000	2001	2002	2003	2004
Downbound	Cargo	1558	1365	1252	1097	1097
	Tanker	5	1	1	1	0
	Passenger	436	384	351	382	321
	Total	**1999**	**1750**	**1604**	**1480**	**1418**
Upbound	Cargo	1602	1355	1294	1100	1135
	Tanker	3	0	1	1	0
	Passenger	441	400	348	385	326
	Total	**2046**	**1755**	**1643**	**1486**	**1461**

Source: U.S. Army Corps of Engineers Waterborne Commerce Statistics.

Data obtained for Exhibit 5.3-1 do not state whether these vessel trip totals are reflective of the entire length of North Portland Harbor or specific portions. The vessel counts are similar in magnitude to those on the Columbia River, which indicate that they are more closely related to the western portion (Port of Portland) than the eastern portion (floating homes and recreational vessels). The similarity of North Portland Harbor vessel counts with Columbia River Vessel counts along with the limitations of navigational clearances beneath the I-5 North Portland Harbor Bridge indicate larger commercial vessels do not use the navigation channels of the I-5 North Portland Harbor Bridge.

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6. Current and Future Navigational Uses

This chapter describes navigation traffic trends through the existing Interstate Bridges over the Columbia River and provides an overview of anticipated future uses as well. Included below are: an analysis of data collected on bridge lifts or openings, an overview of the types and numbers of vessels that transit under the Interstate 5 Bridge (including vessel air draft information), analysis of anticipated future river users, and an analysis of potential future changes in land use that could affect navigation.

6.1 Overview of Interstate Bridge Opening Trends

6.1.1 Introduction and Methodology

In order to provide a context for the share of marine traffic currently requiring bridge lift span openings, this section summarizes the navigation traffic trends of the existing I-5 bridge. The bridge tenders operating the lift spans of the existing bridges record details of each lift in a logbook. Information recorded in the log includes the date and time of the opening, the name of the vessel or vessels transiting, the type of vessel, the lift elevation, the current water level, and weather conditions, among other data. Personnel from the CRC team transcribed approximately 25 years of data into a spreadsheet, providing information on all lifts from January 1, 1987, to December 17, 2011.

The project team reviewed the logs and categorized bridge openings by type of vessel:

- Tugs and barges (including tugs proceeding with no barge or with barges in tow)
- Sailboats
- Construction equipment (defined as power barges, crane barges, derricks, etc.)
- Cruise and passenger boats (vessels providing passenger service between downriver and upriver locations)
- Dredges (including the U.S. Army Corps of Engineers (USACE) dredge *Yaquina* and other privately owned dredges)
- Government vessels (U.S. Navy (Navy), U.S. Coast Guard (USCG) and the Astoria Job Corps, etc.)
- Tall ships (Lady Washington, Hawaiian Chief, and other visiting tall ships)
- Other (vessels that had no name or designation)

Each opening was classified as an event in the analysis. Some vessels were called out specifically by name and type (sailboats, tugs without barges, cruise/passenger boats, government vessels, dredges and tall ships) in the logbook. In these cases, each vessel was considered an event in the spreadsheet. In other cases, vessels were called out as a group (tugboat was named and was accompanied by one or more barges) in the logbook. Each of these instances was also considered an event in the spreadsheet.

6.1.2 Description of Bridge Characteristics Relevant to Bridge Openings

As described in Section 5.2, the Primary Channel through the existing Columbia River Bridge provides a vertical clearance of 178 feet above CRD when the lift span is raised, or 39 feet above CRD when the lift span is in the lowered position. Navigation lights below the structure reduce the clearance to 38 feet above CRD.

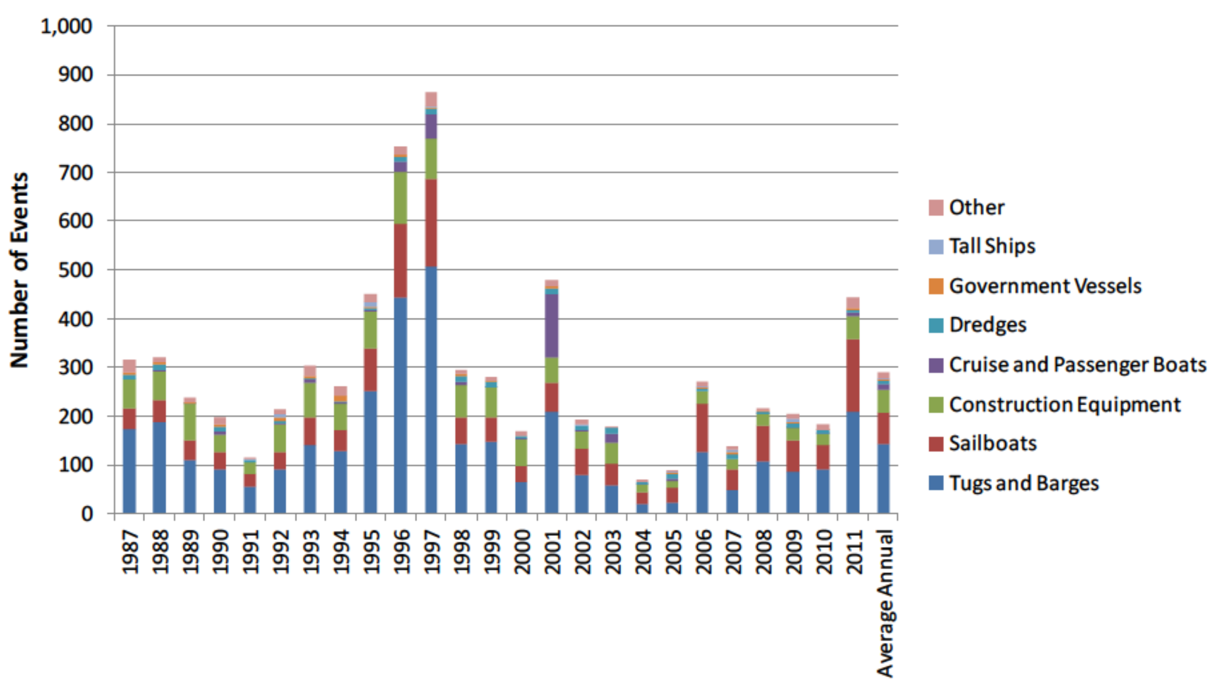
Many vessels do not currently require an opening of the lift span. These vessels are either low enough to pass through the lift span in the lowered position or use one of the two alternate channels to the south of the lift span. The highest clearance of these alternate channels provides a vertical clearance of 72 feet above CRD, or 56 feet above a 16-foot CRD river stage.

Depending on the selected bridge height, the proposed new bridges will provide a minimum clearance of 95 to 125 feet above CRD. Within this range, most of the traffic that currently requires a bridge opening will not require one, but some of the traffic will still be constrained.

6.1.3 Bridge Opening Trends

Bridge opening trends are presented in Exhibit 6.1-1 and Exhibits 6.1-3 and 6.1-4. The number of bridge opening events (excluding openings for bridge maintenance, in which no vessel transited) ranged from a low of 70 events (2004) to a high of 863 events (1997) with an average of 289 events per year. High water occurred in 1995, 1996, 1997, 2001 and 2011, which resulted in an increase in the number of bridge opening events in those years.

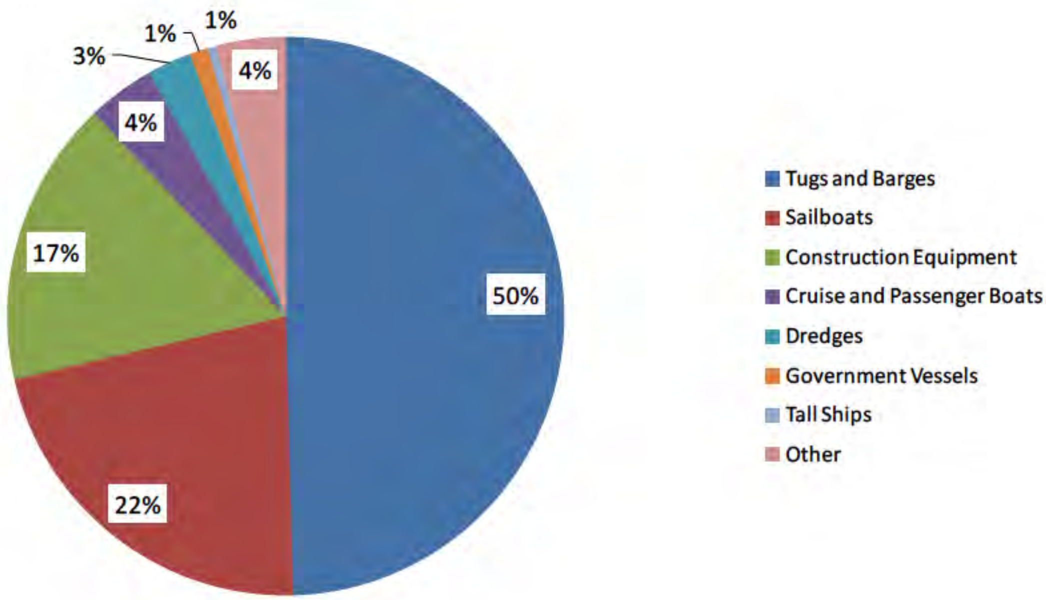
Exhibit 6.1-1. Bridge Opening Trends



Source: I-5 Bridge Tender Logs as categorized by the project team.

Exhibit 6.1-2 summarizes the share of bridge opening events by type of vessel over a 25-year time period: Tugs and barges accounted for half of all openings, followed by sailboats at 22 percent and construction equipment at 17 percent. Each of the remaining vessel types accounted for between one and four percent, as shown in Exhibit 6.1-2.

Exhibit 6.1-2. Average Share of Bridge Openings by Type of Vessel from 1987 to 2011



Source: I-5 Bridge Tender Logs as categorized by the project team.

Tugs and barges

Commercial tugs and barges have the highest share of river usage and transit year round, accounting for approximately 50 percent of the bridge opening events across the 25-year study period. Their usage share ranged from a low of 25 percent (2005) to a high of 59 percent (1996 and 1997).

The air draft for tugs and barges ranges from 28 to 61 feet and they are usually able to use the middle channel, which has a clearance of 72 feet above CRD. Tugs and barges will request an opening of the I-5 Bridge to provide sufficient vertical clearance, or to make a straight course between the Interstate 5 Bridge and the BNSF bridge downstream. The largest share of these bridge lifts for tugs and barges occurs during the spring, when high rainfall and mountain snow melt combine to raise the river level at I-5. Approximately 42 percent of bridge lifts for tugs and barges occur in April, May, and June.

Sailboats

Sailboats accounted for an average of 22 percent of bridge opening events, ranging from a low of 13 percent (2001) to a high of 37 percent (2006).

Recreational sailboats and powerboats typically use the river more frequently during the peak recreational boating season which occurs between April and October. Sailboats that are affected by the existing bridges generally had an air draft ranging from 50 to 90 feet, with an average of approximately 70 feet. Most, but not all, of these sailboats would be able to transit the bridge height options being studied.

Powerboat air drafts ranged from 20 feet to 25 feet and never required a bridge opening.

Construction Equipment

Construction equipment used by marine contractors accounted for an average of 17 percent of bridge opening events, ranging from a low of 10 percent (2006) to a high of 32 percent (1989 and 2000).

Bridge transits by marine contractors are dependent upon their home location and the location of the construction project. Three marine contractors are located upriver of the I-5 bridges (including JT Marine, Mark Marine Services and SDS Lumber Company). These contractors transit the I-5 bridges for downriver construction projects or to pick up supplies from downriver locations. Contractors that are located downriver of the I-5 bridges must transit the bridges for projects located upriver of the bridges.

Marine contractors reported they use the river on an as-needed basis all months of the year depending on the timing of the construction project. Air drafts for construction equipment ranged from 20 feet to 131 feet.

Cruise and passenger boats

Cruise and passenger boats accounted for an average of 4 percent of bridge opening events, ranging from a low of 0 (several years including 2006, 2007 and 2011) to a high of 27 percent (2001). In 2001, a frequent passenger service was initiated between Portland and upriver ports, but it was terminated in 2001.

Cruise and passenger vessels transit the river year round, but more frequently in the summer months. Most of these boats have an air draft of 50 feet to 65 feet.

Dredges

Dredges accounted for an average of 3 percent of bridge opening events, ranging from a low of 0 (1989) to a high of 10 percent (2005).

The USACE Hopper *Dredge Yaquina* has an air draft of 92 feet and the Port of Portland's *Dredge Oregon* has an air draft of 103 feet.

Other Government Vessels

Government vessels accounted for an average of 1 percent of bridge opening events, ranging from a low of 0 percent (there were several years when a government vessel did not request an opening, including 2000, 2002, 2003 and 2004, among others) to a high of 5 percent (1994).

Government vessels include Puget Sound Naval Shipyard nuclear transporters and a vessel used by the Astoria Job Corps. The largest transport barge is *Barge 40* with an air draft of 51 feet, and the largest escort is the *YTT 10 Battle Point* with an air draft of 74 feet.

Tall Ships

Tall ships accounted for an average of 1 percent of bridge opening events, ranging from a low of 0 (several years including 2004, 2008, 2010 and 2011, among others) to a high of 3 percent (1992, 2007 and 2009).

The Grays Harbor Historical Seaport Authority has two sailing vessels with air drafts of 74 and 85 feet that take passengers upstream typically once in May, once in June, and twice in October. In 2012 the vessels are not anticipated to transit up the Columbia River.

Metal Fabricators

Due to lack of detail in the bridge tenders' logs, it is difficult to define the transits associated with metal fabricators located at the Columbia Business Center, which is located just upstream of the I-5 Bridge in the City of Vancouver. However, discussions with the fabricators (Thompson Metal Fab, Greenberry Industries and Oregon Iron Works) reveal that there is a shipment every year or two, consisting of structures for the oil industry (oil rig modules), local Pacific Northwest industries (structures for forest products plants and other local firms), USACE (lock gates, fish weirs and other structures) and departments of transportation (mainly bridge structures). In addition, these firms are currently fabricating structures that support offshore energy programs (wind and tidal power).

Marine industries and fabricators ship products or have vessels transiting under the bridges on an as-needed basis all months of the year. The reported air drafts ranged from 60 feet to 141 feet.

6.1.4 Bridge Openings as a Share of Total Navigation Activity

There are no sources of information that directly compare the number of bridge opening events with all river activity because the only recorded transits of the bridge are those that require a bridge opening. However, data is available that characterizes the annual vessel activity for commercial tugs and barges and recreational boats, as discussed below.

Tugs and Barges

The number of commercial lockages at Bonneville dam provides a useful estimate of the total transits (events) that occur at the existing bridges, because nearly all of the traffic passing through Bonneville locks was linked to terminals located downriver of the bridges. In 2009, approximately 92 percent of the cargo tonnage that moved between Vancouver and The Dalles either originated (consisting of petroleum products and chemicals) or terminated (consisting of grain, forest products, aggregates, et al.) downriver of the I-5 Bridge.

There was an annual average of 2,596 commercial lockages at Bonneville Lock between 2000 and 2011 (see Exhibit 6.1-3). The share of this traffic that required an opening at the bridges represented an average of 3.6 percent of the estimated total trips, ranging from a low of 0.7 percent (2004) to a high of 9.1 percent (2011, a high water year).

Exhibit 6.1-3. Bridge Openings for Tugs and Barges

Year	Bridge Openings for Tugs/barges	Commercial Lockages at Bonneville Dam	Percentage Requiring Bridge Opening
2000	65	3,021	2.2
2001	209	3,092	6.8
2002	78	2,644	3.0
2003	57	2,631	2.2
2004	19	2,601	0.7
2005	22	2,664	0.8
2006	125	2,610	4.8
2007	47	2,813	1.7
2008	107	2,416	4.4
2009	86	2,054	4.2
2010	90	2,287	3.9
2011	210	2,317	9.1
Average	**93**	**2,596**	**3.6**

Source: I-5 Bridge Tender Logs as categorized by the project team; U.S. Army Corps of Engineers Waterborne Commerce Statistics.

Sailboats

The Oregon State Marine Board undertakes a survey of boating activities approximately every three years, which provides information on boating activity by Oregon residents by body of water and by county.

For the four most recent surveys (2001, 2005, 2007 and 2011), there were an average of 188,109 activity days by recreational boats of all types on the Columbia River in Multnomah County (see Exhibit 6.1-4). Activity by sailboat operators averaged 19,760 days or approximately 10.5 percent of all boating activity in this area. Non-sailboat activities include power boats used for cruising, fishing, water-skiing and other activities.

During the four years of the survey, there was an annual average of 71 bridge openings for sailboats. This amounts to 0.04 percent of all recreational boating days and 0.36 percent of sailboat activity days. This indicates that most sailboats either do not require a bridge opening or avoid bridge openings.

Exhibit 6.1-4. Bridge Openings for Recreational Boats as a Share of Total Activity

		# of Activity Days on Columbia River in Multnomah County		Percentage of Activity Days requiring Bridge Opening	
Year	**Bridge Openings**	**All Boats***	**Sailboats**	**All Boats[a]**	**Sailboats**
2001	60	215,198	13,361	0.03	0.45
2005	31	202,433	28,302	0.02	0.11
2007	44	197,956	16,730	0.02	0.26
2011	147	136,851	20,288	0.11	0.72
Average	**71**	**188,109**	**19,670**	**0.04**	**0.36**

Source: I-5 Bridge Tender Logs as categorized by the project team; Triennial Survey by the Oregon State Marine Board, Registered and documented vessels from the Oregon State Marine Board and from the Washington State Department of Licensing and the U.S. Coast Guard.

a Includes motorboats and sailboats.

6.2 River User Data

6.2.1 Introduction

Known Columbia River users who transit under the I-5 bridges were contacted and asked about the navigation and dimensional characteristics of their vessels, equipment, or fabrications. Additional users were sought through placement of announcements in the USCG *Local Notice to Mariners* and numerous publications. Target mailings were sent out. Of particular interest were the height, breadth, and air gap (clearance) requirements to pass underneath a bridge. All of the information received was self-reported. Some of the taller vessel air drafts were then verified by measuring their heights with surveying equipment. This section documents the methodology and findings of the Columbia River system user survey.

6.2.2 Summary

The main channel was identified as being the primary route of transit for the majority of the respondents. Very few respondents provided information on Oregon Slough transits due to the existing height limitations of that route.

Commercial tugs and tows have the greatest frequency of usage on the river and transit year round. Air drafts for tugs and tows ranged from 28 to 61 feet, with an average air draft of 49 feet.

Recreational sailboats and powerboats typically use the river more frequently between April and October. The sailboats ranged in air draft from 50 to 90 feet, with an average of approximately 70 feet. The powerboats ranged from 20 to 25 feet of air draft and were the only users that reported transiting the Oregon Slough.

Marine contractors reported they use the river on an as-needed basis year round. Air drafts ranged from 20 feet to 131 feet (excluding two Manson Construction cranes that are not expected to work on the Columbia River). The Port of Portland's *Dredge Oregon* has an air draft of 103 feet.

The federal government users include USACE Hopper *Dredge Yaquina* with an air draft of 92 feet and Puget Sound Naval Shipyard nuclear transporters that include barges and escorts. The largest transport barge is *Barge 40* with an air draft of 51.25 feet, and the largest escort is the *YTT 10 Battle Point* with an air draft of 74 feet.

Marine industries and fabricators ship products or have vessels transiting under the I-5 bridges on an as-needed basis all months of the year. The air drafts ranged from 60 feet to 141 feet.

Passenger cruise vessels transit the river year round, but more frequently in the summer months. The upriver motor vessels have air drafts that range from 42 to 65 feet. The Grays Harbor Historical Seaport Authority has two sailing vessels with air drafts of 74 and 85 feet that take passengers upstream typically once in May and June, and twice in October. However in 2012 the vessels are not anticipated to transit up the Columbia River.

Most air gap (clearance) requested by users ranged from 1 foot to 10 feet. A few users desired larger air gaps up to 20 feet. These air gaps are in addition to the air draft.

Summary tables, sorted by group, listing vessel owner, vessel name, vessel type, length overall, beam, draft, air draft, and frequency of passage, as well as additional information on existing users, are included in Appendices B, C and J.

6.2.3 Methodology

The CRC project team initially obtained navigation information from 34 users (see Exhibit 6.2-1).

Exhibit 6.2-1. Initially Identified Users

Advanced American Construction	Marine Resources
American West Steamboat Company	Mark Marine Service, Inc.
Bergerson Construction Inc.	Nuclear transporters (U.S. Navy escorts Puget Sound)
Bernert Barge Lines	Oregon Ironworks, Inc.
Cruise West	Oregon Ports Association
Christensen Shipyards Ltd.	Portland Yacht Club
Diversified Marine, Inc.	Port of Portland
Dutra Group	Riverlines
Farwest Steel	Rose City Yacht Club
Foss Maritime	Schnitzer Steel Industries, Inc.
General Construction Company	Schooner Creek Boat Works
Glacier Bay	Shaver Transportation Company
Hickey Marine Enterprises	Sundial Marine
J.E. McAmis	Thompson Metal Fab Inc.
Kiewit Pacific	Tidewater
Linblad Expeditions, Inc.	USACE
Manson Construction Group	USI

User contact information was updated from previously supplied data or from telephone book and Internet searches. Users were called and face-to-face interviews were scheduled. If the user preferred, the interview was conducted by telephone. Users located outside of the Portland and Seattle metro areas were interviewed by telephone and email.

The following six users from the initial list are no longer in business: Sundial Marine, USI, Riverlines, Glacier Bay, American West Steamboat Company, and Cruise West. Farwest Steel stated that they do not send their products on barges or ships on the Columbia River or Oregon Slough (North Portland Harbor). The Oregon Ports Association recommended contacting the ports individually. Input from the ports is summarized at the end of Section 6.2.4.

Discussions with known users identified other users not included in the initial list. These additional users are listed in Exhibit 6.2-2.

Exhibit 6.2-2. Additional Users

American Cruise Lines	JT Marine, Inc.
American Safari Cruises/InnerSea Discoveries	Knife River Northwest
American Waterways Inc.	Legendary Yachts, Inc.
CalPortland Company	Ross Island Sand and Gravel
Columbia Grain	SDS Lumber Company
Crowley Maritime Corporation	Tongue Point Job Corps Center
Greenberry Industrial	

In addition, mailings requesting navigation user information were sent to owners having vessels longer than 45 feet and registered either in Multnomah County (with the Oregon State Marine Board) or Clark and Skamania Counties (with the Washington Department of Licensing). The project team mailed 71 letters to Oregon-registered vessels and 78 letters to Washington-registered vessels. Public notices requesting navigation user information were published in various newspapers and listed in the USCG *Local Notice to Mariners*. In addition, 55 letters were mailed to members of the Pacific Northwest Steel Fabricators Association, and 51 letters were mailed to riverfront industrial property owners in the Columbia Industrial Park in Clark County, Washington, and Multnomah County, Oregon, located upstream of the I-5 bridges. The publications that posted the notice include the following:

Exhibit 6.2-3 Publications Posting USCG Notice

Oregonian	published on Feb. 8, 2012
Columbian	published on Feb. 8, 2012
DJC Oregon	published on Feb. 8, 2012
DJC Seattle	published on Feb. 8, 2012
Daily Astorian	published on Feb. 8, 2012
Longview Daily News	published on Feb. 8, 2012
St. Helens Chronicle	published on Feb. 8, 2012
Camas-Washougal Post-Record	published on Feb. 8, 2012

The Dalles Chronicle	published on Feb. 8, 2012
Hermiston Herald	published on Feb. 8, 2012
Tri-City Herald	published on Feb. 8, 2012
Walla Walla Union Bulletin	published on Feb. 8, 2012
Lewiston Morning Tribune	published on Feb. 8, 2012
Pacific Northwest Waterways Association[14]	online Feb. 8, 2012
Merchants Exchange newsletter[15]	published on Feb. 14, 2012
Columbia River Crossing Website[16]	started on Feb. 3, 2012

The CRC website also included the notice. Sixteen users responded.

A River User Data Sheet was provided to users in order to solicit the requested information. The following user information was requested:

- Company and/or owner of vessel and contact information
- Vessel name
- Vessel type
- USCG Document Number
- Length overall in feet
- Beam (width) in feet
- Draft (depth of hull below waterline, fully laden) in feet
- Air draft (height of the highest fixed point above the waterline, unladen) in feet
- Air gap for vessel (desired clearance from the highest fixed point on the vessel to lowest part of the bridge) in feet
- Frequency of passage underneath the I-5 bridges in the main channel
- Frequency of passage through North Portland Harbor (Oregon Slough)
- Time of year of passage
- Business plan regarding vessels transiting under the I-5 bridges or into Oregon Slough (e.g., 10-year or 20-year plan)

Exhibits 6.2-4 through 6.2-9 depict the vertical reference descriptions identified above.

[14] http://www.pnwa.net/new/aboutPNWA.aspx
[15] http://www.pdxmex.com/media/MEX/Newsletter/Fall2011Newsletter.pdf
[16] http://www.columbiarivercrossing.com/ProjectInformation/CurrentWork/Fieldwork.aspx

Exhibit 6.2-4. Vertical Reference Diagram – Tugs and Tows

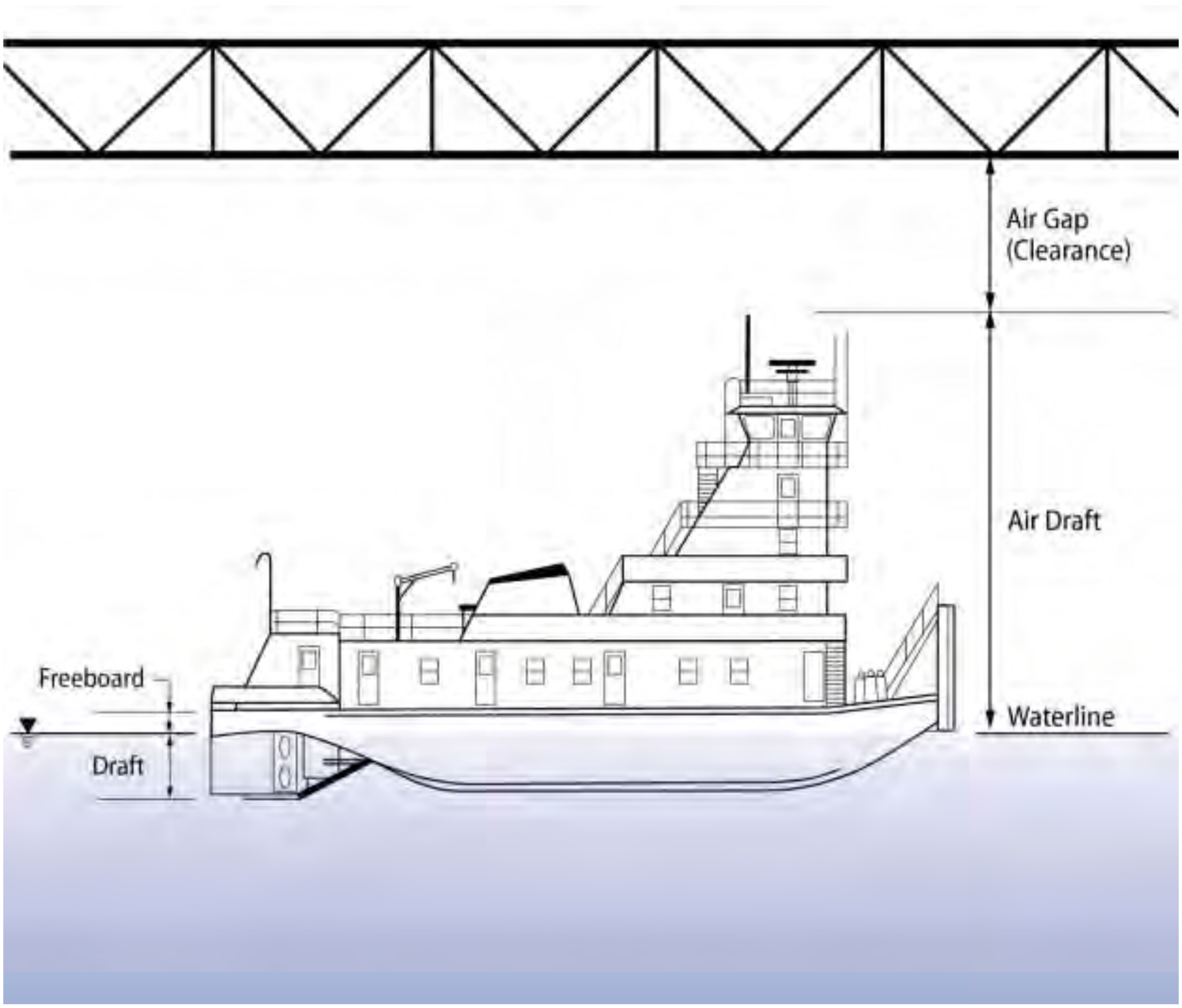


Exhibit 6.2-5. Vertical Reference Diagram – Sailboats

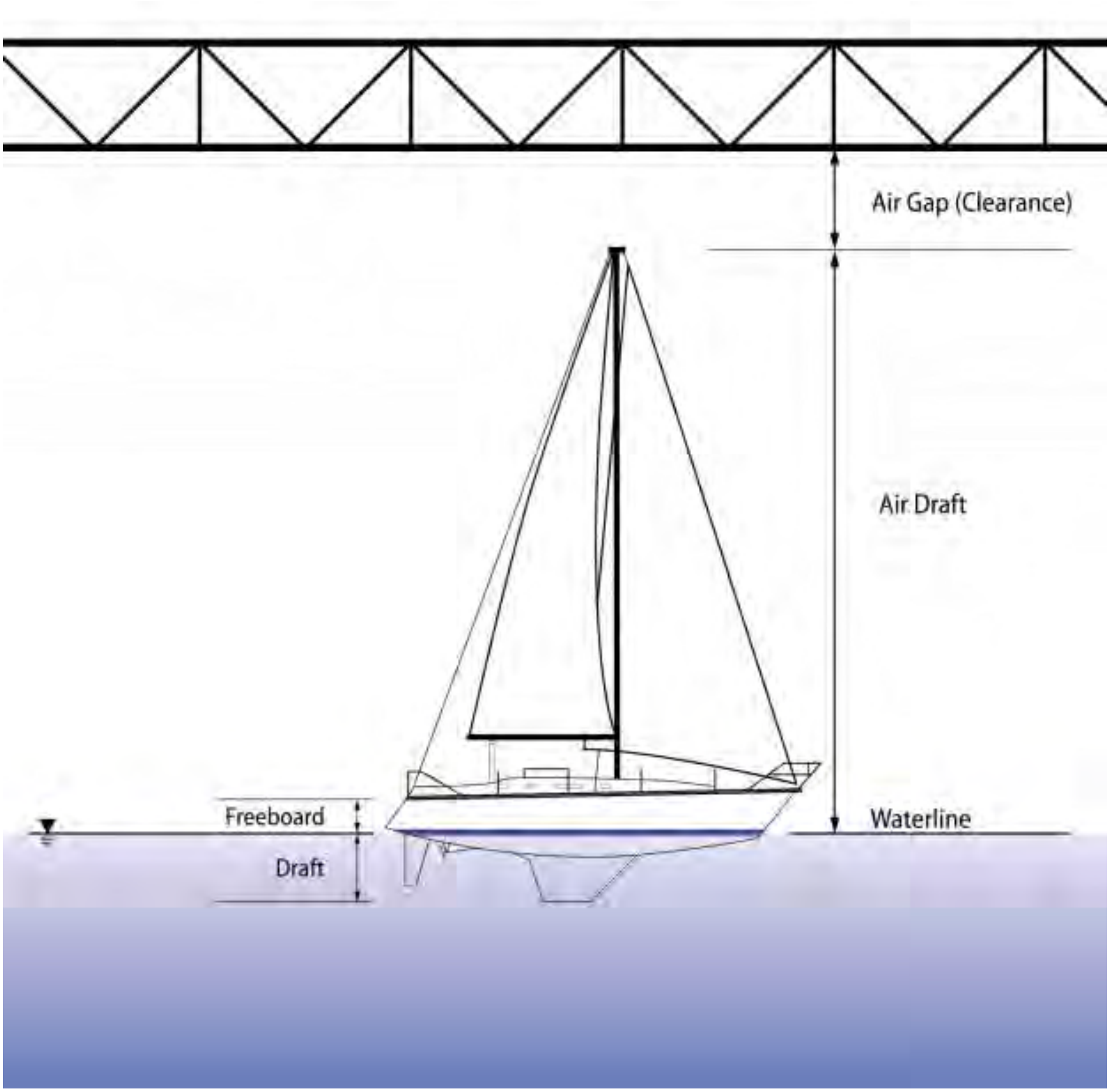


Exhibit 6.2-6. Vertical Reference Diagram – Crane Barge

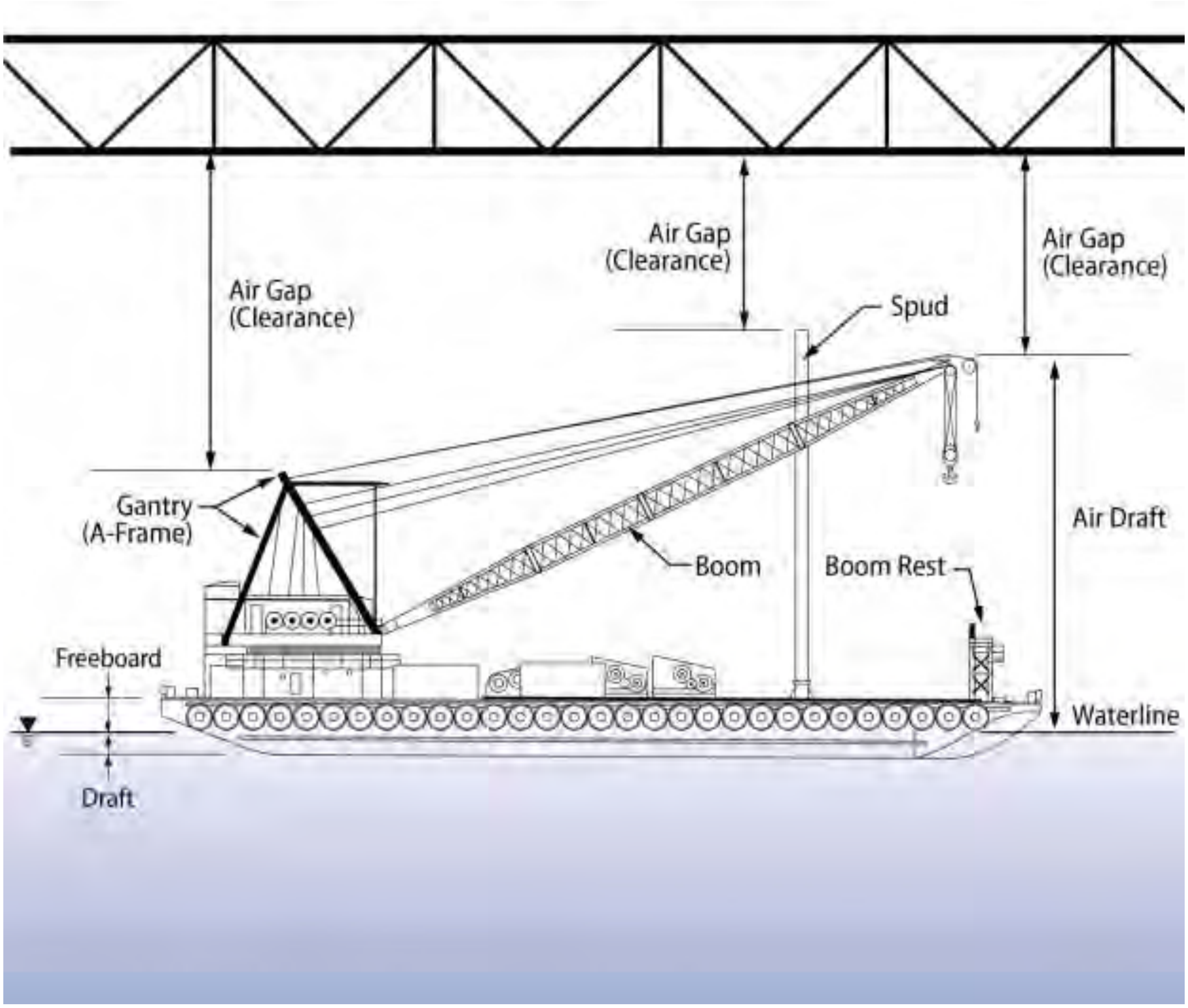


Exhibit 6.2-7. Vertical Reference Diagram – Cutter Suction Dredge

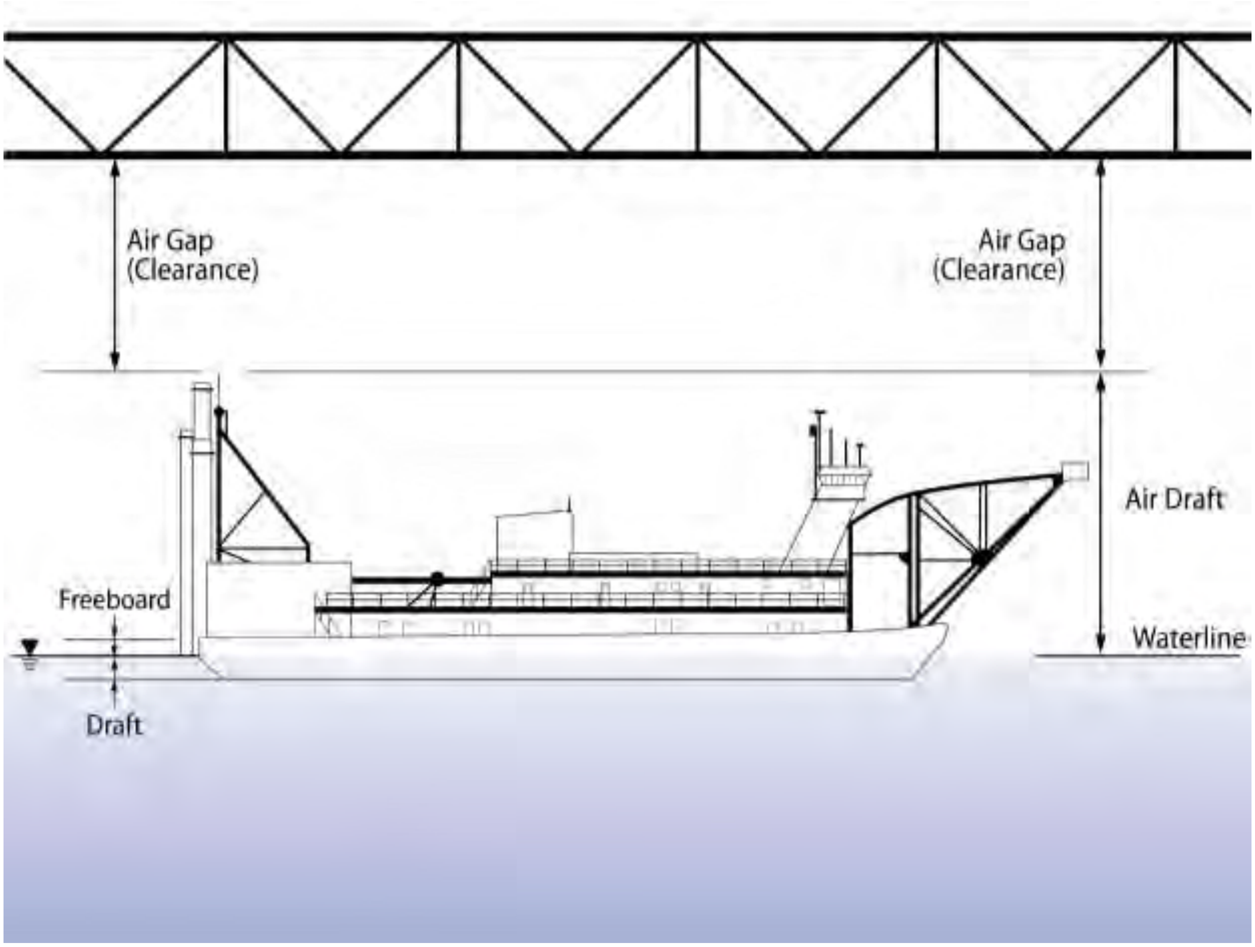


Exhibit 6.2-8. Vertical Reference Diagram – Hopper Dredge

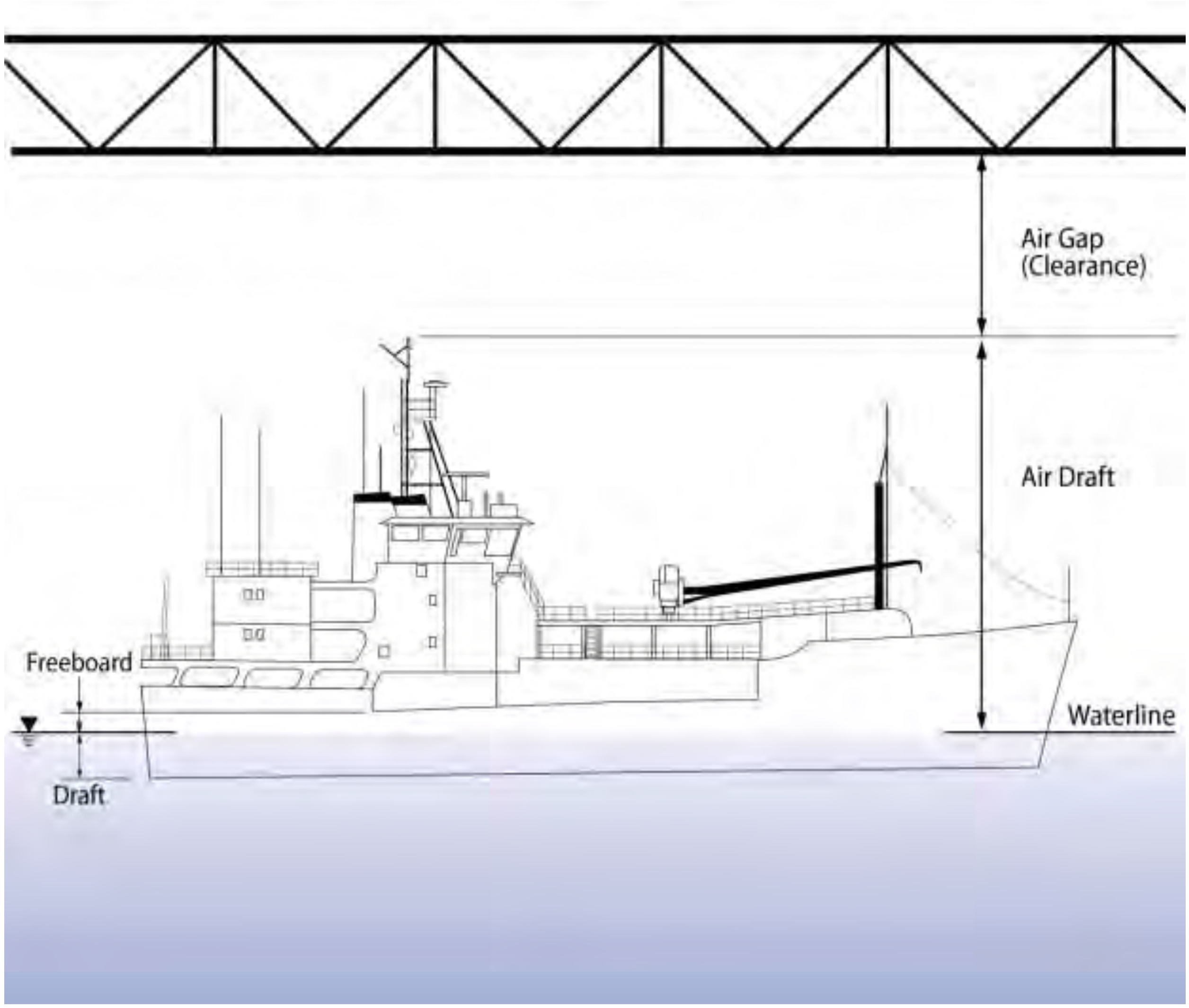
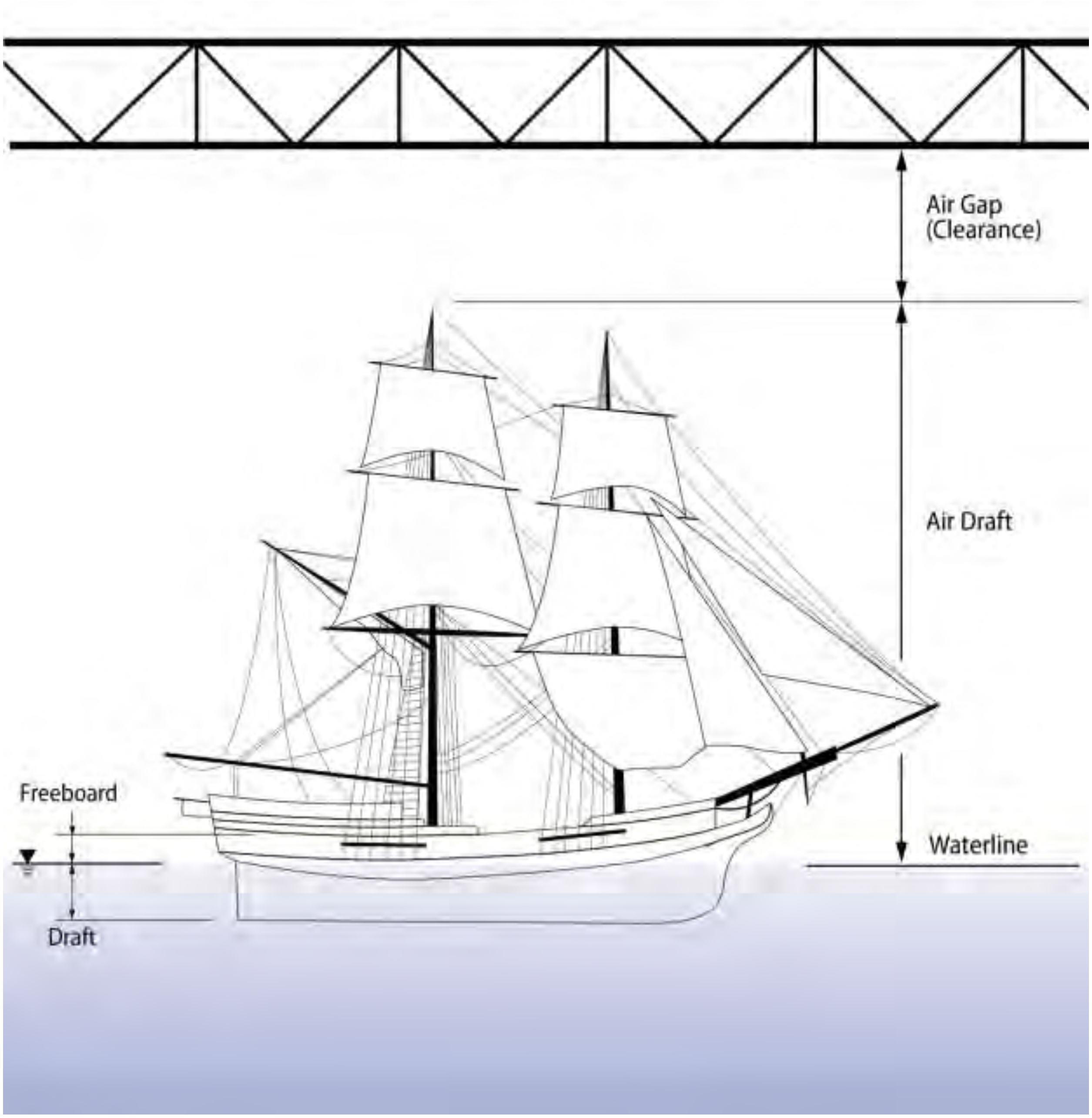


Exhibit 6.2-9. Vertical Reference Diagram – Passenger Cruise Sailboat



Face-to-face interviews were recorded when possible and when permission was granted by the user. Completed user data sheets and additional information provided by the users are included in Appendices B and C.

6.2.4 User Data

The users were divided into the following groups:

- Commercial tugs and tows
- Recreational sailboats and powerboats
- Marine contractors
- Federal government
- Marine industries
- Passenger cruise
- Other

Data was collected on anticipated future vessels and is reported in Section 7.4. When possible, vessels with a reported air draft greater than 68 feet were physically surveyed to verify heights. Data on smaller vessels and vessels that could not be surveyed came from information supplied by the vessel owners. Survey and owner-supplied data is included in Appendices B and C. Unless otherwise noted, vessel related air drafts or heights are expressed relative to zero CRD.

Commercial Tugs and Tows

This group consists of tugboats and towboats that handle commercial barges. Most of the barges carry cargo (such as grain from upriver ports) downstream to lower Columbia River ports. Some of the tugs move barges loaded with cargo from fabricators. (The air drafts of the fabricator tows are listed in the marine industries and fabricators group.) Air drafts for tugboats and towboats are presented in Exhibit 6.2-11 at the end of this chapter. The following is a list of users in the commercial tug and tow group:

- Bernert Barge Lines Inc. is a family-owned business that has been on the Columbia River system since the 1870s. It owns three towing vessels named *Kathryn B*, *Lori B*, and *Mary B*. The largest air draft for these vessels is 52 feet. The vessels average about four to seven trips per month on the Columbia River main channel under the I-5 bridges and do not transit under the North Portland Harbor Bridge; a 5-foot air gap (clearance) is preferred.
- Columbia Grain stated that none of its vessels transits up the Columbia River beyond the I-5 bridges. Its vessels may anchor in Vancouver, toward Kalama, or stay at Astoria, Oregon.
- Crowley Maritime Corporation stated that its vessels typically do not transit under the I-5 bridges, so no additional information was provided.
- Foss/Marine Resources Group primarily performs harbor-assist work and does not usually transit upriver of the I-5 bridges. In the past, it has conducted special project work above the I-5 bridges into the upper Columbia and Snake Rivers. It has moved barges with equipment—the height of some was no higher than the lowest fixed

bridge in the upper river system. It has also transported equipment/fabrications on barges from Vancouver (Columbia) Industrial Park where the full lift of the I-5 bridges was used. Tugs from Foss include: *Betsy-L*, *Daniel Foss*, *Halle Foss*, *Pacific Escort*, *Pacific Explorer*, and *PJ Brix*. The tallest of these vessels is the *Pacific Explorer* with an air draft of 61 feet.

- Schnitzer Steel owns two vessels—*MAX 111* (flat deck barge with bin walls) and *CHIPPY 002* (flat deck barge with bin walls)—and uses a third—*Inland Conveyor* (flat deck self-unloading barge with bin walls)—which is owned by Cemex and chartered to Bernert Barge Lines. Schnitzer Steel uses Bernert Barge Lines as its tug company. The information provided by Bernert Barge Lines for air draft and air gap would apply to Schnitzer Steel since none of the Schnitzer Steel vessels is taller than the tugs. The vessels average two trips in March and four trips per month during all other months of the year.
- SDS Lumber Company manufactures lumber, plywood, power, and pulp and is located in Bingen, Washington. The company also offers tug and barge services. SDS Lumber's largest vessel is the tugboat *Dauby* with an air draft of 55 feet and a preferred air gap of 10 feet. They also have a barge that may have equipment loaded on it with an air draft of up to 100 feet. They make about ten trips a month all year.
- Shaver has six tug boats that may require bridge lifts: *Cascades* (push knee), *Clearwater* (push knee), *Deschutes* (tractor tug), *Lassen* (harbor), *Umatilla* (push knee), and *Willamette* (tractor tug). The vessels typically have an air draft of 51 feet and an air gap of 1 foot is preferred. All of the tugboats combined pass under the I-5 bridges approximately 20 times a month all year. Lifts are requested for around 10 percent of the tug boats' trips because they use the high span.
- Tidewater has 16 tug boats. The tallest vessel is the *Outlaw* at 53 feet. A 2-foot air gap is requested. The masts extend beyond the highest fixed point but are easily lowered. The line boats average 22 round trips per year in the main channel under the I-5 bridges. The busiest season for most boats is August to October, which is harvest season. The boats do not pass under the I-5 bridges to access the Oregon Slough. Tugs from Tidewater include: *Betty Lou*, *Captain Bob*, *Challenger*, *Clarkston*, *Defiance*, *Hurricane*, *Invader*, *Legend*, *Mary Gail*, *Liberty*, *Maverick*, *Outlaw*, *Rebel*, *Sundial*, *The Chief*, and *Tidewater*.

Recreational Sailboats and Powerboats

There are numerous recreational and small boat moorages located between I-5 and I-205. Most of the moorages are located on Hayden Island and along the shores of north Portland. The tallest vessels in this group are the sailboats. In addition to mail-in responses from users, two yacht clubs were interviewed to solicit vessel information. Air drafts for these vessels are presented in Exhibit 6.2-12 at the end of this chapter.

Fourteen of Portland Yacht Club's largest sailboats were surveyed. The tallest has an air draft of 74 feet. A majority of its members sail during the summer months, usually beginning the first weekend in May. It was reported that each boat will typically make 15 to 20 trips under the I-5 bridges every year. The Portland Yacht Club members do not travel down the Oregon Slough. The following vessels were surveyed:

Exhibit 6.2-10. Surveyed Vessels

Vessel name (location surveyed)	Height (Feet above waterline) Mast	Height (Feet above waterline) Mast with Antenna
Camelot (Portland Yacht Club)	59	62
Galatea (Portland Yacht Club)	59	61
Halsey (Portland Yacht Club)	63	66
High Flight (Portland Yacht Club)	49	51
Luscious (Portland Yacht Club)	62	65
Moondance (Portland Yacht Club)	56	59
Runaway (Portland Yacht Club)	67	70
Rya (Port Angeles, Washington)	62	66
Saphira (Portland Yacht Club)	51	54
Sargasso (Portland Yacht Club)	62	65
Sovereign (Portland Yacht Club)	56	58
Sylvia (Portland Yacht Club)	56	58
Tropicale (Portland Yacht Club)	58	61
Whisper (Portland Yacht Club)	72	74

Rose City Yacht Club provided vessel information for four of the club's largest sailboats: *Crystal Swan, Down Wind Drift, Draco,* and *Morgan Le Fay*. The tallest, *Crystal Swan*, has an air draft of approximately 63 feet. Roughly a third of its members require 50 to 55 feet of air draft. Rose City Yacht Club members typically make around three to four trips under the I-5 bridges a year.

- Mail-in responses from individuals included vessels whose air drafts ranged from 20 to 71 feet. Most of the recreational craft typically use the river from April through October. Two of the vessels were surveyed. The *Wakadui* was surveyed at Salpare Bay Marina, Portland, with a mast height of 63 feet with an additional 3 feet of antennae for a total height of 66 feet. The *Nancy Riley* was surveyed at the Portland Yacht Club and its mast was measured at 68 feet; equipment at the top of the mast adds another 3 feet to the height for a total of 71 feet.
- The owner of Legendary Yachts Inc. has a sailboat named *Radiance* that is homeported in Vancouver, Washington. It is the largest air draft to date that the company has built with an air draft of 85 feet (surveyed). It transits under the I-5 bridges approximately two times a month from July through September. They prefer an air gap of 3 feet.
- The owner of Schooner Creek Boat Works has a sailboat named *Rage* with an air draft of 80 feet (surveyed). A 5-foot air gap is preferred. The owner reported sailing the vessel through the bridge's reach approximately four times a month from March through September. The owner also provided information on a future sailboat (see Section 7.4.2).
- The *Make It So* was measured at the Salpare Bay Marina with an air draft of 90 feet. No information about its ownership or frequency of passage is known.

Marine Contractors

Construction contractors occasionally need to transport vessels such as crane barges, clamshell dredges, cutter suction pipeline dredges, hopper dredges, or other marine construction equipment. The work is generally performed on an as-needed or contract basis, so transits tend to be sporadic and not entirely predictable. Air drafts for these vessels are presented in Exhibit 6.2-13 at the end of this chapter.

Marine contractors typically operate crane barges to conduct a wide range of water-related construction activities. These can range from dredging, to heavy lifts, to high lifts. The size of the work activity often dictates the minimum size crane barge that the contractor can use; however, larger ones may be utilized to do the work if the minimum size crane is not available or for other business reasons. The crane barges are non-motorized and are moved about with tugs or tows. They are kept stationary on job sites through the use of anchors or spuds. Spuds are often preferred because they limit the amount of barge movement once they are embedded into the sediment.

During travel, spuds are either raised to a level high enough that will prevent them from grounding during transit or they are removed and lashed to the deck. Crane barges already in the Columbia River prefer to travel with their spuds raised because this involves the least amount of work. Crane barges coming from the ocean have their spuds removed and lashed to the deck in order to maintain stability in heavy seas; they are installed once the barge arrives at the project site. Crane barges are unmanned during transit.

For many vessels, the spuds are the highest points of the vessel if left raised during transit. If the spuds are removed and placed on deck during transit, and the crane boom can be and is lowered to the pedestal or deck, the gantry (A-frame) is the highest point. Some crane barges cannot lower their booms below the gantry and for these users, the tip of the boom at the lowest configuration is the highest point on the vessel.

While not truly a marine contractor, the Port of Portland’s cutter suction pipeline dredge *Oregon* is included in this group for convenience.

Advanced American Construction (AAC, previously known as Advanced American Diving) provided vessel information for one of its tugs and five crane barges. The AAC facility is located immediately downriver of the St. John’s Bridge on the south side of the Willamette River. For AAC’s vessels, the raised spuds during transit result in the highest part of the vessels. The *DB 4100* has the tallest spud height at 92 feet above water level (air draft) and their preferred minimum air gap is 10 feet. The minimum crane gantry height for the *DB 4100* is 35 feet. The minimum crane gantry height of the *DB 125* is 51 feet. The vessels travel a couple of times a month up and down the Columbia River all year. The following dimensions were reported by AAC.

DB 125	Spuds: 78 feet	Gantry: 51 feet
DB 4000	Spuds: 79.5 feet	Gantry: 35 feet
DB 4041	Spuds: 71 feet	Gantry: 35 feet
DB 4100	Spuds: 92 feet	Gantry: 35 feet
Paul Bunyan	Spuds: 78 feet	Deck: 7 feet

Note that the *DB 125* is a fixed crane on a spud barge. The *Paul Bunyan* is a spud barge. All of the others are portable cranes on spud barges. The tug boat, the *Linde Marie*, has an air draft of 35 feet.

Bergerson Construction is based in Astoria, Oregon, and has five vessels: two tug boats, one sectional barge and one crane barge. The tug boats, *Darryl B* and *Olaf J*, have air drafts of 20 and 35 feet, respectively. During transit the raised spuds are the highest part of the crane barges. Its vessels have air drafts that range from 40 to 150 feet; however, if they lower their cranes to the minimum height, the required air draft is only 78 feet on the tallest vessel. The vessels transit the river as required when contracts are awarded. The following are measured dimensions (heights) for their crane barges:

Carr Barge	Spuds: 78 feet	Crane lowered: 52 feet

Note that the *Sectional Barge* was unavailable for survey but has a reported air draft of 70 feet.

CalPortland Company has a tugboat, *Johnny Peterson*, and a dredge, *Sanderling*, with an air draft of 32 feet each and a preferred air gap of at least 4 feet. The tugboat and dredge transit through the I-5 reach approximately eight times a month all year.

Diversified Marine's facility is located in North Portland Harbor just downstream of the I-5 bridges. Diversified Marine has 13 barges and tugs. They operate three derrick barges: *DB Freedom*, *DB Lucy* and *DB Vulcan*. The *DB Freedom* and the *DB Lucy* are fitted with 85-foot spuds (above waterline), while the *DB Vulcan* does not have spuds. Diversified Marine also operates three spud barges: *BRG22, BMC44,* and *DMI 60*; spud heights were measured on these barges. The crane height, boom length, and pivot height were measured on the *DB Freedom* and the *DB Vulcan*. The boom was lowered on the *DB Vulcan* for traveling and was also measured. The height of the crane lowered was computed for the *DB Freedom* and the *DB Lucy* based on a traveling angle of 34 degrees from horizontal. The tallest vessel is the *DB Freedom* which requires a 119-foot air draft and a preferred air gap clearance of ten feet. Transit frequency varies greatly depending on workflow. Travel on the Columbia River is completely dependent on what jobs they are contracted to work on; consequently, approximately one trip a month all year is estimated for each vessel. The following are dimensions for the larger vessels:

BMC44	*Spuds: 78 feet*	
BRG22	Spuds: 58 feet	
DB Freedom	Spuds: 85 feet	Crane Lowered: 119 feet
DB Lucy	Spuds: 85 feet	Crane Lowered: 73 feet
DB Vulcan	Spuds: N/A	Crane lowered: 89 feet
DMI 60	Spuds: 84 feet	

Diversified Marine's tugboats, *Cougar*, *Mariner,* and *Tiger* have air drafts of 50, 45, and 38 feet, respectively. The other barges, *DMI 100* and *DMI 50*, have reported air drafts of 60 feet each. No height data was provided on the *DMI 40* work barge or the *MV Sandwick* utility landing craft.

The Dutra Group is located in San Rafael, California. They have two crane barges that have the potential to work in the Columbia River and transit under the I-5 bridges. These crane barges are the *Paula Lee* and the *Derrick 24* (same name as Manson Construction's crane barge). Neither was surveyed as they are both working in Southern California. Vessel drawings may be available, but they have not yet been obtained. Crane barge information as relayed by Dutra

Group is below. The highest point of these crane barges during transit is the A-frame. The A-frame height above the waterline assumes that the freeboard is half the given hull height. This is halfway between the light- and full-loaded draft. The following are dimensions for the *Derrick 24* and *Paula Lee*:

Derrick 24	Hull height: 13 feet	A-Frame: 67 feet 4 inches
Paula Lee	Hull height: 15 feet	A-frame: 77 feet 6 inches

General Construction is a division of Kiewit that operates the majority of Kiewit's marine vessels and marine equipment. These include floating cranes, dump barges, flat deck barges, spud barges, and sectional barges.

The largest floating crane owned by General Construction Co. is the *DB General*, which has an air draft of 93 feet and was used to take the crane off of the *Davy Crocket* many years ago. It has also had some pickups at Thompson Metal Fabrication. There is no record of any transit up the Oregon Slough. An air gap of 5 to 10 feet is desired for all equipment. The *DB General* cannot go any farther up the river than the Bonneville Dam. Other marine barges have gone up the river as far as Lewiston, Idaho.

All floating crane barges have an optimal angle for the crane boom to be positioned in order to be safely towed. This is for stability purposes, particularly when transiting along the coast. For the *DB General*, if the crane is too tall to pass under a bridge when positioned at the optimal angle for towing, the barge will moor at the shore near the bridge, bring a crew on board to lower the crane (the barge is towed unmanned), take the crew off while the barge is towed under the bridge, and then reverse the procedure. For the *DB General*, this lowered height is 93 feet above the waterline. The following are reported dimensions for the larger vessels:

DB Alameda	Gantry: 71 feet 2 inches	
DB General	Gantry: 93 feet	
DB Oakland	Gantry: 78 feet 10 inches	
DB Olympia	Gantry: 70 feet 2 inches	
DB Pacific	Gantry: 83 feet	Antenna: 86 feet 5 inches
DB Seattle	Gantry: 75 ft 6 in	Antenna: 85 ft 11 inches

General Construction's reported that their other barges would not be put into service on the Columbia River system.

Hickey Marine Enterprises is located in Vancouver, Washington, downstream of the I-5 bridges and has four derrick crane barges. These crane barges are the *Sea Hawk*, *Sea Horse*, *Sea Lion*, and Sea *Vulture*. All were surveyed; however, booms for the *Sea Lion* and Sea *Vulture* were not in the lowest position possible for transit; and the spuds on the *Sea Lion* were not in their raised position. Each of these crane barges uses spuds to maintain position. The largest is the *Sea Horse*, which has a gantry height of 73 feet and a spud height of 88 feet. A 10-foot air gap is preferred and a 100-foot total clearance (air draft plus air gap) is typically requested when transiting under a bridge. Depending on the draft, the barges can often "sneak" under the high span of the existing I-5 bridges rather than use the lift span. The gantry height is fixed and is not adjustable. Spuds are usually not lowered, but can be if the draft is adequate. Lowering the spuds introduces a risk of losing or bending them. Trips primarily occur between October and March during the in-water work window. Most work is in the Willamette River, but there is also work on the Columbia, Willamette, and Snake Rivers. The company estimates that its barges go upstream approximately six times per year. The following are surveyed dimensions for the vessels:

Sea Hawk	Spuds: 75 feet	Gantry: 28 feet
Sea Horse	Spuds: 88 feet	Gantry: 73 feet
Sea Lion	Spuds: 75 feet (self-reported)	Gantry: 34 feet
Sea Vulture	Spuds: 75 feet	Gantry: 43 feet

J.E. McAmis is a marine construction company based in Chico, California. J.E. McAmis has one spud barge (*Heidi Renee*, currently located in Astoria, Oregon) and two dump scows (*Swan Island* and *Sand Island*). The dump scows have air drafts of 16 feet each. The surveyed air draft for the *Heidi Renee* with the spuds up is 81 feet, and a 10-foot air gap is preferred. With the spuds removed, the air draft of the barge is approximately 12 feet. The company transits the river as required when contracts are awarded.

JT Marine is a marine construction company located in the Columbia Business Center (CBC) in Vancouver, Washington. Its tugboats, *Cristy T* and *Stacy T*, have heights of 50 and 55 feet respectively. Its larger vessels include the crane barge *DB Taylor* with an air draft of 131 feet and the crane barge *DB Astoria* with an air draft of 80 feet. Surveyed dimensions for these two vessels are as follows:

DB Astoria	Spuds: 80 feet	Gantry: 36.5 feet
DB Taylor (160 ft boom)	Spuds: 80 feet	Gantry: 51 feet
DB Taylor (220 ft boom)	Spuds: 80 feet	Boom lowered: 131 feet

The company also owns two tugboats, the *Christy T* with an air draft of 50 feet and the *Stacy T* with an air draft of 55 feet, and a dry dock with an air draft of approximately 40 feet. They prefer an air gap of 10 feet. Their vessels transit the area approximately 10 times a month all year.

Knife River has one deck barge with an air draft of 48.5 feet; a 5- foot air gap is preferred. The company transits the area approximately 4 to 18 times a month all year.

Manson Construction is a marine contractor with headquarters in the Seattle, Washington, area. While they have a number of crane barges, only two have been identified as possibly being used in the Columbia River: the *Derrick 24* and the *Haakon*. The *Derrick 24* is working on the SR 520 Bridge replacement project in Lake Washington, Washington, and the *Haakon* is in the Gulf of Mexico. Drawings are available for both crane barges, so no surveys were made. Like the General Construction crane barges, transit heights for these vessels are limited by the gantry heights. The *Derrick 24* has not been in the Columbia River system in at least 10 years; however, it would go into the river if contracted to do so. Larger crane barges include the *E.P. Paup* (132 feet) and *Wotan* (109.5 feet); however, these rigs are located in the Gulf of Mexico and Mississippi River, respectively, and have never been in the Columbia River. The following are dimensions for the *Derrick 24* and the *Haakon*:

Derrick 24	Gantry: 98 feet 7 inches
Haakon	Gantry: 84 feet

Mark Marine Service is a family business that has been operating since the 1950s and is located in Camas, Washington. The company primarily performs pile-driving work on smaller projects.

They have four crane barges: *DB Columbia*, *DB Camas*, *Amazon*, and *Barge #7*. The *Amazon* is currently retired and *Barge #7* is under construction (see Section 7.4). The *DB Camas,* at the time of this report, was working on a job site in Scappoose, Oregon, and was not available for surveying. The *DB Columbia* was surveyed. Mark Marine also provided data on two towboats, *Patricia* and *Umatilla*, which have heights of 48 and 50 feet, respectively. Typically, two boats accompany one crane. Its largest crane barge, *DB Camas*, has a spud height (air draft) of 75 feet, and at least a 10-foot air gap is preferred. Spuds are often lowered (almost always going upstream), and it is not a big effort to do so. The company's busiest season is usually November through February because of the in-water work window. For the main channel passing under the I-5 bridges, the company averages one round trip per month among its three crane barges. It is estimated that each of its vessels makes one round trip per year to the Oregon Slough, but the vessels go downstream in the main channel under the I-5 bridges and then up into the Oregon Slough (not passing under I-5). The following are dimensions for the *DB Columbia* and *DB Camas*:

DB Columbia	Spuds: 66 feet	Crane lowered: 45 feet
DB Camas	Spuds: 75 feet (self-reported)	Gantry: N/A

Port of Portland owns and operates the cutter suction hydraulic pipeline *Dredge Oregon*. The dredge was surveyed and has a minimum air draft of 103 feet with the spuds fully raised. The dredge captain desires an air gap of at least 2 feet. The *Dredge Oregon* has traveled upstream approximately six times in the last 30 years.

Ross Island Sand and Gravel is a marine construction company based in Portland, Oregon. They operate two cutter suction hydraulic dredges (*Dredge #7* and *Dredge #8*) and two crane barges (*Dredge #6* and *Dredge #9*). *Dredge #8* is currently working in Stockton, California, and will be there for the foreseeable future. It is currently fitted with 80-foot spuds that when fully raised have approximately 3 feet below the water line thus yielding a 77 foot-air draft. *Dredge #7* is currently working in Willapa Bay, Washington, and has spuds similar to *Dredge #8*; however, the spuds are removed at this time to enable the dredge to work in a wave environment with anchors. *Dredge #6* and *Dredge #9* at the time of this report were working in Ross Island Lagoon in Portland, Oregon, and were not available for surveying. *Dredge #6* has 80-foot spuds (air draft of approximately 77 feet) and *Dredge #9* has shorter spuds, but will be fitted with 80-foot spuds in the near future (air draft of approximately 77 feet). Approximately six passages a year are made under the I-5 bridges for each of the vessels, January through June. The following are dimensions for the dredges:

Dredge #6	Spuds: 77 feet	Gantry: 35 feet
Dredge #7	Spuds: 77 feet	Gantry: 40 feet
Dredge #8	Spuds: 77 feet	Gantry: N/A
Dredge #9	Spuds: 77 feet	Gantry: 35 feet

Federal Government

The U.S. Navy Puget Sound Naval Shipyard (U.S. Navy PSNS) and Intermediate Maintenance Facility in Bremerton, Washington, dismantles nuclear reactor compartments from deactivated nuclear submarines and cruisers. The nuclear reactor compartments are shipped by barge from Bremerton, down the Washington coast, then up the Columbia River to the Port of Benton where the nuclear reactor compartments are transferred to a large trailer for permanent disposal at the

U.S. Department of Energy Hanford Reservation approximately 7 miles from the Port of Benton. Air drafts for these vessels are presented in Exhibit 6.2-14 at the end of this chapter.

The U.S. Navy PSNS has been disposing of nuclear reactor compartments at Hanford since 1986. The compartments are welded to barges for transport, and the barges are towed with a commercial tugboat. A backup tug and a Navy or USCG escort vessel accompany each shipment.

The U.S. Navy deploys one of two escort vessels to accompany the shipment of nuclear reactor compartments as they travel from Bremerton to Hanford; an air gap of 15 feet is desired. The primary escort vessel is the *YP701 Liberty Bay* with an air draft of 47 feet. The *YP701 Liberty Bay* uses the alternate barge channel under the high span of the existing bridge or the lift span if the alternate barge channel is unusable or unavailable.

The largest escort vessel—the *YTT 10 Battle Point*—has an air draft of 74 feet and uses the lift span. The *YTT 10 Battle Point* is a torpedo trial/recovery craft stationed at the Naval Undersea Warfare Center Division at Keyport, Washington. One of many U.S. Navy support vessels, this is the largest that is used to assist in transporting barges to the Hanford Nuclear Reservation. Due to the location of the vessel within a secure facility, surveys were not allowed and no drawings are available, but information was obtained during telephone interviews. While the height of the *YTT 10 Battle Point* is reported to be 74 feet with the mast raised, the stepped-down mast height is only 58 feet.

The vessels transit down the coast from Puget Sound to the Columbia River. While in the ocean their mast is fully raised with the upper portion of the mast carrying the radar array. Once in the Columbia River, the vessels lower the upper mast in order to transit in a stepped-down position up the river and under the I-5 bridges.

The water depth at their dock in the east end of the McNary Pool determines the months in which they can travel upriver. During the spring runoff, the dock can be under several feet of water. So the time of year when the vessel transits upriver is determined by the flow (controlled by the USACE upstream dams) and the pool height.

U.S. Navy PSNS's shipping plan is based on the shipyard's long-range dry-dock schedule and ocean and river conditions. The number of shipments per year can vary. They currently average two per year and will increase to five per year in the near future. The number of shipments per year can range from one to 11. The time of year can also vary. Shipments typically occur during two seasons: mid-March through mid-April and September through October. The frequency of one-way passage under the I-5 bridges for a barge is currently twice per year laden and twice per year unladen (based upon two shipments per year) at some point during the two seasons. The barges currently use the alternate barge channel under the high span of the existing bridge. If this span is unusable, the lift span is used instead. U.S. Navy PSNS currently has four freight barges (*Barge 40*, *Barge 60*, *Beluga*, and *Edgecumbe*) with air drafts ranging from 42.5 to 51.25 feet. The U.S. Navy PSNS also provided information on two future barges (see Section 7.4).

The Tongue Point Job Corps Maritime Training Program utilizes the *M/V Ironwood* for training maritime students. The *M/V Ironwood* is a retired USCG buoy tender. The *M/V Ironwood* was surveyed and has an air draft of 77 feet and a preferred air gap of 6 feet. The Tongue Point Job Corps reported one trip per month from May through August.

USACE, Portland District conducts annual maintenance dredging from the I-5 bridges upstream to the Bonneville Dam. In 2011, approximately 100,000 cubic yards were dredged with the hopper dredge *Yaquina* from this reach of the Columbia River. The surveyed air draft of the *Yaquina* is 92 feet and an 8-foot air gap is preferred. The *Yaquina* used flowlane (in-water) disposal for the dredged material. USACE needs to have the capability to respond to emergency conditions, so the dredging could occur during any time of the year.

Marine Industries and Fabricators

The Columbia Business Center (CBC), located on the Washington side of the river near river mile 108, has a number of marine industry tenants. These include companies such as Greenberry Industrial, Oregon Ironworks, and Thompson Metal Fab. In addition, Christensen Shipyards LTD is located just upstream of CBC. These companies utilize waterfront access to ship construction equipment and large metal-manufactured products for heavy construction and maintenance, such as bridges, oil drilling rigs, and offshore facilities. Air drafts for these vessels are presented in Exhibit 6.2-15 at the end of this chapter.

Christensen Shipyards LTD builds luxury yachts and manufactures wind turbine components. The turbine components are 30 feet high and are transported via the road system. Christensen's yachts have an air draft of 60 feet, and at least a 5-foot air gap is requested. Christensen delivers approximately two completed yachts per year. During the construction, the yachts make about six round trips to the ocean and back, averaging about 12 passages under the I-5 bridges per year throughout the year. Christensen does not travel through the Oregon Slough. Christensen also provided information on future vessels planned for construction (see Section 7.4).

Greenberry Industrial has been located at CBC since November 2010. It fabricates various modules, structural steel, tanks, vessels, and pipe spools. A drill rig was shipped in 2011 that was also worked on by Thompson Metal Fab (see below). The air draft on that shipment was estimated by Thompson Metal Fab to be 133 to 141 feet. Greenberry also provided information on possible future shipments (see Section 7.4).

Legendary Yachts, Inc., is a builder of classic wooden yachts and is located in Washougal, Washington. Their services include boat building and repair. The owner has a sailboat named the *Radiance*, which is described in the section on recreational sailboats and powerboats. The boats they build typically range in air draft from 45 to 63 feet. They prefer an air gap clearance of 3 feet.

Oregon Ironworks is a heavy industrial fabricator with a facility located in the Columbia Industrial Park in Vancouver, Washington. They occasionally ship products by barge or ship from the site. They did not provide data on historical shipments, but did provide estimates on future shipments (see Section 7.4).

Schooner Creek Boat Works is a boat repair, maintenance, and new construction shipyard. The shipyard is located downstream of the I-5 bridges on Hayden Island. Some of the shipyard's customers transit through the bridge's reach from upstream moorages. In addition, the owner has a sailboat named *Rage*, which is described in the section on recreational sailboats and powerboats. Information about another Schooner Creek Boat Works sailboat under construction is included in Section 7.4.

Thompson Metal Fab has been located at CBC site since 1975 and has been servicing the North Slope in Alaska building drill rigs and other modular units for the oil industry since 1980. It also fabricates large components for bridges and hydroelectric and power generation. The company has licenses to build masts, derricks, and such structures. The large bay facilities are some of the largest on the West Coast. A roll-on/roll-off barge dock capable of 3,500 tons was completed in 2009. Data was provided on 10 shipments that have occurred since 1985. The shipments are usually placed on an ocean-going barge whose freeboard varies from 20 to 28 feet. The largest loads were two that were shipped in 2011. The resulting air draft for these loads was estimated to be between 133 and 141 feet. A 20-foot air gap was suggested. Shipments to the North Slope typically occur in July, but other shipments could occur at any time of the year.

Passenger Cruise

Several cruise lines provide up- and downriver tours that require frequent transits underneath the I-5 bridges. Air drafts for these vessels are presented in Exhibit 6.2-16 at the end of this chapter. The following is a list of the cruise lines contacted:

- American Cruise Lines operates small cruise vessels throughout the United States, including Alaska. Its specialty is smaller vessels operating week-long cruises and accommodating fewer than 150 guests. On the Columbia River system they operate the *Queen of the West*, which moors at the Red Lion Inn on Hayden Island just east of the I-5 bridges. The *Queen of the West* travels from Portland, Oregon, to Astoria, Oregon, then back up the Columbia and Snake Rivers to Clarkston, Washington/Lewiston, Idaho. Once there, passengers disembark and new passengers embark for the trip back to Portland. The vessel has an air draft of 64.3 feet. Its 2012 schedule includes week-long cruises from March through November. Information on other future cruise vessels planning to travel the Columbia River is included in the Section 7.4.
- American Safari Cruises/InnerSea Discoveries operates two passenger vessels that transit up the Columbia River. The vessel *Safari Legacy* has an air draft of 52 feet, and the *Safari Spirit* has an air draft of 42 feet. An air gap of at least 2 feet is preferred. The vessels make a total of approximately 23 trips per year, mainly from August through November.
- American Waterways, Inc., provides passenger service on the Willamette and Columbia Rivers. The company owns five vessels and provided data for their two largest vessels—the *Portland Spirit* and the *Crystal Dolphin*—both of which are passenger vessels with air drafts of 54 and 50 feet, respectively. The vessels average about 80 trips per month each on the Columbia River main channel and North Portland Harbor from June through October, with fewer trips the rest of the year. A 4-foot air gap is preferred.
- Grays Harbor Historical Seaport Authority has two sailing ships—the *Lady Washington* and the *Hawaiian Chieftain*—both of which sail up and down the Columbia River providing education programs for youth and the general public.
    - The *Hawaiian Chieftain* is a topsail ketch and was constructed in 1988 in Hawaii. It has been up the Columbia River to Pasco, WA, but the last time was a few years ago. The vessel has fore and aft masts, each consisting of an

upper and lower mast section. The upper mast is forward of the lower mast and can be lowered to the top of the lower mast in order to get under height restrictive structures, such as bridges. To lower the upper mast takes about 2 days. The rigging must be lashed to the deck and the vessel cannot have passengers when motoring in this configuration. Once it gets to the other side of the obstruction, the upper mast is raised. The crew can do this. Raising and lowering the mast is not feasible on a weekly basis, but it can be done if the *Hawaiian Chieftain* needs to go upriver for a 2 to 3 month program. The vessel was surveyed in Port Angeles, Washington. The height of the forward mast is 74 feet above the waterline. The step to which the upper mast can be lowered is 49 feet above the waterline.

    - The *Lady Washington* is a replica of the original *Lady Washington*. It has two masts, with three steps, and the upper mast can be lowered. Lowering the upper mast takes 2.5 to 3 days, with the same amount of time needed to raise it. The surveyed height of the aft mast is 85 feet above the waterline. The step to which the upper mast can be lowered is 65 feet above the waterline.

  An air gap of 15 feet is requested. Both ships travel the main channel under the I-5 bridges. They have sailed to The Dalles, Oregon, and on rare occasions have down-rigged the ships to provide access to the Tri-Cities area in Washington.

- Linblad Expeditions operates two passenger vessels on the main channel: the *National Geographic Sea Bird* and the *National Geographic Sea Lion*. Both vessels have an air draft of 59 feet and a 6-foot air gap is preferred. The *Sea Bird* averages about 7 to 8 trips a year on the Columbia River main channel under the I-5 bridges in October and November, while the *Sea Lion* is reported to travel about 4 trips per year on the main channel under the bridges in September and October.

River Ports and Upper Columbia/Snake River Navigation

Many ports along the Columbia and Snake Rivers rely on navigation access as part of their business. This traffic includes tug and barge traffic carrying bulk commodities such as grain, fuel, wood chips, sand and gravel, etc., as well as container and project cargo; excursion vessels; and pleasure crafts. As part of the data gathering effort, 21 ports along the Columbia and Snake Rivers were contacted regarding their existing navigation-related activities. Ports located upriver of the I-5 bridges were asked about their recent dredging and marine construction activities because of the potential of generating contractor-related navigation at the I-5 bridges.

This summary is provided as a general discussion of the overall information obtained with respect to existing navigation at the I-5 bridges. Some of the information related to overall cargo types was obtained from the latest statistics available online from USACE. This was consistent with an earlier synopsis of cargo movements presented by Parsons Brinckerhoff in the *Navigation Baseline Report* for the SR 35 Bridge Feasibility Study prepared for the Southwest Washington Regional Transportation Council in 2003.

Port Operations

Barges are used to move cargo on the upper Columbia and Snake River system because of geometric constraints at the navigation locks. Access is limited to vessels having maximum drafts of 14 feet, widths of 86 feet, and lengths between 650 feet and 675 feet per information available on the USACE channel condition surveys available through the Portland District.[17] Of the 8.2 million short tons of cargo navigating between Vancouver, Washington, and The Dalles, Oregon, on the Columbia River in 2009, wheat was by far the most common commodity at 52 percent, followed by petroleum and petroleum products at 22 percent, forest products (primarily wood chips) at 9 percent, sand and gravel at 8 percent, waste and scrap at 3 percent, and chemicals (fertilizer and ethanol) at 2 percent.[18] While the most common bulk commodities are grain, fuels, wood products and aggregate, other project cargo and equipment include dredges; cranes; fabricated structural components such as dam and lock components for USACE; wind turbine components, including blades, nacelles and steel tube; U.S. Navy shipments of decommissioned reactor cores to the Hanford Nuclear Reservation; and modular cargo recently delivered by barge to the Ports of Pasco and Lewiston for oil shale processing sites in Canada.

Container traffic in 2010 reported by USACE[19] included 26,500 twenty-foot equivalent units overall, with about four out of five inbound loaded while only one of four outbound were loaded. This traffic is primarily handled by the Ports of Morrow, Umatilla, Pasco, Whitman Co. (Wilma) and Lewiston.

Excursion vessel traffic includes several operators and one or more vessels per operator. Some vessels transit the entire system terminating the extent of their upstream trip at or near the Port of Clarkston. These vessels as well as those that do not transit the entire distance may stop at one or more docks, including the Ports of Skamania County, Cascade Locks, Hood River, City of The Dalles, Klickitat County, Arlington (operator was granted permission in the past but never stopped), Umatilla, Walla Walla, Garfield (operator was granted permission in the past but never stopped) and Clarkston.

Dredging for Ports

USACE needs to have the capability to respond to emergency conditions in the federal navigation channel, environmental and/or man-made, so dredging may be required any time of the year. This dredging could be performed by the hopper dredge *Yaquina* or other equipment. Ongoing maintenance dredging needs include channel and/or berth maintenance at several of the ports upriver of the I-5 bridges, including the Ports of Cascade Locks, Benton County, Walla Walla, Clarkston and Lewiston. In many cases the ports try to contract with the USACE dredging contractor when they are in the area (i.e., private contractors). However, the Port of Cascade Locks contracted with SDS Lumber to conduct their dredging with its equipment (clamshell bucket). Others, such as the Port of Benton, have their facility maintained by the U.S. Navy who uses divers to remove sediment at the low dock.

Marine Construction for Ports

To the extent possible marine construction at the upriver ports is performed using land-based equipment. Recent examples include the Port of Cascade Locks (recent boarding float replacement); Hood River (groin and riprap slope protection repair); Arlington (piling and boat

[17] http://www.nwp.usace.army.mil/navigation/home.asp
[18] USACE 2009. "Water Borne Commerce of the United States, Part 4 – Waterways and Harbors Pacific Coast, Alaska and Hawaii," IWR-WCUS-09-4, Institute for Water Resources, USACE, Alexandria, Virginia.
[19] http://www.ndc.iwr.usace.army.mil//wcsc/by_state10.html

ramp); Pasco (seawall upgrade); and Whitman County (repaired sheet pile dock and removed rock from a berth). Recent and ongoing work that involved water-based equipment includes a City of The Dalles commercial dock project, which is currently under construction using barge-mounted cranes. Pile driving and dolphin construction at Willow Creek for the Port of Arlington was completed several years ago before the project was indefinitely postponed because of regulatory issues. The Port of Morrow had two projects funded under Connect Oregon I and III involving in-water work on docks and barge slips using barge-mounted equipment by West Coast Contractors and Bergerson Construction, respectively.

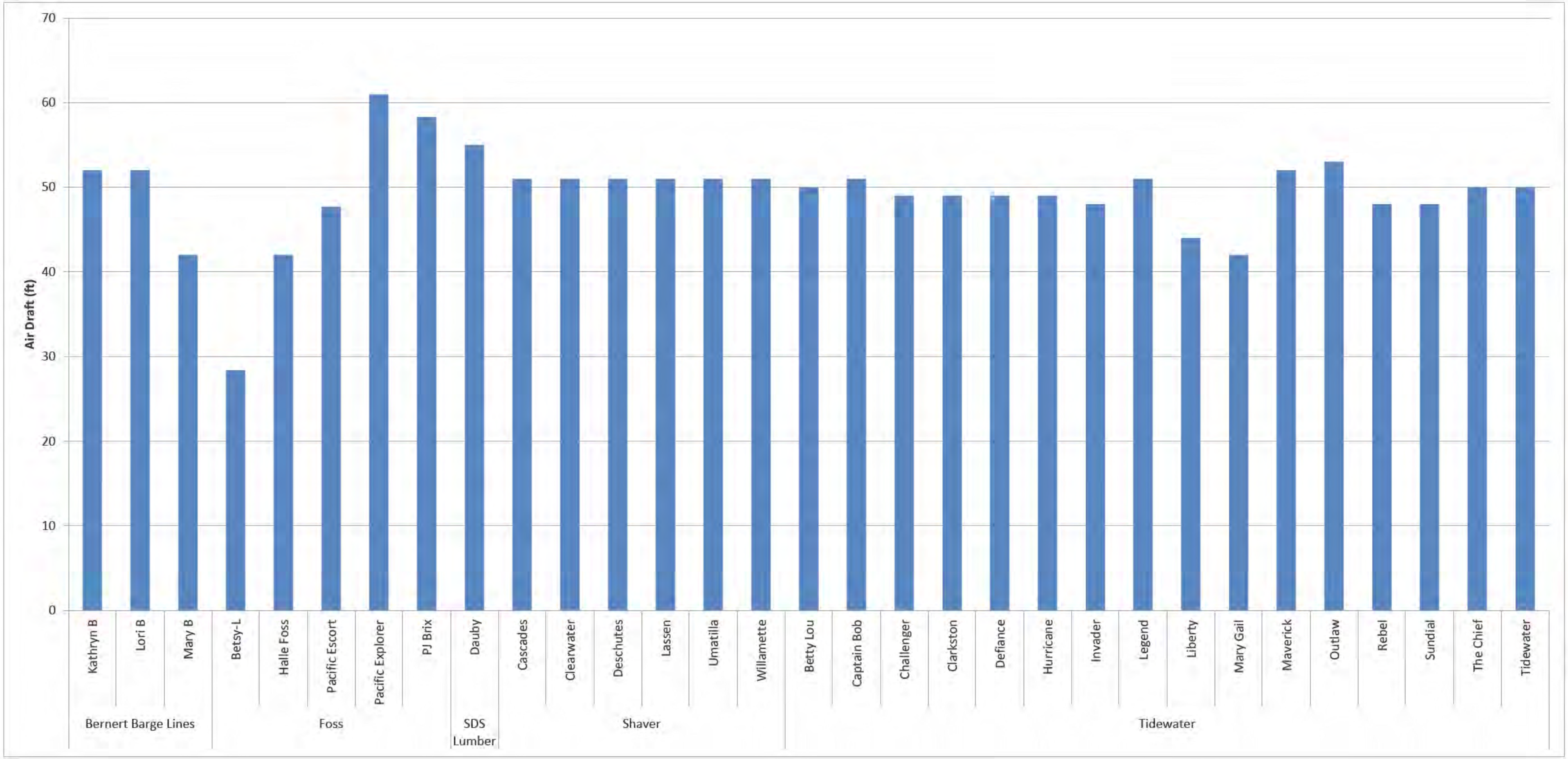


Exhibit 6.2-11
Air Drafts of Commercial Tug and Tow Vessels

Columbia River CROSSING

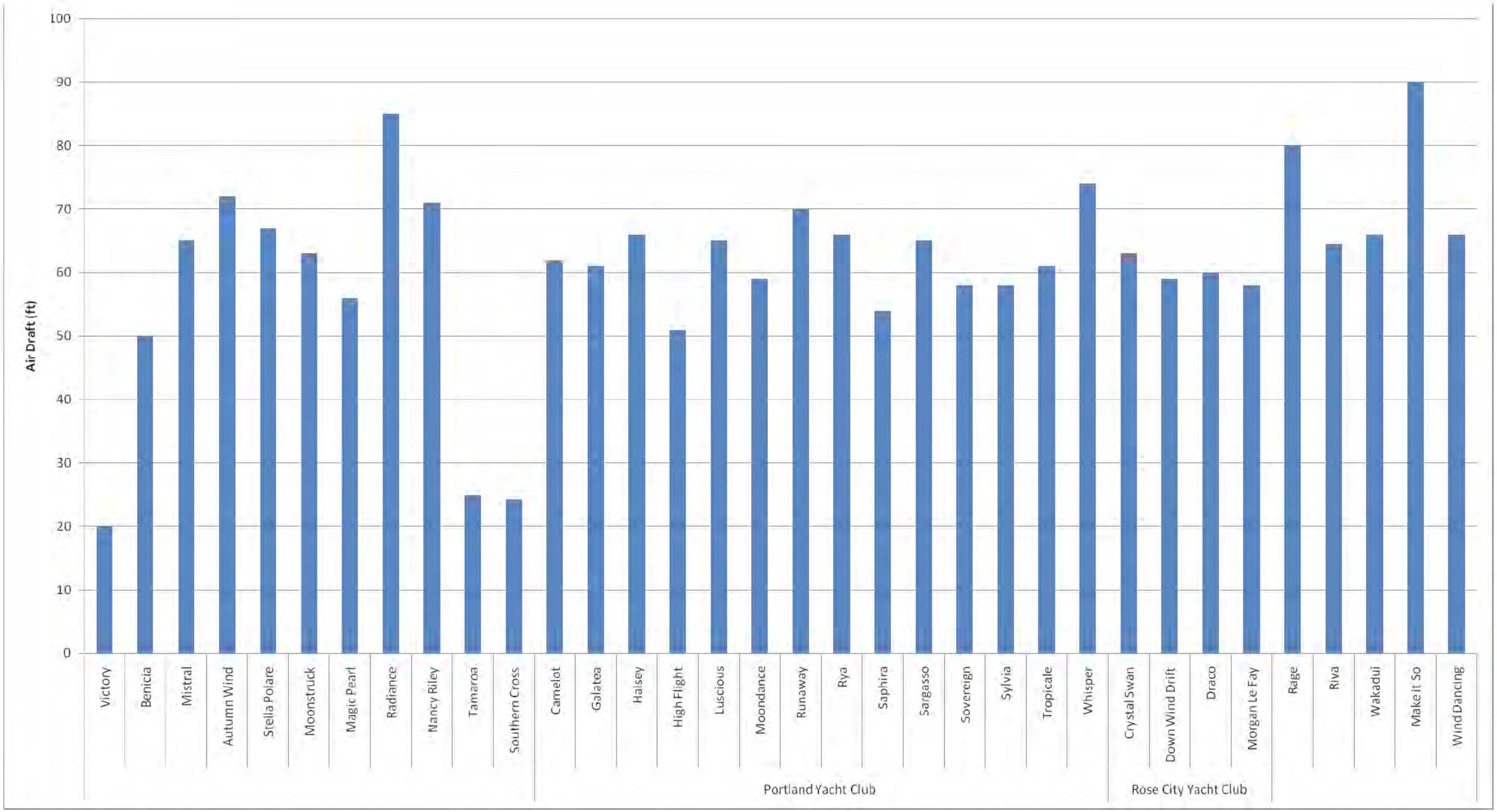


Exhibit 6.2-12
Air Drafts of Recreational Sailboat and Powerboat Vessels

Columbia River CROSSING

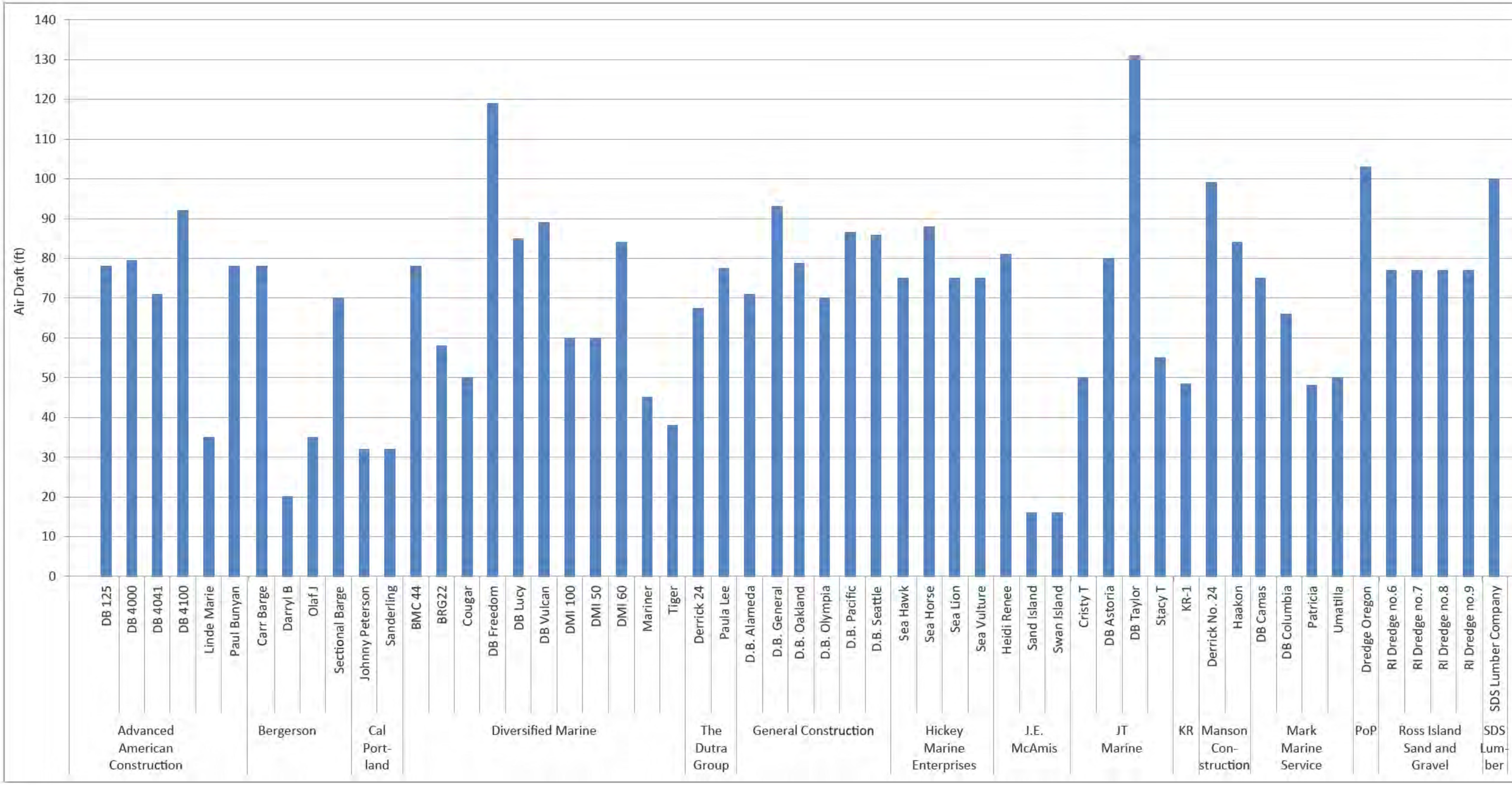


Exhibit 6.2-13
Air Drafts of Marine Contractor Vessels

Columbia River CROSSING

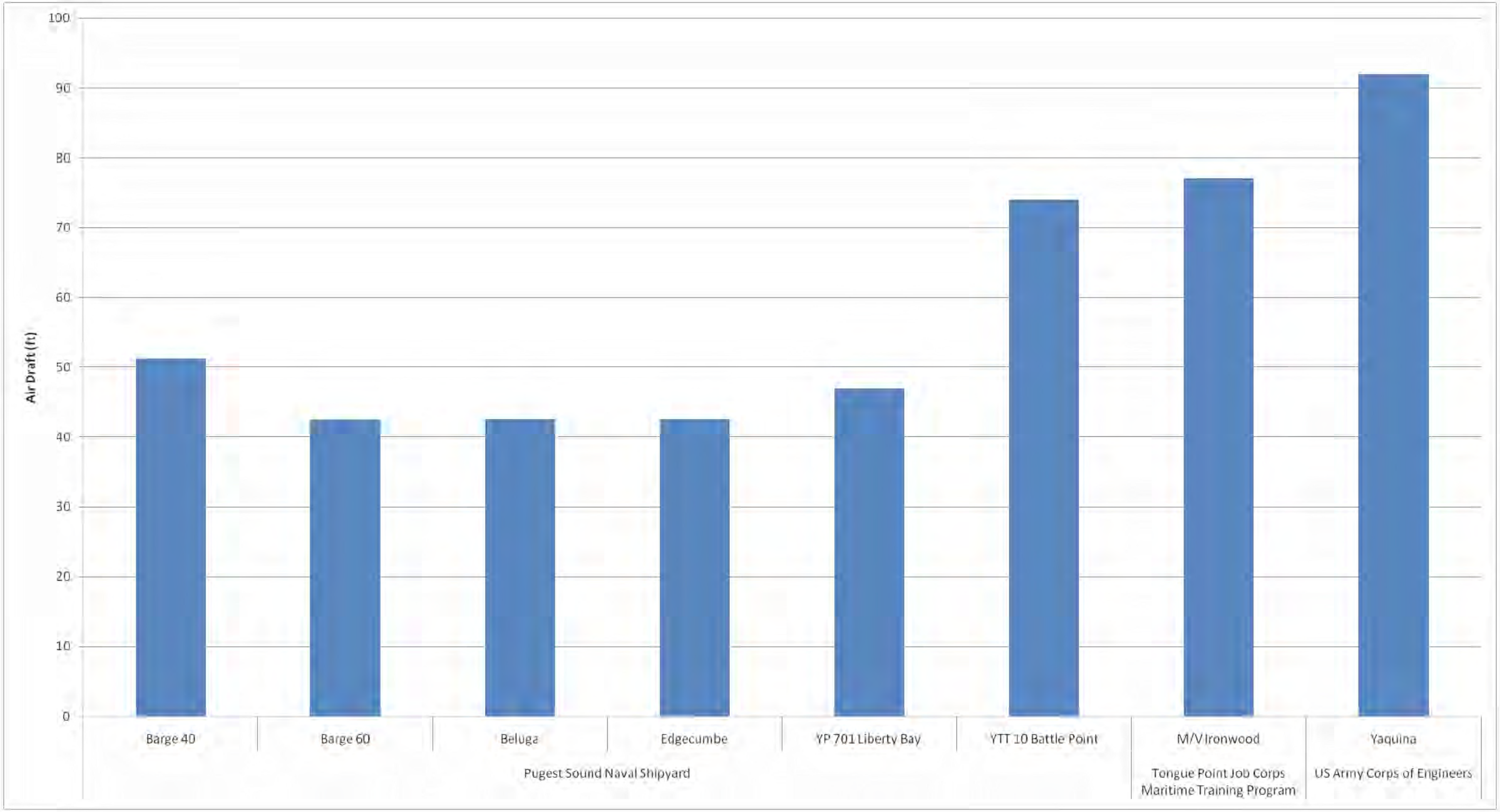


Exhibit 6.2-14
Air Drafts of Federal Government Vessels

Columbia River CROSSING

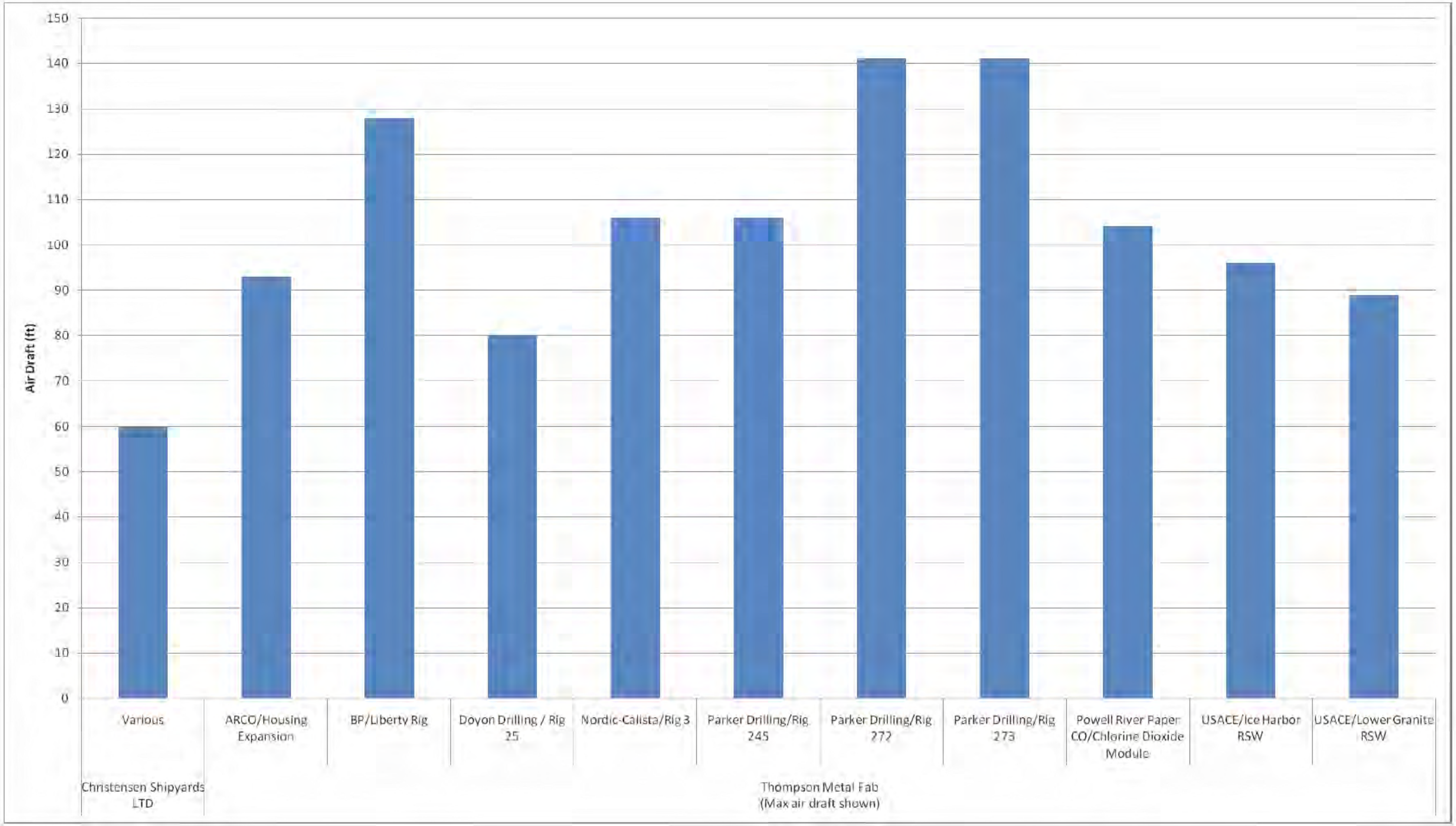


Exhibit 6.2-15
Air Drafts of Marine Industries and Fabricators

Columbia River CROSSING

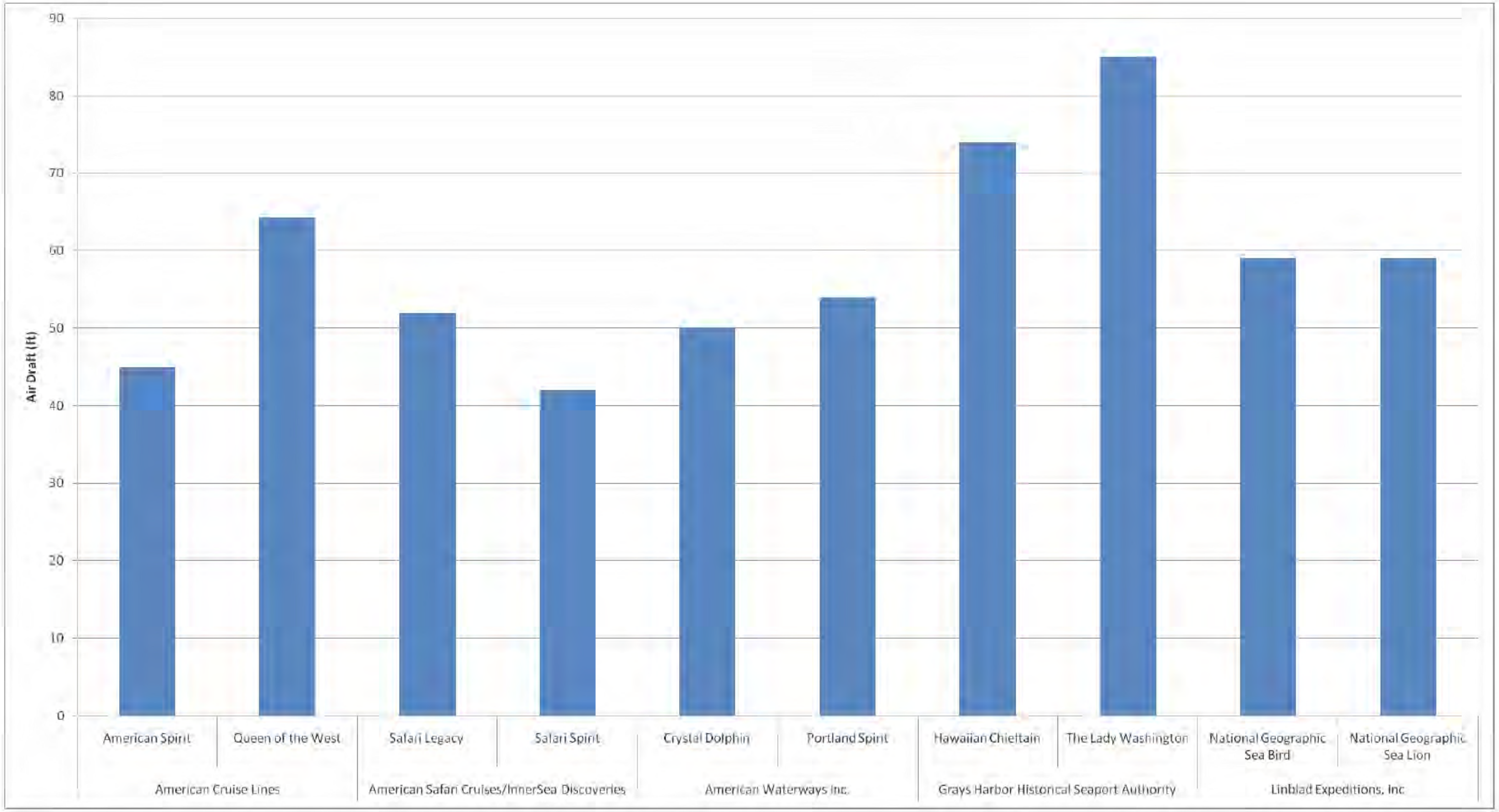


Exhibit 6.2-16
Air Drafts of Passenger Cruise Vessels

Columbia River CROSSING

7. Long-term Impacts

7.1 Factors Affecting Safe Vessel Clearance

7.1.1 Introduction

Vertical clearance beneath the proposed bridge is the primary impact of concern in this report. However, that is just one of the factors that vessels transiting in a channel or under a bridge must consider to determine if the passage can be accomplished safely. These factors are both operational and physical. The major operational factors considered by the USACE that affect the vessel transits in channels include the following:

> "Wind, wave, and current conditions; visibility (day, night, fog, and haze), water level (including possible use of tidal advantage for additional water depth), traffic conditions (one- or two-way, pushtows, cross traffic), speed restrictions, tug assistance and pilots, under keel clearance, and ice" (USACE 1984, 1995, 1999).

Physical factors affecting safe transit include vertical and horizontal clearance of man-made structures as well as natural obstacles. For the I-5 Bridge, the man-made physical factors include the bridge height and the width between piers. In addition the proximity of, and channel alignment to, other man-made structures (such as other bridges) may also impact safe transit.

Before proceeding into the details of vessel clearance this section discusses operational factors because changes in the physical surroundings may result in users having to address the operational factors differently, even though the factors themselves do not change.

This navigation technical analysis does not include a discussion of operator skills or experience. Vessel operators are assumed to have sufficient training and qualifications to transit the Columbia River. This includes having an understanding of the factors that affect their vessel, having knowledge of the aids-to-navigation in the area, and knowledge of the presence of natural and man-made river obstacles.

7.1.2 Wind and Wave Environment

Wind forces on a vessel produce two effects: a sideways drift and a turning moment. The former is overcome by steering a course to counteract it, and the latter is overcome by applying a certain amount of helm. Counteracting the drift will induce vessel yaw.

The degree to which wind affects a vessel depends on the relative direction of the wind, the ratio of wind speed to vessel speed, the depth to draught ratio, the vessel profile and whether the vessel is in a light or loaded condition.

Winds from the bow are generally not a concern for wind speeds less than 10 times the vessel speed. However, winds become a greater concern as the wind increases or they shift abeam. The maximum effect occurs when the wind direction is perpendicular to the ship's beam.

Transiting in a strong wind or through a curve requires more skills and room for navigational tolerance than transiting in a light wind.

Wind blowing over water creates wind waves. The wave environment for the Columbia River is most pronounced at the mouth of the Columbia River and within the coastal estuary. These wave effects do not propagate up to the I-5 bridges. Wind-driven waves could occur during those periods of highest wind speeds from the east as the wind exits the Gorge. Under typical wind conditions, these waves are expected to be small compared to waves caused by vessel bow wake (bow wave) for two-way traffic.

When wave heights are great the vessel reacts by riding up on the wave crest and descending into the trough. This results in a varying vessel height relative to the still water level as the highest point of the vessel rises and falls with each wave. High points near the bow and stern of a vessel have the greatest elevation change, whereas points amidships have the least. This is important when determining a bridge height since the vessel should be able to transit during adverse weather. This is used to help determine the desired air gap, which is discussed more in Section 7.1.7.

7.1.3 Current

According to the FEMA Flood Insurance Study for Portland, Multnomah County, Oregon dated November 26, 2010, the average cross sectional velocity for the 100 year flood near the I-5 crossing is 3.8 feet/sec (2.25 knots). Note that this velocity is the average of the entire cross section. Localized velocities, especially near the center of the channel, could be greater. During low flow periods the current is affected by tides, such that slack tide can result in very little to no current.

When traveling with a river current vessels need to maintain a faster speed than the current in order to provide steerage. Consequently at higher river velocities, the required distance to negotiate turns becomes greater. Should the vessel need to stop for any reason it must compensate for the river flow by backing down. If the vessel is towing a non-self-propelled barge or other vessel the tow can lose control and the only chance to stop the tow would be to turn around. This is one of the reasons barges being towed often have a tug alongside the barge while transiting under bridges and along other parts of the river to provide greater control.

7.1.4 Visibility

Fog, rain and transiting at night reduce visibility. The net result is that there is less time to react should a vessel need to maneuver quickly. Even with radar, vessels will travel slower than they normally would during periods of good visibility. This affects vessel steerage and maneuverability. In addition, knowing the bridge clearance and the vessel's height becomes extremely important because it may not be possible to simply "eyeball" whether or not the vessel will clear a bridge height. Users may want a greater air gap while transiting during these conditions.

7.1.5 River Level and Characteristics

Due to water runoff and influence of tides, the river level changes daily and over the course of the year. River level data (from 1972-2012) for the Columbia River at the I- 5 Bridge is summarized in Chapter 5 with more detail provided in Appendices D and F. Included are daily maximum, daily minimum, average monthly maximum, average monthly minimum, average daily high, and average daily low.

In general, the following trends can be observed:

- The average daily high is at approximately 10 feet above CRD in early May of each year.
- The average daily low is at approximately 2 feet above CRD in early September of each year.
- The water level went above the ordinary high water mark (16 feet above CRD) less than two percent of the time between 1972 and 2012.

A number of vessels that would have insufficient air draft during high flows would be able to transit under fixed-span I-5 bridges during periods of low flow. Periods of low flow decrease the amount of water draft available for the vessels, but water draft has not typically been a concern for barge traffic including the marine construction crane barges as long as their spuds are raised during transit.

According to records maintained by the National Weather Service, the following are the flood categories and river stages for the Columbia River downstream of the I- 5 Bridge:

- Action Stage – 15 feet above CRD
- Flood Stage – 16 feet above CRD
- Moderate Flood Stage – 20 feet above CRD
- Major Flood Stage – 25 feet above CRD

The top five historical river crests (feet above CRD) for the Columbia River downstream of the I-5 bridges are:

1. 31.0 feet on June 13, 1948
2. 30.8 feet on June 1, 1948
3. 27.7 feet on December 25, 1964
4. 27.6 feet on June 4, 1956
5. 27.2 feet on February 9, 1996

The top four low water records for the Columbia River downstream of the I-5 bridges are:

1. -1.20 feet on January 7, 1937
2. -1.10 feet on November 8, 1936
3. -0.80 feet on July 30, 1978 and July 24, 1989
4. -0.74 feet on July 14, 2001

While many vessels will not transit during very high water stages, self-reported observations from marine contractors included reports of being very busy during the February 1996 flood event where they had to perform many rescues and temporary repairs of vessels, docks, and moorings, and had frequent transits under the lift span of the I-5 bridges.

7.1.6 Channel Width and Depth

The channel width determines not only the greatest width of a vessel able to transit, but also the amount of maneuvering room vessels have to adjust to operational factors. The depth determines how heavily loaded vessels can be. The existing authorized navigation channel upstream from the I-5 bridges (Columbia river mile 106.7) to the port facilities at The Dalles at river mile 187.9 is 27 feet deep by 300 feet wide. However, the depth is maintained at only 17 feet. The existing navigation channel downstream from the I-5 bridges consists of two turning basins. The Upper Vancouver turning basin is authorized at 35 feet deep (only maintained to 17 feet deep) by 800 feet wide by 2,000 feet in length. The Lower Vancouver turning basin is authorized and maintained at 43 feet deep by 800 feet wide by 5,000 feet in length. From the downstream end of the lower turning basin (river mile 104.6) to the mouth of the Willamette River (river mile 101.4) the existing navigation channel is 43 feet deep by 500 feet wide. Downstream from the mouth of the Willamette River to the Columbia River entrance the existing navigation channel is 43 feet deep by 600 feet wide.

The maintenance of the navigation channel to only 17 feet from the upper Vancouver turning basin to The Dalles limits the water draft of vessels traveling upstream from Vancouver.

The channel depth and width limit large ocean-going freighters, container vessels, and automobile carriers to the end of the 43-foot-deep channel at the Lower Vancouver turning basin, downstream of the I-5 Bridge. Travel upstream from the I-5 Bridge is limited to those vessels that can navigate in a 300-foot-wide channel that is only maintained to 17 feet of depth. Travel upstream is also limited by the width and length of the locks at the upstream dams as well as height restrictions at upriver bridges.

In addition to the channel depth and the draft of the vessel, the under keel clearance, or gap between the bottom of the vessel and the channel, is important. In order to take into account variations in the channel depth, the effect of propellers rotating near the channel bottom, and the bottom soil type (i.e.: mud, sand or rock) river users desire a minimum under keel clearance of two to five feet.

7.1.7 Bridge Height and Air Gap (Vertical Clearance)

The bridge vertical clearance is the distance from the water surface to the lowest member of the bridge structure. Since the river level fluctuates, a river level that is exceeded only two percent or less of the time during the life of the project is a conservative design criterion for determining the near maximum surface for a heavily used channel. At the I-5 bridges, this design river level is 16 feet CRD.

The air gap is the additional height above the highest point on a vessel necessary to allow for a safety factor when transiting under a bridge due to wave- and wind-induced movements in the vertical plane. This is especially applicable for sailboats and other low weight vessels since they have greater responses to wave conditions. Vessel responses are unique for a given ship geometry and weight distribution and vary with the ship's forward speed, the channel bathymetry, and environmental conditions such as wind and wave direction. The amount of air gap is also influenced by visibility. For a project with a long design life the long term effects caused by changing river runoff characteristics, sea level rise and land subsidence are potential considerations as well.

Based on self-reporting, vessel owners expressed a need for air gaps ranging from just one foot to more than ten feet. Through discussions with the US Coast Guard, this report used a conservative air gap assumption of ten feet for the basic impact analysis. The report also provides a second impact scenario based on an assumption of a five foot air gap.

7.1.8 Width between Bridge Piers (Horizontal Clearance)

From a navigation perspective vessel operators consider the following when transiting between bridge piers:

1. Vessel size and maneuverability
2. Dredged channel width and distance to bridge piers
3. Operational factors
4. Risk of collisions
5. Vessel operator's experience

Bridge piers should be placed outside the top of the dredged channel's slopes. Any width greater than that increases the safety margin of the transit.

7.2 Impacts of Bridge Heights on River Users

7.2.1 Introduction and Methodology

As discussed in Chapter 6, the user identification process identified a number of vessels that could be impacted by one or more of the bridge height options being studied. A vessel was determined to be "impacted" if it could not pass under the bridge with a 10 foot air gap (vertical clearance between the highest point of the vessel and the lowest point of the underside of the bridge) while the river water level is at 16 foot CRD or higher. The combination of air gap and 16-foot river stage is called the "assumed condition". The 16 foot river stage is known as the Ordinary High Water level and represents a near worst case analysis. The river level fluctuates but is lower than 16 feet CRD 98 percent of the time. Since the river level fluctuates daily as well as seasonally there can be months during the course of a year when a vessel that would be impacted at 16 feet CRD is not impacted at all. In addition, the inclusion of a 10 foot air gap in the analysis is a worst case assumption of impacts because many vessels can safely pass with less air gap.

User heights were determined during the user identification and data gathering phase of the work. In order to confirm the accuracy of the self-reported vessel air drafts, surveys were conducted on all vessels possible that were identified to be impacted at 95 zero CRD, as reported in Chapter 6. Where reliable vessel drawings or configurations were available, these were used in lieu of field surveys. Not every vessel could be verified due to their being away from dock, sailing, working, or undergoing yard maintenance. Some vessels may be available for surveying at a future date.

Once vessel heights were confirmed, an impact analysis was conducted with bridge heights of between 95 and 125 feet in five foot increments. In addition to identifying which of the seven bridge heights result in vessel impacts under the assumed condition (10 foot air gap and 16 feet

CRD), each vessel was evaluated related to the percent of time it can pass during different months of the year.

Impacts were also assessed for four other bridge conditions, including: the existing lift span with a maximum vertical clearance of 178 feet above zero CRD; a high level fixed span bridge with the same maximum vertical clearance as the existing lift span; a mid-level bridge with a lift span with the same vertical clearance as the existing lift span; and, a high level fixed span of approximately 135 feet maximum vertical clearance. Each bridge height above 95 feet would minimize impacts to navigation compared to the 95-foot bridge described in the ROD. The bridge options allowing 178 feet of vertical clearance would avoid any additional adverse impacts to navigation beyond any impacts that would occur under the existing conditions. The existing bridge lift has a maximum vertical clearance of 178 feet above CRD.

For the impact analysis, vessels were grouped according to their user type. Vessels identified but not potentially impacted are also listed, however they were not analyzed. Additional vessel information can be found in Appendices B and C.

While extensive work was performed to identify vessels that could be impacted by the bridge heights studied, there may be other vessels that have not yet been identified. Some local vessel owners may not have responded to the project's outreach program. Some vessels noted in the I-5 bridge logs could not be verified. Also, vessels from out of the area that have transited in the past may not be aware of the I-5 bridge replacement program. Marine contractors from out of the area may come into the area if they are awarded a contract.

7.2.2 Vessels Impacted by Each Bridge Height

Vessel passage as a function of bridge height was analyzed for a total of nine bridge heights from 95 feet to 178 feet above zero CRD feet. To characterize worst case impacts, all vessels were analyzed at a river stage of 16 feet CRD and with an air draft of 10 feet. All vessels were evaluated in their current configuration or configuration typical for river travel. The height of marine contractors' crane barges were based on their spuds set in the up and locked position and their crane booms set at their lowest angle for travel. For marine industries and fabricators, vessel heights were based on their largest documented shipment package by barge. For sailboats and other vessels, height was based on the highest point of their fixed mast. No mitigation measures were considered for this basic impact evaluation (see Chapter 9 for a mitigation discussion), although the potential for passage during lower water periods is discussed.

The results of this analysis are provided graphically in Exhibit 7.2-1 and tabulated in Exhibit 7.2-2, which portray the vertical clearance impacts to individual vessels, for each bridge height studied, under the assumed conditions. These results are further detailed in tables and graphics in Appendices H, and I. Appendix H contains charts, one per impacted vessel, showing the percent of days per month that each vessel could pass under the various bridge heights studied. Appendix I contains charts of the same data but it is organized by bridge height rather than by individual vessel. In addition to impacts under the assumed conditions, impacts under slightly less conservative assumptions are portrayed graphically in Exhibit 7.2-3 and tabulated in Exhibit 7.2-4. These exhibits represent how vessels would be potentially impacted by a river water stage of 8.65 feet (water levels were below this stage for 80 percent of the days over the last 40 years) and a 5-foot air gap.

As shown in Exhibits 7.2-1 and 7.2-2, the bridges with a maximum vertical clearance of 178 feet (whether under a fixed span or a lift span) would impact one possible future shipment by a marine fabricator (Greenberry Industries). A bridge height of 135 feet would constrain five additional users, including one anticipated future sailboat (from Schooner Creek Boat Works), the two largest crane barges (the *DB Taylor* and the *DB Freedom*); and the possible future shipments of two marine industries/fabricators (from Thompson Metal Fab and Oregon Iron Works). For the 125-foot bridge height, one additional marine contractor vessel (the dredge Oregon) and an possible shipment by a marine contractor (SDS Lumber) would not be able to pass under the bridge under the assumed conditions. For the 120-foot bridge height, one additional crane barge (Derrick No. 24) would be unable to pass under this bridge. A 115-foot bridge would impact all of the above plus a sailboat (Make it So), two marine contractor vessels (the *DB General* and *DB 4100*), and a federally owned dredge boat (the *Yaquina*). A 110-foot bridge would impact all of the above plus another sailboat, five more marine contractor vessels, and a passenger cruise boat. A 105-foot bridge would impact all of the above plus another sailboat and six additional marine contractor vessels. A 100-foot bridge would impact all of the above plus 14 additional marine contractor vessels, another federally owned dredge boat, and the future shipment of a fabricator/marine industrial company. A 95-foot bridge would impact all of the above plus four additional sailboats, four additional marine contractor vessels, a US Navy vessel, and another cruise passenger vessel. These impacts are based on the assumed conditions for river level and air gap, and are without employing the mitigation measures identified in Chapter 9. The river level was below the level assumed in this impact analysis (16 feet CRD) more than 98 percent of the days over the last 40 years.

In Exhibit 7.2-2, the vessels listed for each incrementally lower bridge height are in addition to the vessels noted at the next higher bridge height. The total number of impacted vessels/users counts individual vessels except for the marine industries/fabricators. Each fabricator is counted just once in the totals because they reported their tallest projected future shipment rather than all future shipments. No vessel name is included for the fabricators because the vessel itself is not relevant to the vertical clearance impact. For fabricators, the vertical clearance challenge is due to the cargo that is being shipped; it is not due to the actual vessels (barge and tug) moving the cargo. Following the tables, the narrative briefly describes, how each vessel that would be impacted under the assumed conditions would be able to pass under other bridge heights studied when considering less conservative assumptions regarding river level.

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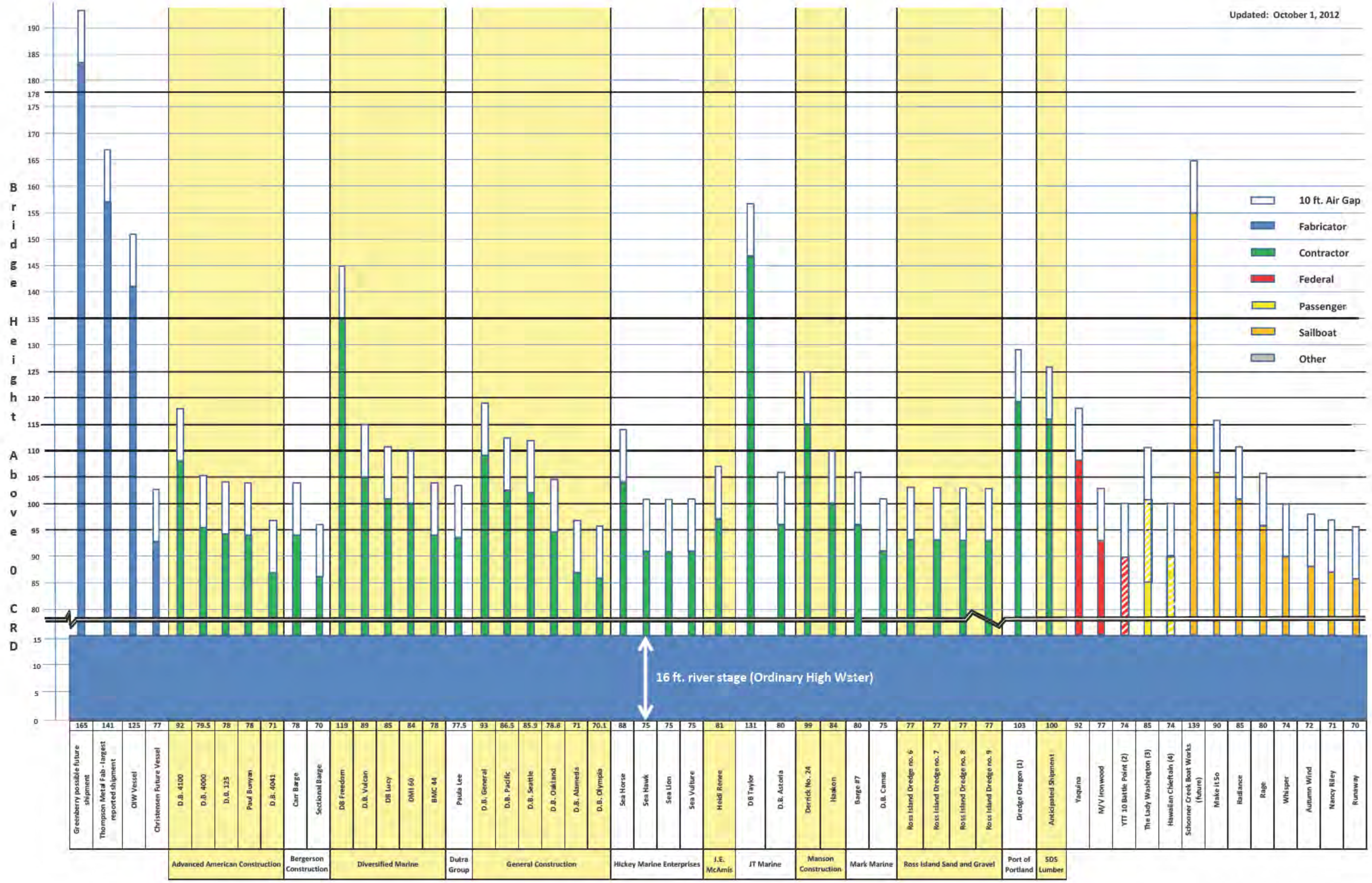

(1) Captain reports spuds can be lowered 10 ft. with adequate water depth.
(2) Mast can be stepped down to 58 ft.
(3) Mast can be lowered to 64.8 ft., a 2-3 day effort.
(4) Mast can be lowered to 49 ft., a 2-3 day effort.

Exhibit 7.2-1
Vertical Clearance Impacts to Individual Vessels
(assuming 16 feet CRD river level and 10-foot air gap)

Columbia River CROSSING

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Exhibit 7.2-2. Vessel Impacts (at 16 feet CRD and 10-foot Air Gap)

Vessels that cannot pass under a bridge height of 178 feet, (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Marine Industries and Fabricators	Greenberry Industries	Largest anticipated future shipment
	Total number of vessels/users =	**1**

Additional Vessels that cannot pass under a bridge height of 135 feet, (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Sailboats and Powerboats	Schooner Creek Boat Works	Future sailboat
Marine Contractors	Diversified Marine	*DB Freedom*
	J.T. Marine	*DB Taylor*
Marine Industries and Fabricators	Thompson Metal Fab	Past and future shipments (multiple)
	Oregon Ironworks	Past and future shipments (multiple)
	Total number of vessels/users =	**6**

Additional Vessels that cannot pass under a bridge height of 125 feet, (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Marine Contractors	Port of Portland	Dredge Oregon
	SDS Lumber	Future shipment (up to 100 ft high)
	Total number of vessels/users =	**8**

Additional vessels that cannot pass under bridge height of 120 feet (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Marine Contractors	Manson Construction	Derrick No. 24
	Total number of vessels =	**1**
	Cumulative total number of vessels/users =	**9**

Additional vessels that cannot pass under a bridge height of 115 feet (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Sailboats and Powerboats	Unknown	Make It So
Marine Contractors	Advanced American Construction	*DB 4100*
	General Construction	*DB General*
Federal Government	U.S. Army Corps of Engineers	Yaquina
	Total number of vessels =	**4**
	Cumulative total number of vessels/users =	**13**

Additional vessels that cannot pass under a bridge height of 110 feet (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Sailboats and Powerboats	Legendary Yachts	Radiance
Marine Contractors	Diversified Marine	*DB Vulcan*
	Diversified Marine	*DB Lucy*
	General Construction	*DB Pacific*
	General Construction	*DB Seattle*
	Hickey Marine Enterprises	*Sea Horse*
Passenger Cruise	Grays Harbor Historical Seaport	*Lady Washington*
	Total number of vessels =	**7**
	Cumulative total number of vessels/users =	**20**

Additional vessels that cannot pass under a bridge height of 105 feet (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Sailboats and Powerboats	Schooner Creek Boat Works	Rage
Marine Contractors	Advanced American Construction	*DB 4000*
	Diversified Marine	*DMI 60*
	J.E. McAmis	*Heidi Renee*
	J.T. Marine	*DB Astoria*
	Manson Construction	*Haakon*
	Mark Marine	Barge #7
	Total number of vessels =	**7**
	Cumulative total number of vessels/users =	**27**

Additional vessels that cannot pass under a bridge height of 100 feet (with 10-ft air gap and 16 ft CRD water level)

Group	User	Vessel Name
Marine Contractors	Advanced American Construction	*DB 125*
	Advanced American Construction	*Paul Bunyan*
	Bergerson Construction	*Carr Barge*
	Diversified Marine	*BMC 44*
	Dutra Group	*Paula Lee*
	General Construction	*DB Oakland*
	Hickey Marine Enterprises	*Sea Hawk*
	Hickey Marine Enterprises	*Sea Lion*
	Hickey Marine Enterprises	*Sea Vulture*
	Mark Marine	*DB Camas*
	Ross Island Sand and Gravel	*Dredge No. 6*
	Ross Island Sand and Gravel	*Dredge No. 7*

	Ross Island Sand and Gravel	*Dredge No. 8*
	Ross Island Sand and Gravel	*Dredge No. 9*
Federal Government	Tongue Point Job Corps	*M/V Ironwood*
Marine Industries and Fabricators	Christensen Shipyard	Future Vessel
	Total number of vessels =	**16**
	Cumulative total number of vessels/users =	**43**
Additional vessels that cannot pass under a bridge height of 95 feet (with 10-ft air gap and 16 ft CRD water level)		
Group	**User**	**Vessel Name**
Sailboats and Powerboats	Portland Yacht Club	*Whisper*
	Hardiman Family Trust	*Autumn Wind*
	McClure Loving Trust	*Nancy Riley*
	Portland Yacht Club	*Runaway*
Marine Contractors	Advanced American Construction	*DB 4041*
	Bergerson Construction	*Sectional Barge*
	General Construction	*DB Alameda*
	General Construction	*DB Olympia*
Federal Government	U.S. Navy	*YTT Battle Point*
Passenger Cruise	Grays Harbor Historical Seaport	*Hawaiian Chieftain*
	Total number of vessels =	**10**
	Cumulative total number of vessels/users =	**53**

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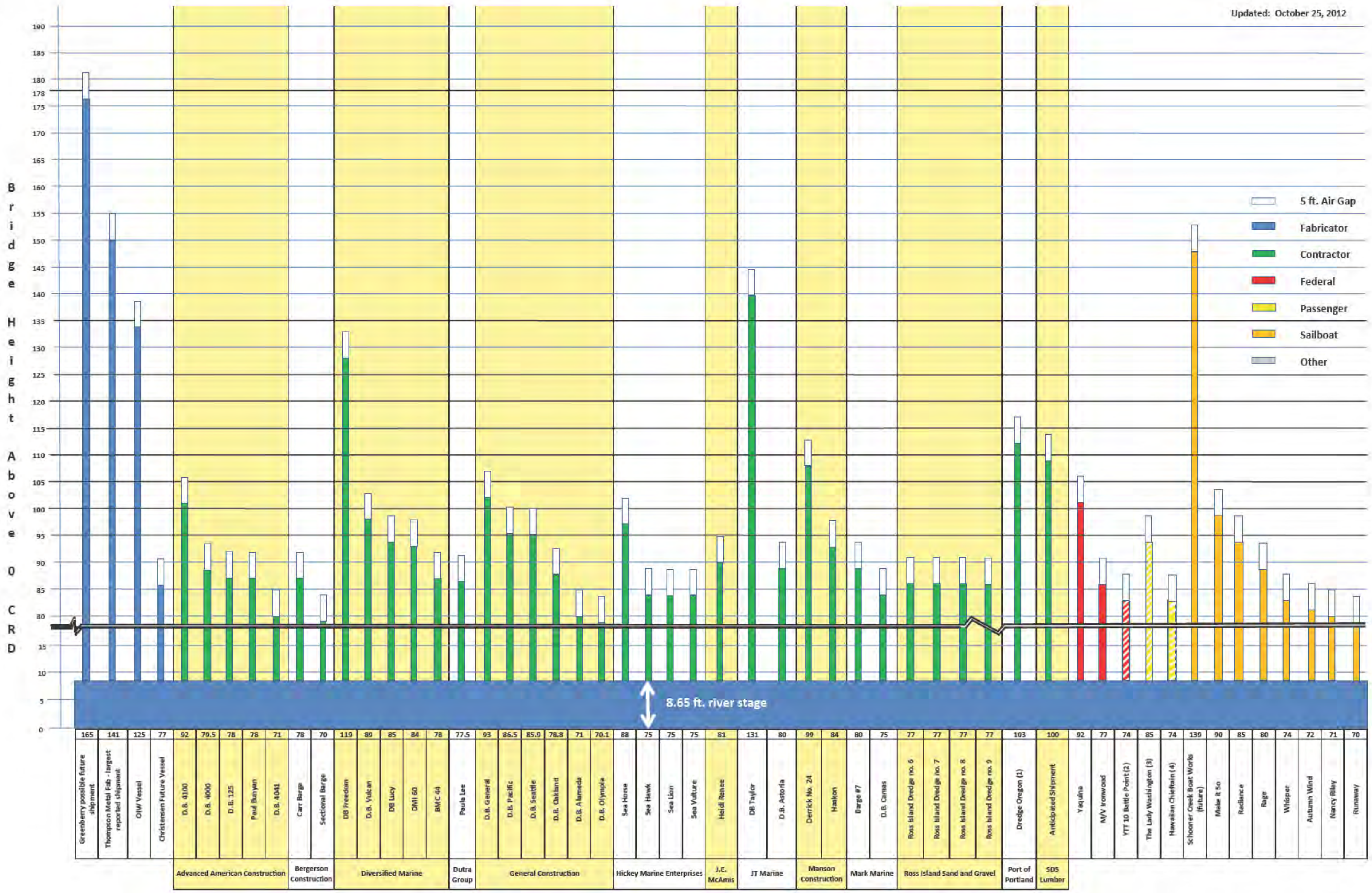

(1) Captain reports spuds can be lowered 10 ft. with adequate water depth.
(2) Mast can be stepped down to 58 ft.
(3) Mast can be lowered to 64.8 ft., a 2-3 day effort.
(4) Mast can be lowered to 49 ft. , a 2-3 day effort.

Exhibit 7.2-3
Vertical Clearance Impacts to Individual Vessels
(assuming 8.65 feet CRD river level and 5-foot air gap)

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Exhibit 7.2-4. Vessel Impacts (at 8.65-feet CRD and 5-foot Air Gap)

	Existing Vessels					Anticipated Vessels			
Bridge Height	**MF**	**MC**	**F**	**P**	**S**	**MF**	**MC**	**S**	**Total**
178 ft						1			**1**
135 ft	2	1				1		1	**5**
125 ft	2	2				1		1	**6**
120 ft	2	2				1		1	**6**
115 ft	2	3				1		1	**7**
110 ft	2	4				1	1	1	**9**
105 ft	2	6	1			1	1	1	**12**
100 ft	2	9	1		1	1	1	1	**16**
95 ft	2	13	1	1	2	1	1	1	**22**

Notes:
“Other” Assumed Conditions are 8.65 feet CRD river stage and a 5-foot air gap.
MF = Marine Industry/Fabricator, MC = Marine Contractor, F = Federal, P = Passenger/Cruise, S = Sailboat.

Each of the vessels identified as impacted under the assumed conditions (10 foot air gap and 16 feet CRD river level) for any of the studied bridge heights, is discussed below. This discussion identifies the lowest bridge height that would avoid impacting the vessel under the assumed conditions. It also identifies the bridge height that would allow the vessel to pass during at least 80 percent of the year and notes the potential to further reduce impacts with a 5-foot air gap. This discussion does not assume any of the mitigation measures discussed in Chapter 9.

7.2.3 Commercial Tugs and Tows

Tugs and tows (towboats) are the primary vessels used for moving non-powered vessels and barges through the river system. Non-powered barges carry such commodities as dry bulk (grain, aggregate, coal), liquid bulk, and fabrication equipment. In the case of marine contractors, the barges support cranes used for marine construction as well as other construction-related equipment and materials.

No tugs or tows were identified that were unable to pass under the assumed conditions for any of the bridge heights considered.

Tugs and Tows Identified but not Investigated Further

The following tugs and tows were identified but not investigated further due to their low height. Barges from Schnitzer Steel were included in this category since Schnitzer Steel is not a marine contractor and their vessels do not fit in other categories. The list is not all inclusive as there may be other tugs and tows that appear in the I-5 bridges’ logs.

Tugs from Bernert Barge Lines including:

Kathryn B *Lori B* *Mary B*

Tugs from Foss including:

Betsy-L	*Daniel Foss*	*Halle Foss*
Pacific Escort	*Pacific Explorer*	*PJ Brix*

Barges from Schnitzer Steel including:

Chippy 002	*Inland Conveyor*	*MAX 111*

Tugs from SDS Lumber

Dauby (also have a barge that may have equipment loaded to 100 feet)

Tugs from Shaver Transportation Company including:

Cascades	*Clearwater*	*Deschutes*
Lassen	*Umatilla*	*Willamette*

Tugs from Tidewater including:

Betty Lou	*Captain Bob*	*Challenger*
Clarkston	*Defiance*	*Hurricane*
Invader	*Legend*	*Liberty*
Mary Gail	*Maverick*	*Outlaw*
Rebel	*Sundial*	*The Chief*
Tidewater		

7.2.4 Recreational Sailboats and Powerboats

No recreational power vessels were found to be impacted under the assumed condition. Seven existing sailboats and one future sailboat were found to be potentially impacted under the assumed conditions for any of the bridge heights considered.

The anticipated future Schooner Creek Boat Works sailboat with a 139-foot air draft would pass only under the bridge options that match the 178 feet elevation of the existing lift span. For all other heights considered, it would not be able to pass under at any time within a calendar year without employing one or more of the mitigation measures identified in Chapter 9.

Under the assumed conditions, the sailboat *Make It S*o, would be able to pass under a bridge height of 120 feet or greater in the vessel's current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under a 110-foot bridge during most of the year. As shown in the charts in Appendices H and I, the *Make It So* could pass under a 110-foot bridge between 80 percent and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 70 percent and 60 percent of the days, respectively.

Under the assumed conditions, the sailboat *Radiance* would be able to pass under a bridge height of 115 feet or greater in the vessels' current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under a 105-foot bridge during most of the year. As shown in the charts in Appendices H and I, the *Radiance* could pass under a 105-foot bridge between 80 percent and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 70 percent and 65 percent of the days, respectively.

Under the assumed conditions, the sailboat *Rage* would be able to pass under a bridge height of 110 feet or greater in the vessels' current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under a 100-foot bridge during most of the year. As shown in the charts in Appendices H and I, the *Rage* could pass under a 100-foot bridge between 80 percent and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 70 percent and 65 percent of the days, respectively.

Under the assumed conditions, the sailboats *Autumn Wind, Nancy Riley, and Runaway* would be able to pass under a bridge height of 100 feet or greater in the vessels' current configuration, and the *Whisper* would be able to pass under a bridge height of 100 feet. When taking into account the seasonal variations in the river stages, these vessels would be able to pass under a 95-foot bridge during most of the year. As shown in the charts in Appendices H and I, these four sailboats could pass under a 95-foot bridge from about 90 percent to 100 percent of the days for all the months of the year except the highest flow months of May and June when the *Whisper* could pass about 80 percent and 75 percent of the days, respectively, and the other three could pass about 90 percent and 85 percent of the days, respectively.

Sailboats and Powerboats Identified and Surveyed but not Impacted

A number of sailboats were identified as being potentially impacted by a lower height bridge. The following sailboats were surveyed to confirm their heights, but were found to not be impacted by the assumed condition.

Vessels surveyed at the Portland Yacht Club

Camelot	*Galatea*	*Halsey*
High Flight	*Luscious*	*Moondance*
Saphira	*Sargasso*	*Sovereign*
Sylvia	*Tropicale*	

Vessels surveyed in other locations

Rya, Port Angeles, Washington

Wakadui, Salpare Bay Marina, Portland

Additional sailboats were identified but not surveyed due to reported heights not being impacted by the assumed condition.

Benicia	*Crystal Swan*	*Down Wind Drift*
Draco	*Magic Pearl*	*Mistral*
Moonstruck	*Morgan Le Fay*	*Riva*
Stella Polare	*Wind Dancing*	

No powerboats were identified as being impacted by the assumed condition. The following power vessels were identified but not investigated further:

Southern Cross	*Tamaroa*	*Victory*

7.2.5 Marine Contractors

Marine contractor barges make up the majority of the vessels that are impacted by the bridge heights studied. These users typically operate crane barges that conduct a wide range of water related construction activities.

Advanced American Construction

Under the assumed conditions, the *DB 4100* would be able to pass under a bridge height of 120 feet or greater in the vessels' current configuration. When taking into account the seasonal variations in the river stages, the *DB 4100* would be able to pass under a 110-foot bridge during much of the year. As shown in the charts in Appendices H and I, the *DB 4100* could pass under a 110-foot bridge between 60 percent and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 45 percent of the days, and could pass under a 115-foot bridge between 90 percent and 100 percent of the days of the year except May when it could pass about 85 percent of the days. As bridge heights are lowered from 110-feet, the ability of the *DB 4100* to pass under the I-5 bridges would be further hampered without employing mitigation.

The remainder of Advanced American Construction's vessels would be able to pass under a bridge height of 105 feet or greater in the vessels' current configurations. When taking into account the seasonal variations in the river stages, these vessels would be able to pass under a 100-foot bridge during much of the year. As shown in the charts in Appendices H and I, the next tallest vessel in their fleet (the *DB 4000*) could pass under a 100-foot bridge between 85 percent and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 75 percent and 70 percent of the days, respectively. The rest of their vessels would be even less constrained. As bridge heights are lowered from 100-feet, the ability of Advanced American Construction's taller vessels to pass under the I-5 bridges would be further hampered without employing mitigation.

Bergerson Construction Inc.

Bergerson Construction's vessels would be able to pass under a bridge height of 105 feet or greater in the vessels' current configurations. When taking into account the seasonal variations in the river stages, these vessels would be able to pass under a 95-foot bridge during much of the year. As shown in the charts in Appendices H and I, their tallest vessel (the Carr Barge) could pass under a 95-foot bridge between about 50 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 30 and 35 percent of the days, respectively. Their tallest vessel would be even less restricted by a 100-foot bridge. It could pass under more than 90 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 85 and 80 percent of the days, respectively. The rest of their vessels would be even less constrained or unconstrained.

Diversified Marine

The *DB Freedom* would not pass under any of the mid-level bridges studied, under the assumed river level of 16 feet and an air gap of 10 feet. With much less air gap (one to two feet), it could pass under a 125-foot bridge about 30 to 40 percent of the days per year. For all other mid-level heights considered, it would not be able to pass under at any time within a calendar year without employing mitigation measures.

The remainder of Diversified Marine's vessels would be able to pass under a bridge height of 115 feet or greater in the vessels' current configurations. When taking into account the seasonal variations in the river stages, these vessels would be able to pass under a 110-foot bridge during the low-flow stages corresponding to the period between August and October. As shown in the charts in Appendices H and I, their second tallest vessel (the *DB Vulcan*) could pass under a 110-foot bridge between about 85 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 75 percent of the days. Their third and four tallest vessels (the *DB Lucy* and *DMI 60*) could pass under a 105-foot bridge between about 80 and 100 percent of the days for all the months of the year except the highest flow months of May and June when they could pass more than about 65 and 70 percent of the days, respectively. All of their other vessels would be even less constrained.

Dutra Group

Under the assumed conditions, the *Paula Lee* would be able to pass under a bridge height of 105 feet or greater in the vessel's current configuration. When taking into account the seasonal variations in the river stages, the *Paula Lee* would be able to pass under a 100-foot bridge during much of the year. As shown in the charts in Appendices H and I, the *Paula Lee* could pass under a 100-foot bridge more than 90 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 85 percent of the days.

General Construction Company

Under the assumed conditions, the *DB General* would be able to pass under a bridge height of 120 feet or greater in the vessels' current configuration. When taking into account the seasonal variations in the river stages, the *DB General* would be able to pass under a 115-foot bridge during much of the year. As shown in the charts in Appendices H and I, the *DB General* could pass under a 115-foot bridge more than 90 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 85 percent and 80 percent of the days, respectively.

The *DB Pacific* and *DB Seattle* would be able to pass under a bridge height of 115 feet or greater in the vessels' current configurations. When taking into account the seasonal variations in the river stages, the *DB Pacific* and *DB Seattle* would be able to pass under a 105-foot bridge during the low-flow stages. As shown in the charts in Appendices H and I, these two vessels could pass under a 105-foot bridge between about 70 and 100 percent of the days for all the months of the year except the highest flow months of May and June when they could pass more than about 50 percent of the days. The vessels would be even less restricted by a 110-foot bridge. They could pass under more than 90 percent of the days for all the months of the year.

The remainder of General Construction's vessels, that were identified as possibly working in the Columbia system, would be able to pass under a bridge height of 105 feet or greater in the vessels' current configurations. When taking into account the seasonal variations in the river stages, the tallest of their remaining vessels (the *DB Oakland*) would be able to pass under a 95-

foot bridge during at least 80 percent of the days per year (on average). All of their other vessels would be even less constrained.

Hickey Marine Enterprises

Under the assumed conditions, the *Sea Horse* would be able to pass under a bridge height of 115 feet or greater. When taking into account the seasonal variations in the river stages, the *Sea Horse* would be able to pass under a 110-foot bridge during most of the year. As shown in the charts in Appendices H and I, the *Sea Horse* could pass under a 110-foot bridge more than 90 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 85 percent and 80 percent of the days, respectively.

The remainder of Hickey Marine Enterprises' vessels, under the assumed conditions, would be able to pass under a bridge height of 100 feet or greater in the vessels' current configurations. When taking into account the seasonal variations in the river stages, these vessels would be able to pass under a 95-foot bridge more than 80 percent of the days per year.

J.E. McAmis

Under the assumed conditions, the *Heidi Renee* would be able to pass under a bridge height of 110 feet or greater in the vessel's current configuration. When taking into account of the seasonal variations in the river stages, the *Heidi Renee* would be able to pass under a 100-foot bridge during much of the year. The *Heidi Renee* could pass under a 100-foot bridge between about 75 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 50 and 55 percent of the days, respectively.

JT Marine

The *DB Taylor*, in its current configuration would pass only under the bridge options that match the 178-foot clearance of the existing lift span. For all other heights considered it would not be able to pass under at any time within a calendar year without mitigation discussed in Chapter 9.

The *DB Astoria* would be able to pass under a bridge height of 110 feet or greater in the vessel's current configuration. When taking into account the seasonal variations in the river stages, the *DB Astoria* would be able to pass under a 100-foot bridge during most of the year. As shown in the charts in Appendices H and I, the *DB Astoria* could pass under a 100-foot bridge between about 80 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 70 percent and 65 percent of the days, respectively. The *DB Astoria* would be even less restricted by a 105-foot bridge. It could pass under more than 95 percent of the days for all the months of the year.

Manson Construction Company

Under the assumed conditions, the Derrick No. 24 would be able to pass under a bridge height of 125 feet in the vessel's current configurations. When taking into account the seasonal variations in the river stages, the Derrick No. 24 would be able to pass under a 120-foot bridge during much of the year. As shown in the charts in Appendices H and I, the Derrick No. 24 could pass under a 120-foot bridge (or a 115-foot bridge with a 5-foot air gap) at least 90 percent of the days for all the months of the year except the highest flow months of May and June when it could pass at least 75percent of the days. It could pass under a 115-foot bridge at least 80 percent of the days of the year, including at least 50 percent of the days during the high water months of May and June.

As bridge heights are lowered further, the ability of the Derrick No. 24 to pass under the I-5 bridges would be further affected. Under the assumed conditions, the *Haakon* would be able to pass under a bridge height of 110 feet or greater in the vessel's current configuration. When taking into account of the seasonal variations in the river stages, the *Haakon* would be able to pass under a 105-foot bridge during much of the year. As shown in the data in Appendices H and I, the *Haakon* could pass under a 105-foot bridge between about 75 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 60 percent and 55 percent of the days, respectively. As bridge heights are lowered from 105 feet, the ability of the *Haakon* to pass under the I-5 bridges would be further hampered.

Mark Marine Service

Under the assumed conditions, Mark Marine's tallest vessel (the *DB Camas*), in its current configuration, would be able to pass under a bridge height of 105 feet . When taking into account the seasonal variations in river levels, this vessel could pass under a 95-foot bridge during much of the year. As shown in the charts in Appendices H and I, the *DB Camas* could pass under a 95-foot bridge between about 80 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 70 percent and 65 percent of the days. The rest of their vessels would be even less constrained.

Ross Island Sand and Gravel

Under the assumed conditions, Ross Island Sand and Gravel's vessels would be able to pass under a bridge height of 105 feet or greater in the vessels' current configurations. When taking into account the seasonal variations in the river stages, these vessels could pass under a 100-foot bridge during much of the year. As shown in the data in Appendices H and I, their vessels could pass under a 100-foot bridge between about 90 and 100 percent of the days for all the months of the year except the highest flow months of May and June when they could pass about 90 percent and 85 percent of the days, respectively.

Dredge Oregon

Under the assumed conditions, the Port of Portland's dredge *Oregon* with a 103 foot air draft would be able to pass under a 125-foot bridge during much of the year. As shown in the data in Appendices H and I, the dredge *Oregon* could pass under a 125-foot bridge between about 90 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 85 percent and 80 percent of the days, respectively.

SDS Lumber

SDS Lumber has a barge that can ship loads as high as 100 feet. When taking into account the seasonal variations in the river stages, this shipment would be able to pass under a 125-foot bridge or even a 120-foot bridge during most of the year. As shown in the charts in Appendices H and I, this shipment could pass under a 120-foot bridge between about 80 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 70 percent and 65 percent of the days, respectively. These shipments would be even less restricted by a 125-foot bridge; the proposed shipment could pass under a 125-foot bridge more than 95 percent of the days for all the months of the year.

Marine Contractors Identified but not Impacted

Tugboat and dredge from CalPortland

Johnny Peterson	Tugboat
Sandering	Dredge

Barges and tugboats from Diversified Marine

BRG 22	Barge	*Cougar*	Tugboat
DMI 100	Barge	*Mariner*	Tugboat
DMI 50	Barge	*Tiger*	Tugboat

Barges from Dutra Group

Derrick 24	Barge

Barges from J.E McAmis

Sand Island	Dump scow barge
Swan Island	Dump scow barge

Tug boats from JT Marine

Cristy T	Tugboat
Stacy T	Tugboat

Barges from General Construction -No other vessels were identified as being put into service on the Columbia River.

Barges from KnifeRiver

KR-4	Barge

Barge and tugboats from Mark Marine

DB Columbia	Barge
Patricia	Tugboat
Umatilla	Tugboat

7.2.6 Federal Government

Federal government vessels include those from USACE, Tongue Point Job Corps and the US Navy. USCG has not reported that their vessels were identified as having access issues with the assumed condition.

Under the assumed conditions, the USACE dredge *Yaquina* would be able to pass under a bridge height of 120 feet in the vessel's current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under a 110-foot bridge during most of the year. As shown in the charts in Appendices H and I, the *Yaquina* could pass under a 110-foot bridge between about 60 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 40 percent and 45 percent of the days, respectively. With a 5-foot rather than 10-foot air gap (and a 110-foot bridge),the *Yaquina* would be able to pass unrestricted more than 90 percent of the days for all the months of the year except during the lowest flow month of June when it would be able to pass more than 85 percent of the days.

Under the assumed conditions, the Tongue Point Job Corps *M/V Ironwood* would be able to pass under a bridge height of 105 feet or greater in its current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under a 95-foot bridge during most of the year. As shown in the charts in Appendices H and I, he *M/V Ironwood* could pass under a 95-foot bridge between about 65 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 45 percent of the days. A 100-foot bridge would be even less restrictive, allowing the *M/V Ironwood* to pass unrestricted more than 90 percent of the days for all the months of the year.

Under the assumed conditions, the U.S. Navy *YTT 10 Battle Point* would be able to pass under a bridge height of 100 feet or greater in the vessels' current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under a 95-foot bridge during most of the year. As shown in the charts in Appendices H and I, the *YTT 10 Battle Point* could pass under a 95-foot bridge between about 90 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 75 percent of the days.

7.2.7 Marine Industries and Fabricators

The tallest projected future shipment from Greenberry Industries would not be able to pass under any of the bridge heights studied or under the existing lift span. The tallest past and projected future shipments from Thompson Metal Fab and Oregon Iron Works would be able to pass under the bridge height options that would match the 178-foot clearance of the existing lift span. The other past shipments reported by Thompson Metal Fab would be able to pass under a 125-foot bridge for most or all days of the year, depending on the specific shipment, and could pass under a 120-foot bridge at least during the low flow months of July through November. Without mitigation, progressively lower bridges would constrain additional tall shipments. The lower reported shipments could pass under all of the studied bridges at least during some part of the year.

7.2.8 Passenger Cruise

A limited number of passenger vessels have been known to transit up the Columbia River. Of those identified during the data gathering effort, only two were identified as being impacted by a 95-foot bridge. These include the *Lady Washington* and *Hawaiian Chieftain*. Both vessels have the capability of lowering their upper masts to reduce their overall height.

Under the assumed conditions, the *Lady Washington* would be able to pass under a bridge height of 115 feet or greater in the vessels' current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under a 105-foot bridge during most of the year. As shown in the charts in Appendices H and I, he *Lady Washington* could pass under a 105-foot bridge between about 80 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 70 percent and 65 percent of the days, respectively.

Under the assumed conditions, the *Hawaiian Chieftain* would be able to pass under a bridge height of 100 feet or greater in the vessels' current configuration. When taking into account the seasonal variations in the river stages, this vessel would be able to pass under at 95-foot bridge most of the year. As shown in the charts in Appendices H and I, he *Hawaiian Chieftan* could pass under a 95-foot bridge between about 90 and 100 percent of the days for all the months of the year except the highest flow months of May and June when it could pass about 80 percent and 75 percent of the days, respectively.

Passenger Cruise Vessels Identified but not Impacted

Passenger vessels that were identified but not investigated further due to the lower heights not impacted by a 95-foot-high bridge include:

American Spirit	*Crystal Dolphin*	*Portland Spirit*
Queen of the West	*Safari Legacy*	*Safari Spirit*
Seabird (National Geographic)	*Sealion* (National Geographic)	

7.3 Landside Impacts and Costs at Alternative Bridge Heights

7.3.1 Landside Impacts and Costs of Mid-level Bridge Heights

This section describes the impacts of each mid-range bridge height evaluated by the project (100 feet, 105 feet, 110 feet, 115 feet, 120 feet, and 125 feet CRD) compared to a bridge with 95 feet of vertical clearance. A review of the design issues associated with increasing the bridge height identified several areas of concern. Those concerns are described generally below, and then are addressed specifically for each bridge height considered:

- Maximum mainline grades –The maximum grade of the mainline traffic lanes on the north and south ends of the bridges. Typically the higher the bridge, the steeper the mainline grade that is required. As the grade increases traffic performance and traffic safety may decrease because it is more difficult for vehicles to accelerate and maintain speeds as they climb steeper grades. Additional traffic analysis will need to be completed on the selected bridge height, to address changes in traffic operations due to increased grades.
- Changes in entrance ramp grades – Higher bridges will result in longer or steeper on-ramps which will require additional traffic analyses and potentially design changes to ensure safe merging and weaving operations, especially for heavy trucks.
- Transit grade and stations – On the Washington side increased bridge heights will result in changes in the grade of the light rail line. This could affect transit performance and also could create changes in station locations and affect the planned downtown Vancouver street network. For light rail transit it is generally preferable to keep grades at 5 percent or below. A steeper grade can slow light rail vehicle speeds and increase travel times.
- FAA airspace – Take-offs and landings from the Pearson Airpark are directed to use FAA-designated air space (known as the Part 77 Imaginary Surface). The proposed bridge at 95 feet is near to but does not penetrate the westerly Part 77 surface. With increasing bridge heights, there are two primary locations where intrusions into the protected airspace are of concern. One location is on the main span of the bridge over

the Columbia River, and the other is at the SR-14/I-5 interchange (the loop ramp in the NE quadrant of the interchange). The project will need to obtain a 7460 form from FAA to determine whether a specific bridge height is a hazard or not. Typical illumination on the interstate is in the range of 50 feet above the road surface. For purposes of avoiding or minimizing an FAA impact, it is possible to use luminaires as low as 30 to 35 feet but it would result in poor uniformity. The top of an overhead sign is within the same range. If the bridge's road surface is less than 30 or 35 feet below the Part 77 surface, there will be a penetration by both sign bridges and luminaires, even with lower height luminaries. With bridge heights of 105 to 110 feet and above, luminaires on the bridge itself would penetrate the Part 77 surface. Luminaires and sign gantries on the highest ramps within the SR14 interchange would start to penetrate the Part 77 surface when the bridge exceeds about 115 feet.

- Foundation sizes – The size of the bridge piers and foundations. This is of concern not only due to increasing costs, but the potential for impacts to the river beyond those previously identified and addressed.
- Southbound I-5 access from Vancouver – Under some of the bridge heights considered the planned southbound on-ramp to I-5 from 6th Street may no longer be feasible due to the change in on-ramp alignment. This would be a direct result of the lengthened structures on the bridge touch down points in Vancouver.
- Number of potentially affected vessels – With each 5-foot increase in bridge height, the number of vessels impacted would be reduced, as described in Section 7.2.

Each incremental increase in vertical clearance would generally have additional impacts and increased costs; some would be relatively small, while others would be more substantial. Cost estimates are provided for each alternative showing the incremental cost relative to a 95 ft. bridge. Two estimates are provided for each alternative. The base cost estimate describes the estimated cost with no contingencies. The 60 percent cost estimate describes the estimated cost with 60 percent confidence. The confidence level refers to the percent chance that the actual cost will be at or below the cost estimate. Bridges with higher vertical clearance are estimated to cost more than a bridge with a 95 foot clearance, generally increasing more as the height increases. This increase in cost is based on the increase in materials needed to build a higher bridge and longer approaches. Estimates of impacts and costs are preliminary and will be refined following selection of a recommended bridge height.

Exhibits 7.3-8 through 7.3-14, at the end of this section, show the location and type of impacts and cost effects on plan view/aerial photos for each of the bridge height options studied.

The following describes the impacts at each bridge height based on the categories above. Where relevant, the impacts are expressed in comparison to the 95-foot clearance analyzed in the FEIS. If a category is not mentioned in the text below, then there are no or minimal additional impacts in that category from the increase in height.

Exhibit 7.3-1. Vertical Clearance – 95 feet

Impact Category	
Potentially Impacted Vessels (at 16 ft CRD river level and 10-ft air gap)	**53**
Base to 60% Cost Increase	**N/A**

Impact Category		
A.	Maximum Mainline Grade (OR)	2.83%
B.	Traffic Performance	N/A regarding grade. As described in FEIS.
C.	Maximum Mainline Grade (WA)	3.40%
D.	Transit Grade (additional distance at 6%)	N/A
E.	FAA Airspace (CRB-distance from Pearson Imaginary Surface)	42 feet
F.	Foundation Sizes	N/A. As described in Biological Assessment.
G.	FAA Airspace (SR 14-distance from Pearson Imaginary Surface)	49 feet
H.	6th St. to I-5 South	N/A. As described in FEIS.
I.	Transit Alignment and Stations	N/A. As described in FEIS.

At 95 feet, there are 53 potentially impacted vessels under the assumed conditions, and 22 under slightly less conservative assumptions.

The cost estimate is the same as what has been used for the project and is based on the August 2011 CEVP.

The maximum mainline grade for the 95-foot bridge in Oregon is 2.83 percent and the maximum in Washington is 3.4 percent. Grades above 3 percent require a design exception, so the grade in Washington will require it at 95 feet.

At 95 feet, the transit guideway will require 465 feet of track to be at 6 percent grade to pass over the BNSF railway. It would not affect the planned function of downtown Vancouver streets.

A 95-foot bridge would have a minimum of 42 feet between the surface of the mainline control line and the Pearson Part 77 Imaginary Surface and a minimum of 49 feet between the surface of the SR 14 loop ramp and the Part 77 Surface.

In downtown Vancouver, the 6th Street to I-5 south on-ramp, and the transit alignment and stations would be as described in the FEIS. Higher bridges could have impacts on the on-ramp and transit alignment and stations.

Exhibit 7.3-2. Vertical Clearance – 100 feet

Impact Category		
Potentially Impacted Vessels (at 16 ft CRD river level and 10-ft air gap)		**43**
Base to 60% Cost Increase		**$10-$13 million**
A.	Maximum Mainline Grade (OR)	3.16%
B.	Traffic Performance	More traffic analysis needed
C.	Maximum Mainline Grade (WA)	3.61%
D.	Transit Grade (additional distance at 6%)	110 feet
E.	FAA Airspace (CRB-distance from Pearson Imaginary Surface)	37 feet
F.	Foundation Sizes	Cost increase, but no size increase

	Impact Category	
G.	FAA Airspace (SR 14-distance from Pearson Imaginary Surface)	44 feet
H.	6th St. to I-5 South	No impact
I.	Transit Alignment and Stations	No Impact

At 100 feet, 43 vessels would be potentially impacted under the assumed conditions, and sixteen would be impacted under slightly less conservative assumptions. At this bridge height there are three categories of impacts that would likely require further analysis and discussion: Maximum Mainline Grades, Traffic Performance, and Transit Grade. In Oregon, the mainline grade would increase to 3.16 percent. In Washington, the mainline grade would increase to 3.61 percent. The steeper grades on the 100-foot bridge, compared to the 95 foot bridge, would slightly increase (about 18 percent) the predicted number of truck-related crashes[20]. With all bridges higher than 95 feet, more traffic analysis would be needed to evaluate changes to traffic operations due to increased grades. The transit grade would be 6 percent for an additional 110 feet (compared to a 95-foot bridge), thus creating a longer section of track that would need a design exception for a grade above 5 percent. The increase in length of track that would be at 6 percent may impact travel speeds of the light rail vehicles and could impact travel time.

The added cost for a 100-foot clearance bridge would be $10 to $13 million.

Exhibit 7.3-3. Vertical Clearance – 105 feet

	Impact Category	
Potentially Impacted Vessels (at 16 ft CRD river level and 10-ft air gap)		**27**
Base to 60% Cost Increase		**$18-$22 million**
A.	Maximum Mainline Grade (OR)	3.48%
B.	Traffic Performance	More traffic analysis needed
C.	Maximum Mainline Grade (WA)	3.81%
D.	Transit Grade (additional distance at 6%)	120 feet
E.	FAA Airspace (CRB-distance from Pearson Imaginary Surface)	32 feet
F.	Foundation Sizes	Cost increase, but no size increase
G.	FAA Airspace (SR 14-distance from Pearson Imaginary Surface)	38 feet
H.	6th St. to I-5 South	No impact
I.	Transit Alignment and Stations	No Impact

At 105 feet, 27 vessels would be potentially impacted under the assumed conditions, and 12 would be impacted under slightly less conservative assumptions. At this bridge height there are three categories of impacts that would likely require further analysis and discussion: Maximum Mainline Grades, Traffic Performance, and Transit Grade. In Oregon, the mainline grade would increase to 3.48 percent. In Washington, the mainline grade would increase to 3.81 percent. The

[20] Based on applying the Speed Reduction Crash Curves, from *A Policy on Geometric Design of Highways and Streets*, page 3-120, American Association of State Highway Transportation Officials. This was used for all the crash predictions in this section.

steeper grades on the 105-foot bridge, compared to the 95 foot bridge, increase the predicted number of truck-related crashes by more than 50 percent With all bridges higher than 95 feet, more traffic analysis would be needed to evaluate changes to traffic operations due to increased grades. The transit grade would be 6 percent for an additional 120 feet (compared to a 95-foot bridge), thus creating a longer section of track that would need a design exception for a grade above 5 percent. The increase in length of track that would be at 6 percent may impact travel speeds of the light rail vehicles and could impact travel time.

The added cost for a 105-foot clearance bridge would be $18 to $22 million.

Exhibit 7.3-4. Vertical Clearance – 110 feet

Impact Category		
Potentially Impacted Vessels (at 16 ft CRD river level and 10-ft air gap)		**20**
Base to 60% Cost Increase		**$29-$36 million**
A.	Maximum Mainline Grade (OR)	3.73%
B.	Traffic Performance	More traffic analysis needed
C.	Maximum Mainline Grade (WA)	3.99%
D.	Transit Grade (additional distance at 6%)	130 feet
E.	FAA Airspace (CRB-distance from Pearson Imaginary Surface)	29 feet
F.	Foundation Sizes	Cost and size increase
G.	FAA Airspace (SR 14-distance from Pearson Imaginary Surface)	38 feet
H.	6th St. to I-5 South	No impact
I.	Transit Alignment and Stations	No Impact

At 110 feet, 20 vessels would be potentially impacted under the assumed conditions, and nine would be impacted under slightly less conservative assumptions. At this bridge height there are five categories of impacts that would likely require further analysis and discussion: Maximum Mainline Grades, Traffic Performance, Transit Grade, FAA Airspace, and Foundation Sizes. In Oregon, the mainline grade would increase to 3.73 percent. In Washington, the mainline grade would increase to 3.99 percent. The steeper grades on the 110-foot bridge, compared to the 95 foot bridge, would double the predicted number of truck-related crashes. With all bridges higher than 95 feet, more traffic analysis would be needed to evaluate changes to traffic operations due to increased grades. The transit grade would be 6 percent for an additional 130 feet (compared to a 95-foot bridge), thus creating a longer section of track that would need a design exception for a grade above 5 percent. The increase in length of track that would be at 6 percent may impact travel speeds of the light rail vehicles and could impact travel time. The top of roadway deck for the main span bridge would be 29 feet below the Pearson Part 77 Imaginary Surface, which would result in sign bridges and lighting penetrating into the air space.

The added cost for a 110-foot clearance bridge would be $29 to $36 million.

Exhibit 7.3-5. Vertical Clearance – 115 feet

Impact Category	
Potentially Impacted Vessels (at 16 ft CRD river level and 10-ft air gap)	**13**

Impact Category		
Base to 60% Cost Increase		**$75-$91 million**
A.	Maximum Mainline Grade (OR)	3.99%
B.	Traffic Performance	More traffic analysis needed
C.	Maximum Mainline Grade (WA)	3.99%
D.	Transit Grade (additional distance at 6%)	300 feet
E.	FAA Airspace (CRB-distance from Pearson Imaginary Surface)	22 feet
F.	Foundation Sizes	Cost and size increase
G.	FAA Airspace (SR 14-distance from Pearson Imaginary Surface)	30 feet
H.	6th St. to I-5 South	Slight challenge
I.	Transit Alignment and Stations	No Impact

At 115 feet, 13 vessels would be potentially impacted under the assumed conditions, and seven under slightly less conservative assumptions. At this bridge height there are six categories of impacts that would likely require further analysis and discussion: Maximum Mainline Grades, Traffic Performance, Transit Grade, FAA Airspace, Foundation Sizes, and 6th Street to I-5 South on-ramp. In Oregon and Washington, the mainline grade would increase to 3.99 percent. The steeper grades on the 115-foot bridge, compared to the 95 foot bridge, would double the predicted number of truck-related crashes. With all bridges higher than 95 feet, more traffic analysis would be needed to evaluate changes to traffic operations due to increased grades. The transit grade would be 6 percent for an additional 300 feet (compared to a 95-foot bridge), thus creating a longer section of track that would need a design exception for a grade above 5 percent. The increase in length of track that would be at 6 percent may impact travel speeds of the light rail vehicles and could impact travel time. The top of roadway deck for the main span of the bridge would be 22 feet below the Pearson Part 77 Imaginary Surface and the top of roadway deck for the SR 14 eastern loop ramp would be 30 feet below the Part 77 Surface. Both would result in sign bridges and lighting penetrating into protected air space. The increased grade of the proposed 6th Street to I-5 South on-ramp would be a slight challenge but could still maintain functionality .

The added cost for a 115-foot clearance bridge would be $75 to $91 million.

Exhibit 7.3-6. Vertical Clearance – 120 feet

Impact Category		
Potentially Impacted Vessels (at 16 ft CRD river level and 10-ft air gap)		**9**
Base to 60% Cost Increase		**$144-$176 million**
A.	Maximum Mainline Grade (OR)	3.99%
B.	Traffic Performance	More traffic analysis needed
C.	Maximum Mainline Grade (WA)	4%
D.	Transit Grade (additional distance at 6%)	470 feet
E.	FAA Airspace (CRB-distance from Pearson Imaginary Surface)	17 feet
F.	Foundation Sizes	Cost and size increase

Impact Category		
G.	FAA Airspace (SR 14-distance from Pearson Imaginary Surface)	25 feet
H.	6th St. to I-5 South	May be closed
I.	Transit Alignment and Stations	Close 5th Street between Main Street and Columbia Street. Access to businesses on Washington Street between 5th and 6th Streets.

At 120 feet, nine vessels would be potentially impacted under the assumed conditions, and six under slightly less conservative assumptions. At this bridge height there are four categories of impacts that would likely require further analysis and discussion: Maximum Mainline Grades, Traffic Performance, Transit Grade, FAA Airspace, Foundation Sizes, and 6th Street to I-5 South on-ramp. In Oregon, the mainline grade would increase to 3.99 percent. In Washington, the mainline grade would increase to 4.00 percent. The steeper grades on the 120-foot bridge, compared to the 95 foot bridge, would more than double the predicted number of truck-related crashes. With all bridges higher than 95 feet, more traffic analysis would be needed to evaluate changes to traffic operations due to increased grades. The transit grade would be 6 percent for an additional 470 feet (compared to a 95-foot bridge), thus creating a longer section of track that would need a design exception for a grade above 5 percent. The increase in length of track that would be at 6 percent may impact travel speeds of the light rail vehicles and could impact travel time. The 6th Street and Washington Street transit station would need to be raised 6 to 8 feet over existing grade, which would result in closing 5th Street between Main Street and Columbia Street. There will likely be impacts to businesses on Washington Street between 5th Street and 6th Street, due to the raised transit station in front of the businesses. Access to the Central Park and Ride would be limited to Columbia Street. The top of roadway deck for the main span of the bridge would be 17 feet below the Pearson Part 77 Imaginary Surface and the top of roadway deck for the SR 14 eastern loop ramp would be 25 feet below the Part 77 Surface. This would result in sign bridges and lighting penetrating the protected air space. The proposed 6th Street to I-5 South on-ramp may be closed due to the increased grade of the on-ramp. If closed it would result in changes in proposed traffic circulation in Vancouver.

The added cost for a 120-foot clearance bridge would be $144 to $176 million.

Exhibit 7.3-7. Vertical Clearance – 125 feet

Impact Category		
Potentially Impacted Vessels		**8**
Base to 60% Cost Increase		**$140-$171 million**
A.	Maximum Mainline Grade (OR)	4.98%
B.	Traffic Performance	More traffic analysis needed
C.	Maximum Mainline Grade (WA)	4.98%
D.	Transit Grade (additional distance at 6%)	470 feet
E.	FAA Airspace (CRB-distance from Pearson Imaginary Surface)	12 feet
F.	Foundation Sizes	Cost and size increase

	Impact Category	
G.	FAA Airspace (SR 14-distance from Pearson Imaginary Surface)	41 feet
H.	6th St. to I-5 South	May be closed
I.	Transit Alignment and Stations	Close 5th Street between Main Street and Columbia Street. Access to businesses on Washington Street between 5th and 6th Streets.

At 125 feet, eight vessels would be potentially impacted under the "worst case" assumed conditions, and six under slightly less conservative assumptions. At this bridge height there are six categories of impacts that would likely require further analysis and discussion: Maximum Mainline Grades, Traffic Performance, Transit Grade and Stations, FAA Airspace, Foundation Sizes, and 6th Street to I-5 South on-ramp. In Oregon, the mainline grade would increase to 5 percent. In Washington, the mainline grade would increase to 5 percent. The steeper grades on the 125-foot bridge, compared to the 95 foot bridge, would more than triple the predicted number of truck-related crashes. With all bridges higher than 95 feet, more traffic analysis would be needed to evaluate changes to traffic operations due to increased grades. The transit grade would be 6 percent for an additional 470 feet (compared to a 95-foot bridge), thus creating a longer section of track that would need a design exception for a grade above 5 percent. The increase in length of track that would be at 6 percent may impact travel speeds of the light rail vehicles and could impact travel time. The 6th Street and Washington Street transit station would need to be raised 7-9 feet over existing grade, which would result in closing 5th Street between Main Street and Columbia Street. There will likely be impacts to businesses on Washington Street between 5th Street and 6th Street, due to the raised transit station in front of the businesses. Access to the Central Park and Ride would be limited to Columbia Street. The top of roadway deck for the main span of the bridge would be 12 feet below the Pearson Part 77 Imaginary Surface and the top of roadway deck for the SR 14 eastern loop ramp would be 41 feet below the Part 77 Surface, resulting in potential air space intrusions from lighting and signing. The proposed 6th Street to I-5 South on-ramp may be closed due to the increased grade of the on-ramp. If closed it would result in changes in proposed traffic circulation in Vancouver.

The design for the 125 foot high bridge increases the mainline grade to near 5 percent, which decreases the cost and the FAA airspace (SR 14) impact compared to the 120 foot bridge. The added cost for a 125-foot clearance bridge compared to the 95-foot clearance bridge would be $140 to $171 million.

7.3.2 Landside Impacts and Costs of Other Bridge Heights

This section describes the impacts of the evaluated bridge options that would allow vertical clearances greater than 125 feet above zero CRD. These include three options that would allow a 178 foot vertical clearance above zero CRD (including a high level fixed span bridge, a mid-level bridge with a lift span, and a low level bridge with a lift span), and a high level bridge option that would allow a vertical clearance of 135 feet above zero CRD. These are within the range of bridge heights considered and eliminated during the CRC NEPA process.

Although bridge heights above 95 feet would minimize impacts to navigation compared to the 95-foot bridge described in the ROD, each of the options described below was found to be either unable to adequately address the project's purpose and need, or to have unacceptable impacts relative to other reasonable options.

A 178-foot, fixed span bridge would:

- Impact aviation safety associated with Pearson Airpark approaches and departures. The bridge structure itself would penetrate more than 25 feet into the Pearson Part 77 Imaginary surface and sign gantries and luminaires would penetrate about 60 feet
- Significantly change the form of the I-5/SR 14 interchange and potentially eliminate connections to the south
- Significantly change the form of the I-5/Hayden Island interchange and potentially eliminate connections to the north
- Push the transit connection in Vancouver further north, eliminating the transit station proposed at $5^{th}/6^{th}$ Streets, adversely affecting traffic circulation in downtown Vancouver and potentially closing a cross street near the touch down
- Require reconfiguration of I-5 access to and from downtown Vancouver
- Require substantial changes to the Land Bridge, likely requiring that it be a tunnel under SR 14 structures
- Preclude the current concept for the Evergreen connector
- Not be able to connect to existing North Portland Harbor Bridge, thus requiring bridge replacement
- Increase crashes compared to a 95-foot bridge, due to increased grades
- Penetrate the Pearson Part 77 Imaginary Surface, decreasing aviation safety.
- Have substantially higher capital costs (detailed estimate has not been developed).

A low-level bridge with a 178-foot movable span would:

- Cause substantial highway congestion problems due to increasingly frequent bridge lifts, compared to a fixed span bridge
- Reduce transit reliability and travel time due to bridge lifts, compared to a fixed span bridge.
- Decrease safety and increase highway collisions compared to a fixed span bridge.
- Penetrate the Pearson Part 77 Imaginary Surface, decreasing aviation safety
- Have higher capital costs than a fixed span bridge. A cost estimate for a 178-foot lift span has not been developed but the conceptual cost estimate to include a 125-foot lift span is approximately $250 million above the cost of a fixed span. The cost of a 178-foot lift span would add substantially more than that.

A mid-level bridge with a 178-foot movable span would:

- Not be practical with the curved bridge alignment that is part of the preferred alternative

- Potentially increase landside impacts due to straightening out the bridge alignment over the river
- Penetrate the Pearson Part 77 Imaginary Surface, decreasing aviation safety
- Have higher capital costs than a fixed span bridge. A cost estimate for a 178-foot lift span has not been developed but the conceptual cost estimate to include a 125-foot lift span is approximately $250 million above the cost of a fixed span. The cost of a 178-foot lift span would add substantially more than that.

The high-level fixed span bridge with 135 feet of vertical clearance would:

- Displace the proposed transit station at 6th Street in Vancouver. Because the station is an integral element in the transit system design, a number of other elements would have to be examined, redesigned or mitigated including other Vancouver station locations, traffic circulation, business impacts, park and ride locations and bus routes
- Impact FAA airspace. The top of bridge road surface would be less than 5 feet below the Pearson Part 77 Imaginary Surface
- Potentially result in added right-of-way impacts in Vancouver
- Decrease I-5 vehicle performance and safety, including increase crashes due to the steeper grade.
- Increase the size of bridge pier foundations and the number of piles in each foundation
- Increase capital costs (detailed estimate has not been developed but it would be greater than the cost of the 125-foot bridge which is about $171 million more than the 95-foot bridge).

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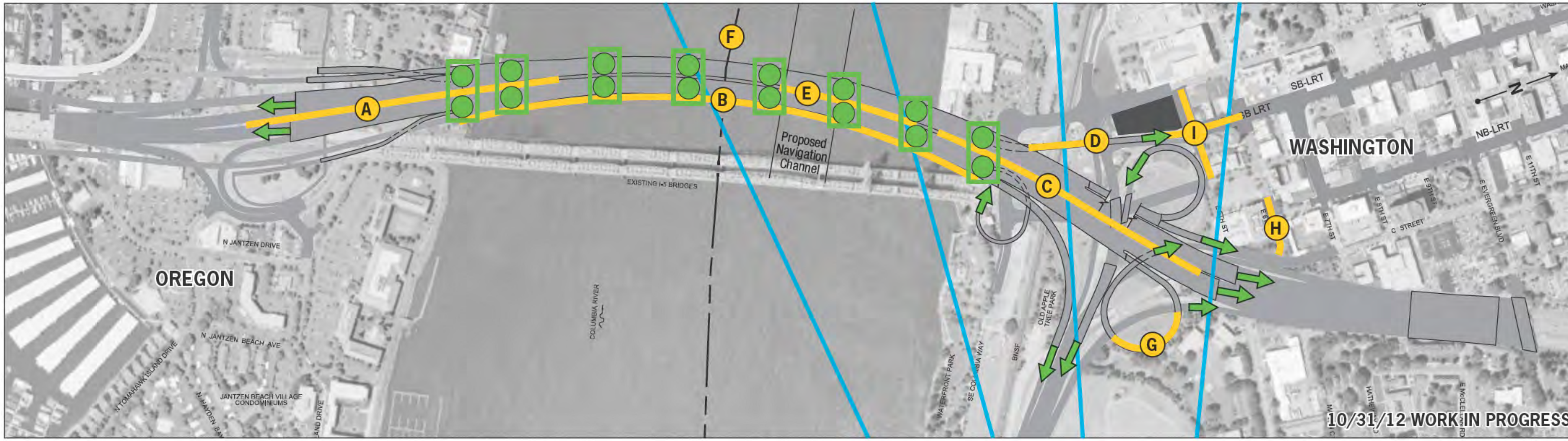
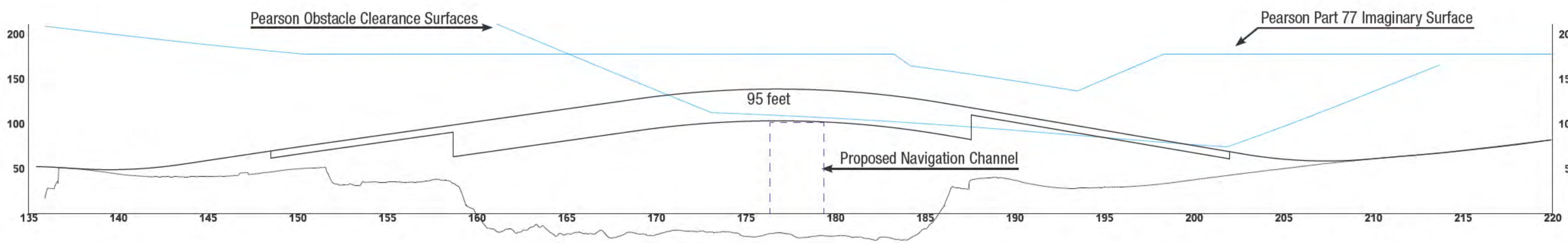




Cost increase

- Ramps lengthen
- Column height increases
- Column height increases and column footprint expands

Preliminary Findings

- **(A) (C) Mainline grade**
- **(B) Traffic performance**
- **(D) Transit grade**
- **(E) (G) FAA airspace**
- **(F) Foundation sizes**
- **(H) 6th Street – I-5 South**
- **(I) Transit alignment and stations**

Significant challenge to maintain function

FAA airspace

VERTICAL CLEARANCE ANALYSIS – 1

Exhibit 7.3-8
Vertical Clearance Analysis for 100-125 feet

** Based on 2011 CEVP, does not include mitigation costs.

* Potential impacts at 16 ft river stage and 10 ft air gap. Some of the vessels would pass at a lower river stage and/or with a smaller air gap. For this illustration each fabricator was represented by 1 vessel.

		Hayden Island	Main Crossing	Vancouver	TOTAL COST
Cost increase estimate over 95 feet**	60%	$5 million	$2 million	$6 million	$13 million
Highway/Transit		(A) In Oregon the mainline grade increases to 3.16% from 2.83%. This would need a design exception for a grade above 3%.	(B) More traffic analysis needed to address changes to traffic operations due to increased grades.	(C) In Washington the mainline grade increases to 3.61% from 3.40%. (D) Transit grade on Washington approach is 6% for an additional 120 feet.	

NOTE: *Estimates of impacts and costs are preliminary and may be refined following selection of a recommended bridge height.*

Cost increase

- Ramps lengthen
- Column height increases
- Column height increases and column footprint expands

Preliminary Findings

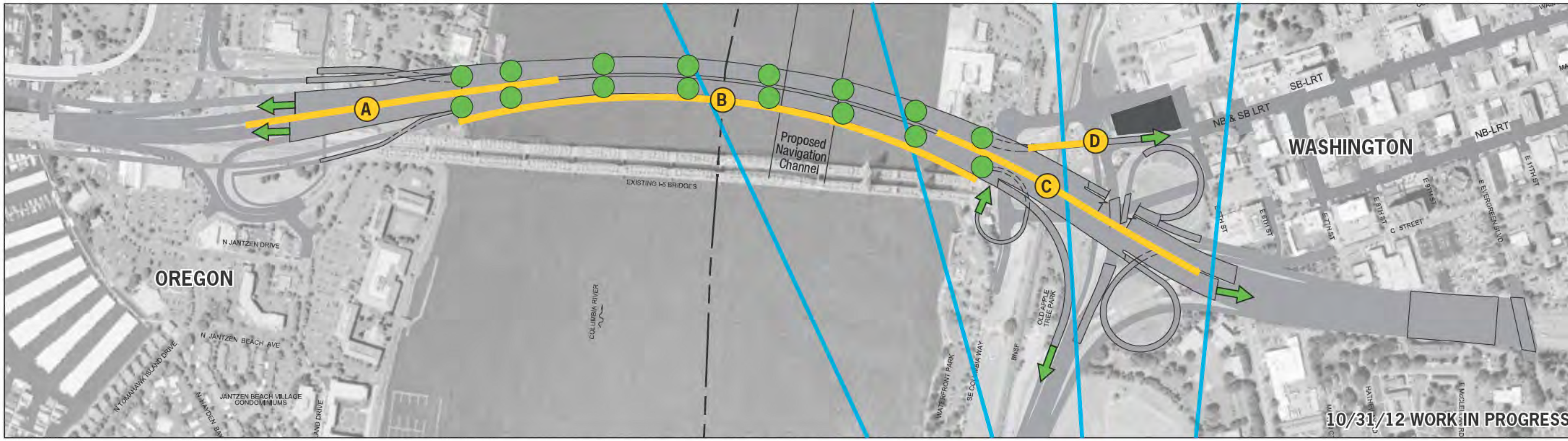
- (A) (C) **Mainline grade**
- (B) **Traffic performance**
- (D) **Transit grade**
- (E) (G) **FAA airspace**
- (F) **Foundation sizes**
- (H) **6th Street – I-5 South**
- (I) **Transit alignment and stations**

Significant challenge to maintain function

FAA airspace

Exhibit 7.3-9
100 feet Analysis
43 Vessels/Users Potentially Impacted*

Columbia River CROSSING



** Based on 2011 CEVP, does not include mitigation costs.

* Potential impacts at 16 ft river stage and 10 ft air gap. Some of the vessels would pass at a lower river stage and/or with a smaller air gap. For this illustration each fabricator was represented by 1 vessel.

		Hayden Island	Main Crossing	Vancouver	TOTAL COST
Cost increase estimate over 95 feet**	60%	$9 million	$3 million	$10 million	$22 million
Highway/Transit		(A) In Oregon the mainline grade increases to 3.48% from 2.83%. This would need a design exception for a grade above 3%.	(B) More traffic analysis needed to address changes to traffic operations due to increased grades.	(C) In Washington the mainline grade increases to 3.81% from 3.40%. (D) Transit grade on Washington approach is 6% for an additional 120 feet.	

NOTE: *Estimates of impacts and costs are preliminary and may be refined following selection of a recommended bridge height.*

Cost increase

- Ramps lengthen
- Column height increases
- Column height increases and column footprint expands

Preliminary Findings

- (A) (C) Mainline grade
- (B) Traffic performance
- (D) Transit grade
- (E) (G) FAA airspace
- (F) Foundation sizes
- (H) 6th Street – I-5 South
- (I) Transit alignment and stations

Significant challenge to maintain function

FAA airspace

Exhibit 7.3-10
105 feet Analysis
27 Vessels/Users Potentially Impacted*

** Based on 2011 CEVP, does not include mitigation costs.

* Potential impacts at 16 ft river stage and 10 ft air gap. Some of the vessels would pass at a lower river stage and/or with a smaller air gap. For this illustration each fabricator was represented by 1 vessel.

		Hayden Island	Main Crossing	Vancouver	TOTAL COST
Cost increase estimate over 95 feet**	60%	$9 million	$17 million	$10 million	$36 million
Highway/Transit		(A) In Oregon the mainline grade increases to 3.73% from 2.83%. This would need a design exception for a grade above 3%.	(B) More traffic analysis needed to address changes to traffic operations due to increased grades. (E) Top of roadway deck at centerline is 29' below FAA surface. (F) Foundation sizes may increase, however, they are still consistent with FEIS.	(C) In Washington the mainline grade increases to 3.99% from 3.40%. (D) Transit grade on Washington approach is 6% for an additional 130 feet.	

NOTE: *Estimates of impacts and costs are preliminary and may be refined following selection of a recommended bridge height.*

Cost increase

- Ramps lengthen
- Column height increases
- Column height increases and column footprint expands

Preliminary Findings

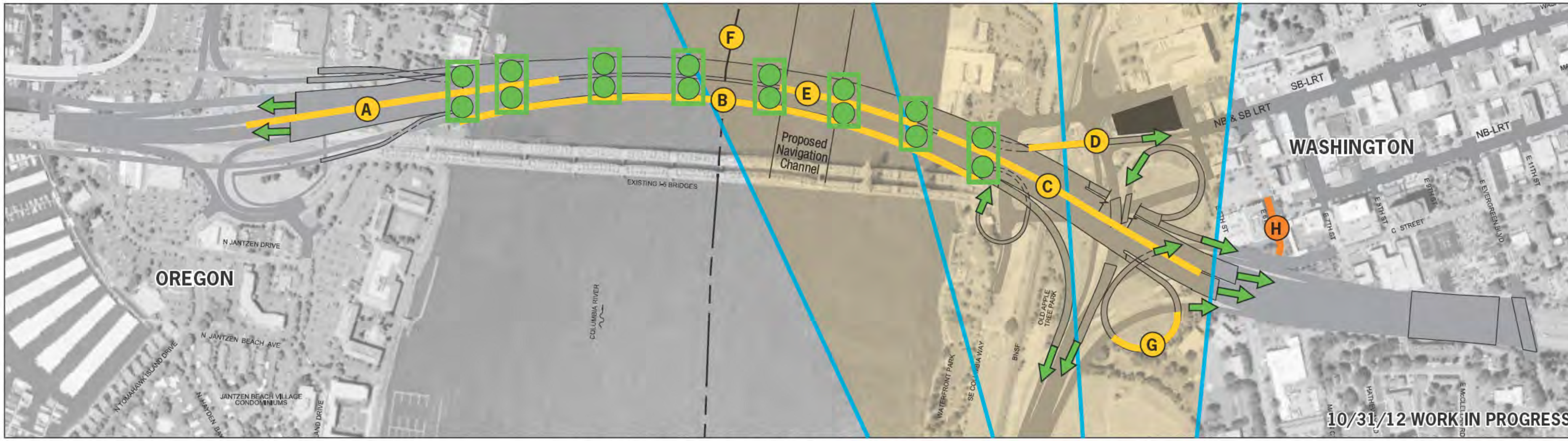
- (A) (C) **Mainline grade**
- (B) **Traffic performance**
- (D) **Transit grade**
- (E) (G) **FAA airspace**
- (F) **Foundation sizes**
- (H) **6th Street – I-5 South**
- (I) **Transit alignment and stations**

Significant challenge to maintain function

FAA airspace

Exhibit 7.3-11
110 feet Analysis
20 Vessels/Users Potentially Impacted*

Columbia River CROSSING



** Based on 2011 CEVP, does not include mitigation costs.

* Potential impacts at 16 ft river stage and 10 ft air gap. Some of the vessels would pass at a lower river stage and/or with a smaller air gap. For this illustration each fabricator was represented by 1 vessel.

		Hayden Island	Main Crossing	Vancouver	TOTAL COST
Cost increase estimate over 95 feet**	60%	**$18 million**	**$19 million**	**$54 million**	**$91 million**
Highway/Transit		(A) In Oregon the mainline grade increases to 3.99% from 2.83%. This would need a design exception for a grade above 3%.	(B) More traffic analysis needed to address changes to traffic operations due to increased grades. (E) Top of roadway deck at centerline is 22' below FAA surface. (F) Foundation sizes may increase, however, they are still consistent with FEIS.	(C) In Washington the mainline grade increases to 3.99% from 3.40%. (D) Transit grade on Washington approach is 6% for an additional 300 feet. (H) 6th St. to I-5 South becomes challenging. (G) Top of roadway deck at 5N-C St. is 30' below FAA surface.	

NOTE: *Estimates of impacts and costs are preliminary and may be refined following selection of a recommended bridge height.*

Cost increase

- Ramps lengthen
- Column height increases
- Column height increases and column footprint expands

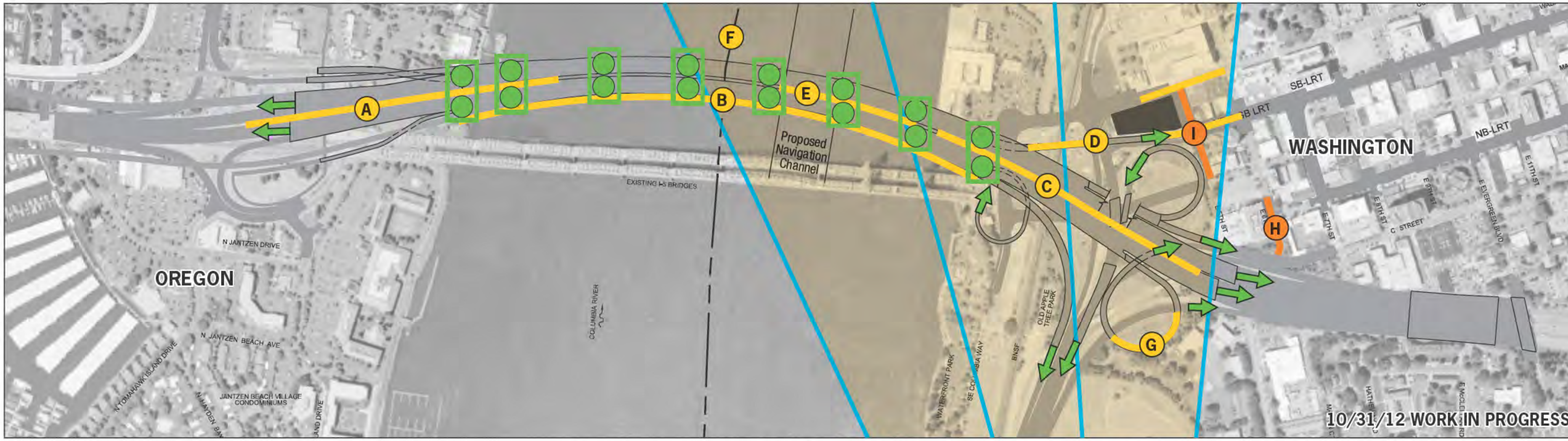
Preliminary Findings

- (A) (C) **Mainline grade**
- (B) **Traffic performance**
- (D) **Transit grade**
- (E) (G) **FAA airspace**
- (F) **Foundation sizes**
- (H) **6th Street – I-5 South**
- (I) **Transit alignment and stations**

Significant challenge to maintain function

FAA airspace

Exhibit 7.3-12
115 feet Analysis
13 Vessels/Users Potentially Impacted*



** Based on 2011 CEVP, does not include mitigation costs.

* Potential impacts at 16 ft river stage and 10 ft air gap. Some of the vessels would pass at a lower river stage and/or with a smaller air gap. For this illustration each fabricator was represented by 1 vessel.

		Hayden Island	Main Crossing	Vancouver	TOTAL COST
Cost increase estimate over 95 feet**	60%	$18 million	$93 million	$65 million	$176 million
Highway/Transit		(A) In Oregon the mainline grade increases to 3.99% from 2.83%. This would need a design exception for a grade above 3%.	(B) More traffic analysis needed to address changes to traffic operations due to increased grades. (E) Top of roadway deck at centerline is 17' below FAA surface. (F) Foundation sizes may increase, however, they are still consistent with FEIS.	(C) In Washington the mainline grade increases to 4% from 3.40%. (H) 6th St. to I-5 South may be closed. (G) Top of roadway deck at 5N-C St. is 25' below FAA surface. (D) Transit grade on Washington approach is 6% for an additional 470 feet. (I) 6th St. Station platform grade raised resulting in 6'-8' over existing grade closing 5th St. Impacts to businesses on Washington between 5th and 6th St. Access to and from Park & Ride limited to Columbia St. Intersection at 6th and Washington requires modification. Challenging to maintain circulation in and out of parking structure.	

NOTE: *Estimates of impacts and costs are preliminary and may be refined following selection of a recommended bridge height.*

Cost increase

- Ramps lengthen
- Column height increases
- Column height increases and column footprint expands

Preliminary Findings

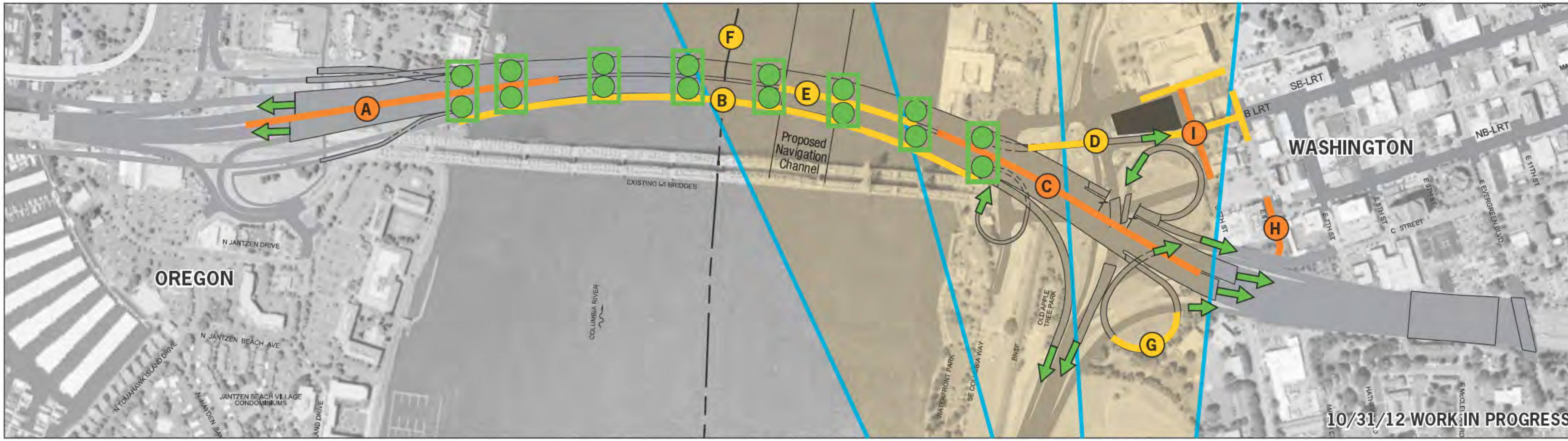
- **(A) (C) Mainline grade**
- **(B) Traffic performance**
- **(D) Transit grade**
- **(E) (G) FAA airspace**
- **(F) Foundation sizes**
- **(H) 6th Street – I-5 South**
- **(I) Transit alignment and stations**

Significant challenge to maintain function

FAA airspace

Exhibit 7.3-13
120 feet Analysis
9 Vessels/Users Potentially Impacted*

Columbia River CROSSING



** Based on 2011 CEVP, does not include mitigation costs.

* Potential impacts at 16 ft river stage and 10 ft air gap. Some of the vessels would pass at a lower river stage and/or with a smaller air gap. For this illustration each fabricator was represented by 1 vessel.

		Hayden Island	Main Crossing	Vancouver	TOTAL COST
Cost increase estimate over 95 feet**	60%	$24 million	$94 million	$53 million	$171 million
Highway/Transit		(A) In Oregon the mainline grade increases to 5% from 2.83%. This would need a design exception for a grade above 3%.	(B) More traffic analysis needed to address changes to traffic operations due to increased grades. (E) Top of roadway deck at centerline is 12' below FAA surface. (F) Foundation sizes may increase, however, they are still consistent with FEIS.	(C) In Washington the mainline grade increases to 5% from 3.40%. (H) 6th St. to I-5 South may be closed. (G) Top of roadway deck at 5N-C St. is 41' below FAA surface. (D) Transit grade on Washington approach is 6% for an additional 470 feet. (I) 6th St. Station platform grade raised resulting in 7'-9' over existing grade closing 5th St. Impacts to businesses on Washington between 5th and 6th St. Access to and from Park & Ride limited to Columbia St. Intersection at 6th and Washington requires modification. Challenging to maintain circulation in and out of parking structure.	

NOTE: *Estimates of impacts and costs are preliminary and may be refined following selection of a recommended bridge height.*

Cost increase

- Ramps lengthen
- Column height increases
- Column height increases and column footprint expands

Preliminary Findings

- (A) (C) **Mainline grade**
- (B) **Traffic performance**
- (D) **Transit grade**
- (E) (G) **FAA airspace**
- (F) **Foundation sizes**
- (H) **6th Street – I-5 South**
- (I) **Transit alignment and stations**

Significant challenge to maintain function

FAA airspace

Exhibit 7.3-14
125 feet Analysis
8 Vessels/Users Potentially Impacted*

Columbia River CROSSING

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7.4 Impacts to Future Users and Land Use

This chapter assesses how the proposed new I-5 bridges, for the bridge heights studied, would impact projected future land uses along the river and future river users. Section 7.4.1identifies likely future land use and impacts to future land use, and Section 7.4.2 identifies and evaluates impacts to anticipated future vessels.

7.4.1 Future Land Use

This section assesses water-dependent land uses along the Columbia River, and the potential for water-dependent development to help inform whether the bridge heights being studied (95 to 125 feet) for the proposed bridges could adversely affect future development of water-dependent sites upriver from the bridge.

Water-dependent land uses are generally defined as those uses that can be carried out only on, in, or adjacent to a body of water, because they require access to the water for transportation or recreation and which, by their nature, can be built only on, in, or over water.

The BNSF railroad bridge at Celilo Falls, located 95 miles above the I-5 bridge, has a vertical clearance of 79 feet in the raised position. Because this vertical clearance is notably less than that proposed for the Columbia River Crossing, no marine-related activities upstream of the Celilo bridge would be affected by the construction of the proposed I-5 bridges with a mid-level vertical clearance. Therefore, the area studied for this report includes that stretch of the Columbia River between the Columbia River Crossing and the BNSF Celilo Bridge.

All sites with the potential for water-dependent development were examined, and owners or controlling agencies were contacted to determine future plans. A summary of the key findings for each of the jurisdictions within the project area is described below. Comprehensive plan and zoning regulations as they relate to water-dependent uses are included in Appendix A.

Issues Affecting Riverfront Development

Some key overarching findings related to the development along the Columbia River in the project extent are summarized in this section.

In general, the Columbia River shoreline is identified by local jurisdictions as a resource to be leveraged for river-dependent uses that are more in line with recreational, environmental, habitat or economical purposes than with industrial marine, water-dependent uses. The intrinsic value of the Columbia River is largely in its natural beauty, especially within the Columbia River Gorge National Scenic Area. Columbia River Gorge Scenic Area (National Scenic Area, or NSA)

An important component of the overall context of the study area is the National Scenic Area (see Appendix A for Scenic Area boundaries), which severely limits industrial development within the project area outside of existing incorporated communities and the Portland-Vancouver Metropolitan Area. This creates an “island” effect for industrial uses, which often support each other. However, the Scenic Area protects the natural beauty of the Gorge, making it desirable for recreationalists and tourists, including those who access the Gorge by boat (potentially by sailboat).

Industrial Campuses Trend

Based on interviews and a literature review, most of the industrially zoned sites along the Columbia River that are owned by ports are being planned as industrial campuses that support light industrial and commercial uses, and that will not generate marine traffic. This includes properties at Cascade Locks, The Dalles, and Stevenson.

Other Freight Options

Rail lines and highways run parallel to the river on both sides and provide options for freight cargo. For example, the Nestlé Corporation has shown interest in developing riverfront property in Cascade Locks; however, Nestlé's plan is to move freight by truck instead of by barge.

In addition to providing alternative means of transportation, the highways and rail lines also constrain development along the waterfront, as described below.

Existing Site Constraints

In many cases the linear rights-of-way of State Route 14 (SR14), Interstate 84 (I-84), and Union Pacific Railroad (UPRR), on both sides of the river, can restrict lot depth, making the area less conducive to certain types of development. Given the steep topography and limited area for placement of these rights-of-way, they often run along the shoreline, precluding industrial development.

Public Access to Waterfront

Many jurisdictions along the river have goals to increase public access and use of the shoreline for river recreation, potentially limiting other types of uses. For example, Cascade Locks has been planning for a new marina. The Dalles just added space to its marina, which is within walking distance of its downtown center, making it ideal for tourists to come to The Dalles by boat. New facilities, the growth in wine tourism, and the beauty of the Gorge are likely to increase tourism to the area, including tourists who may travel by boat. This could generate higher volumes of recreational boats in the area, including recreational power boats (including sailboats) and commercial cruise boats.

Riverfront Trails

Many jurisdictions (such as Hood River, The Dalles, and Vancouver) have recreation trails and plans for future recreation trails along the river. Such trails can create a barrier to other marine-dependent uses of the Columbia River shoreline.

Redevelopment Potential of Industrial Sites with Existing Marine Structures

Redevelopment of sites that have existing marine-traffic docking structures could be significantly easier and less expensive, because redevelopment of such sites would have the potential to bypass, or have less arduous, environmental permitting requirements.

Summary of Findings by Subarea

Within the project area, there are undeveloped and potentially redevelopable sites along the Columbia River, which are zoned for industrial and other uses that could generate marine traffic that requires varying navigational clearances. There are sites that have existing marine infrastructure, such as lumber mills, which could also redevelop with different water dependent uses in the future and that could use the existing marine infrastructure. These sites are primarily located within incorporated jurisdictions.

This section provides a summary of the findings by subarea.

Clark County, Washington (Vancouver)

The water-dependent industrial sites within the jurisdiction of the City of Vancouver include industrial uses at the Columbia Business Center (metal fabricators include Thompson Metal Fab, Oregon Iron Works and Greenberry Industrial; and JT Marine, a marine contractor), Christiansen Shipyard ,the Kiewit property, and recreational moorage at Steamboat Landing Marina and several docks associated with private residences.

It is uncertain whether all of the parcels in the Columbia Business Center will remain in industrial use over the long run. Some of the main fabrication buildings were built in the 1940s and "suffer from some form of functional obsolescence. In addition, many of these older properties are in poor condition with significant deferred maintenance."[21] If these areas are redeveloped, it could be in a mixed use (residential, commercial and retail uses) like the area immediately to the west. A portion of the eastern shoreline of the Columbia Business Center is owned by Oregon Iron Works, which has indicated that it will continue in long-term industrial use.

Only the uses at the Columbia Business Center are currently height constrained in the affected area in the City of Vancouver. The height constrained uses include fabricated structures such as oil rig modules, and fish weirs, among others, and marine equipment owned by JT Marine.

Based upon existing land use regulations, there are no vacant waterfront parcels that could be placed in industrial use.

The marina and private moorages typically serve smaller powerboats and sailboats (up to 40 feet) and are not known to be height constrained. Some recreational sailboats may experience height constraints depending on the option under consideration. However, this constraint is not expected to impact many sailboats.

As noted above, a review of the triennial surveys undertaken by the Oregon State Marine Board underscores the fact that most sailboats either do not require a bridge opening or avoid bridge openings.

Clark County, Washington (Camas)

There are two existing water-dependent sites within the jurisdiction of the City of Camas, including the Georgia Pacific Camas Mill and the City of Camas Boat Ramp. It is likely that both sites could remain in these uses in the future.

The Georgia Pacific mill would not be constrained by the proposed I-5 bridges options because it already has a height constraint imposed by the bridges that connect US 14 to Lady Island.

[21] Source: GS Mortgage Securities Trust, Series 2012-GCJ7 by DBRS, May 15, 2012, page 21.

In addition to the Georgia Pacific mill and the boat ramp, the City of Camas leases a portion of shoreline to Mark Marine Service. The lease was renewed for 5 years in February 2011. Future use of this parcel could remain in industrial use or change to public access.

Clark County, Washington (Washougal)

The waterfront industrial property in Washougal has been rezoned to highway commercial zoning and is undergoing a process of waterfront revitalization, focusing on mixed-use development (residential and commercial). This development encompasses the Port of Camas-Washougal Marina, the site of the former Hambleton Lumber Mill and the Port of Camas-Washougal's 6th Street property. These three properties are collectively referred to as the Washougal Waterfront.

Most of the moorage slips at the Port's marina are covered, and are only usable by power boats, which are not height constrained. It is possible that some of sailboats at the marina could be height-constrained by the bridge height options being studied. However, most of the sailboats are 50 feet or less in length, and sailboats of this size will not be height constrained by the CRC options under consideration.

In Washougal, Legendary Yachts is building sailboats that may be constrained by the CRC options under consideration. However, the boat yard is not located on the river, and the sailboats it builds are transported by road to a launch site, where the mast is stepped. The stepping of the mast could occur downriver of the new bridges.

Industrial development in Washougal is centered in the Port of Washougal's industrial properties at the eastern edge of the City. Heavy industrial zoning at this site accommodates uses such as bulk petroleum product terminals, plants and storage facilities which could generate marine traffic. However, a levee and recreation areas/trails parallel the river and separate the industrial site from the water, which inhibits marine industrial uses along the riverfront in Washougal.

Skamania County, Washington

The industrial waterfront properties in Skamania County have been traditionally used by the forest products industry, including the mill sites at Stevenson, Home Valley and Underwood. As the forest product sector has declined, properties have been held by forest product firms for potential future re-use as a mill site or have been planned for redevelopment to resort or mixed-use development. The proposed I-5 bridges do not impose a height constraint on shipping activities because log rafts or barges can easily pass under the bridge for destinations transiting downriver of the bridge.

The Port of Skamania owns a business park, cruise terminal and boat launch at Stevenson. The Port's property at Stevenson Landing is on the waterfront and has a cruise ship dock but does not offer waterfront access for water-dependent firms requiring barge service. Within the City of Stevenson, there is interest by the community to enhance recreational waterfront with public access.

Other land holdings in Skamania County provide space for commercial and industrial tenants but do not have direct access to the Columbia River (e.g., The Port of Skamania County's Cascades Business Park, the Lewis and Clark Business Park and the Wind River Business Park).

Klickitat County, Washington

Most of the occupied industrial lots along the riverfront in Klickitat County are used by the timber industry, which generates cargoes (logs, wood chips, and aggregates, etc.) that are not height constrained. It is expected that the bridge will not have any impacts to shipping related to the timber industry. However, SDS Lumber also has construction equipment that may be height constrained, as discussed in Section 7.4.2.

There are some undeveloped industrial lots along the river in Klickitat County. The county's Industrial Park zoning allows for boat building, assembly and fabrication of metal products, and additional manufacturing activities as uses permitted outright. However, many of the industrially designated lots are constrained by the railroad right of way, which creates shallow lots from the river and potentially limits large industrial structures on the site.

There are also vacant developable industrial lands at Dallesport Industrial Park. However, the BNSF railroad right of way cuts through the property near the river, leaving a narrow band of land adjacent to the river that is currently used by a barge terminal. It is unlikely that future uses would be height constrained at this location.

Multnomah County, Oregon (Portland)

There are many recreational marinas in the area between Hayden Island and Government Island that are used by both powerboats and sailboats. There are no known plans to change land uses in this section of the riverfront.

Multnomah County, Oregon (Fairview)

The industrially zoned sites in this area generate marine traffic that primarily consists of tugs and barges, which are not height constrained.

The Knife River aggregates terminal is not expected to change uses in the near future. Tugs and barges serving this facility are not height constrained.

Sundial Tug & Barge Works was closed by Tidewater in early 2011, because the vessel repair and construction business was cyclical, and not a core business function. The facility is currently idle, and could be sold or redeveloped.

Hood River County, Oregon (Cascade Locks)

There are undeveloped industrial lots along the river in the City of Cascade Locks. However, these lots have been identified for types of development that would not generate marine traffic, such as a business park serving non-water dependent firms, or entertainment and recreational uses, including a casino.

Cascade Locks is positioning itself as a sailboat racing destination. In general, there is a desire to attract the international sailing community, but the sailboats using this area are smaller and not height constrained by the proposed bridges.

Hood River County, Oregon (Hood River)

Activities that generate marine cargo are limited along Hood River's riverfront, due to the railroad tracks that abut the river for a large portion of the shoreline. In the Port of Hood River area, the emphasis is on recreational development and business park development rather than marine-based industrial uses.

Cruise ships that call Hood River (*Safari Quest*, *Sea Bird*, *Sea Lion* and *Columbia Gorge* Sternwheeler) are not constrained by the proposed height of the CRC.

The sailboats homeported in Hood River or calling on a transient basis at Hood River are typically less than 40-feet long, and as a result are not constrained by the proposed height of the CRC.

There are no known existing or future activities that would be height constrained in Hood River.

Wasco County, Oregon

Bernert Barge Lines and Mid Columbia Producers have barge terminals at the Port of The Dalles. The tugs and barges calling at these terminals are not constrained by the proposed height of the CRC.

The sailboats homeported at or visiting the Port's Marina are typically smaller and are not height constrained by the CRC. As noted above, there are no known boats owned by residents of this area that are longer than 44 feet.

A new cruise dock was opened in The Dalles in September 2012, which provides a float to serve transient recreational boats, and a fixed pier for cruise ships, similar to the vessels calling at Hood River, which are not height constrained.

Other industrial developments are focused on redevelopment of the Northwest Aluminum site, which offers approximately 120 acres for commercial and industrial development. This site does not provide riverfront access.

Summary of Redevelopment Opportunities

There are no known planned developments that would significantly increase the height-constrained activities in the affected area. Efforts are underway in upriver counties to reuse vacant or underutilized industrial waterfront parcels in forest products manufacturing (which is not height constrained) or in non-water-dependent uses, including commercial business parks, mixed use residential/commercial developments and tourist centers.

As discussed in greater detail below, ocean barges, which are used to transport large fabricated structures, cannot pass through the Bonneville Lock. This constraint limits the ability to pursue metal fabrication uses in Skamania, Klickitat, Hood River and Wasco Counties. There are a few sites that could be used for metal fabrication in Clark and Multnomah Counties but future users would likely also consider available Columbia River sites that are located downriver of the I-5 bridge as well locations in other parts of Oregon and Washington. There are no known planned developments for additional metal fabricators in the impacted area.

There are several boatyards and shipyards in the affected area (JT Marine, Sundial Tug & Barge Works, Christianson Shipyard, Legendary Yachts, etc.) Most of the projects undertaken in these yards are not height constrained but there are a few exceptions, including potential future manufacture and/or repair of large sailboats and marine construction equipment. Sundial is currently idle because it was underutilized. It could be reactivated as a boatyard or for another use. There are numerous other yards located downriver of the I-5 bridge in the Columbia River (for example, Vigor Industrial's Swan Island shipyard, Schooner Creek Boat Works, Foss Shipyard in Rainier, etc.) as well as other facilities in Oregon and Washington. There are no known planned developments for additional boatyards or shipyards in the impacted area.

7.4.2 Future Vessel Analysis

This chapter evaluates the expected impact of the bridge heights studied on future river users that could transit under the I-5 bridge. Most of the vessels transiting the I-5 bridge are anticipated to have similar height ranges as occur at the present time:

- Commercial tugs and tows are expected to continue to have air drafts ranging from 28 to 61 feet.
- The larger recreational sailboats, which have an air draft exceeding 69 feet, would have a height constraint using the 26 foot margin (16 feet of water and an 10 foot air gap) if a 95-foot high I-5 bridge is constructed.
- Most powerboats will continue to have a maximum air draft ranging from 20 to 25 feet, and would be unaffected by any of the I-5 bridge options under consideration.
- Future transits by federal government users would likely be similar to existing vessels. The USACE Hopper *Dredge Yaquina* has an air draft of 92 feet). The largest Puget Sound Naval Shipyard transport barge has an air draft of 51.25 feet, and the largest escort has an air draft of 74 feet.
- Passenger cruise vessels that call at upriver ports have air drafts that range from 42 to 65 feet. The Grays Harbor Historical Seaport Authority has two sailing vessels with air drafts of 74 and 85 feet.

The exceptions for height increases are expected increases in size for marine contractors and fabricated structures (particularly oil rig modules).

- Marine contractors utilize barges with cranes or derricks that have an air draft ranging from 20 feet to 131 feet.
- Marine industries and fabricators ship products or have vessels transiting under the I-5 bridges on an as-needed basis all months of the year. The air drafts have ranged from 60 feet to 141 feet in the recent past and could exceed 160 feet in the future.

Reported air drafts for specifically anticipated future vessels and shipments are shown in Exhibit 7.4-1.

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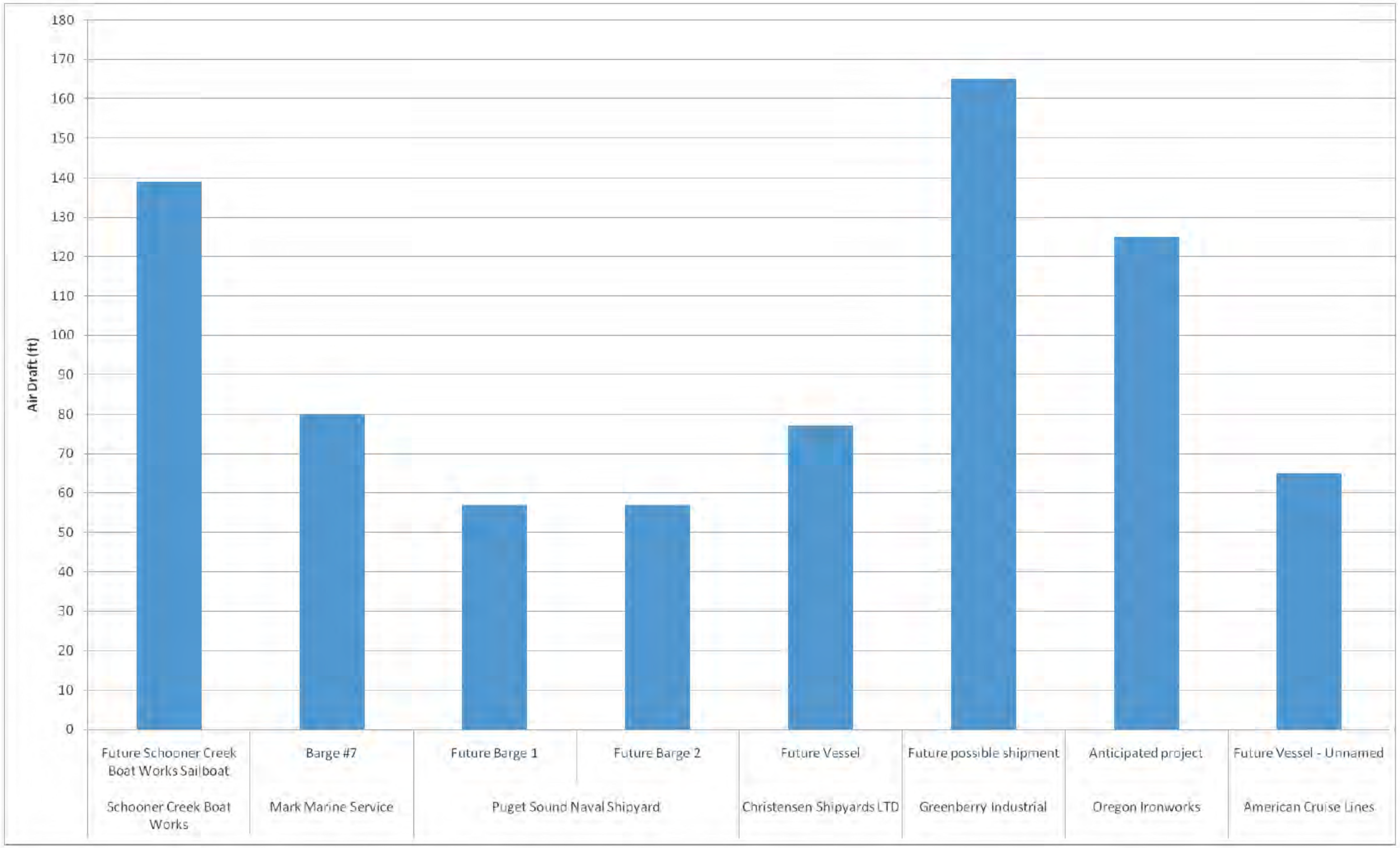

Exhibit 7.4-1
Air Drafts of Future User Vessels

Columbia River CROSSING

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Tugs and Barges

Tugs and barges transiting this region fall into one of two categories: ocean tugs and barges that serve the metal fabricators at the Columbia Business Center and tugs and barges that carry commodities on the shallow draft river system between Portland/Vancouver and Lewiston.

River barges are sized to transit the locks and bridges in the Columbia-Snake River System. Tugs are higher than barges and are the more height constrained component of this group. Tugs operating in the river system typically have a highest fixed point less than 55 feet high are constrained by numerous bridges that cross the channel (61 feet on the Columbia River and 60 feet on Snake River). Future river tugs are expected to remain within these height ranges.

River barges are typically 150 feet to 273 feet long and with a beam (width) of up to 42 feet. A standard tow consists of a tug with four barges lashed two abreast. This tow configuration can pass through the Bonneville Lock, which has a lock chamber that is 86 feet wide and 675 feet long. Future river barges are expected to remain within these dimensions. Ocean tugs and barges are discussed under Marine Industries and Fabricators.

Marine Industries and Fabricators

Based on discussions with fabricators and a review of literature, some of the fabricated structures manufactured at the Columbia Business Center could be taller in the future than the tallest shipments in the past. Oil rigs are growing in dimensions in response to new technologies such as directional drilling of oil fields. These structures may require transiting heights in excess of 125 feet. Other structures, such as fish weirs and bridge trusses, are unlikely to change significantly in the future. However, these future shipments could be constrained by CRC bridge options that are lower than 110 feet.

Most of the fabricated metal structures are transported by ocean barges bound for destinations located outside of the Columbia River, including Alaska, California and elsewhere. Ocean barges are larger than river barges, with lengths of 400 or more feet and a beam (width) of 100 feet or more. Ocean barges cannot transit above the Bonneville Lock, because their beam exceeds the width of the lock chamber. As a result, future fabricated metal operations in the affected region of the river are limited to the area downstream of the Bonneville Dam.

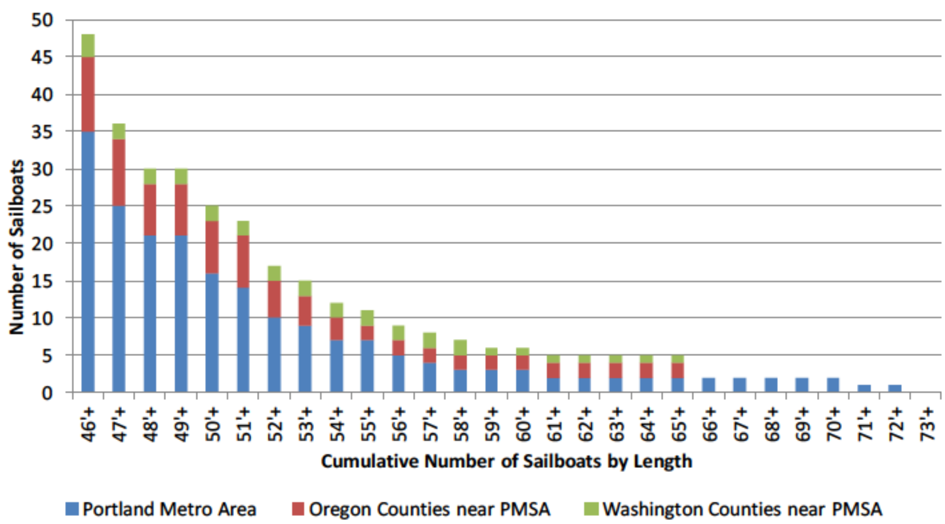
Sailboats

Most of the sailboat activity that transits the bridge is generated by residents living in or near the Greater Portland area.[22] This area is defined as follows: Portland Metro Area (Clackamas, Columbia and Multnomah counties in Oregon and Clark and Skamania counties in Washington), adjacent Oregon counties surrounding the Portland Metro Area (Washington, Yamhill, Polk, Marion, Linn, Wasco, Hood River and Sherman counties) and adjacent Washington counties surrounding the Portland Metro Area (Cowlitz, Lewis, Yakima and Klickitat counties).

[22] According to the Oregon State Marine Board (OSMB) triennial survey of recreational boat users that are registered in Oregon, approximately 97 percent of the recreational boating activity by boaters in Multnomah County is undertaken by residents in the defined area. It should be noted that the survey excludes usage patterns by Washington State residents in the Portland area that keep their boats in Washington state or by boaters from another area.

There are 48 sailboats that are 46 feet or longer in this area (35 sailboats in the Portland Metro area, 10 in Oregon counties surrounding the PMSA and 3 in Washington State counties surrounding the PMSA).[23] (See Exhibit 7.4-2.) There are no sailboats that are 46 feet or longer in Skamania and Klickitat Counties in Washington State or Hood River and Wasco Counties in Oregon State. As the length of the sailboat increases, the number of vessels declines. For example, there are two vessels at 70 feet or longer (both owned by residents of the Portland Metro Area).

Exhibit 7.4-2. Portland Area Large Sailboat Fleet (cumulative number of sailboats)



Source: Oregon State Marine Board and Washington State Department of Licensing.

Portland Metro Area is defined to include: Clackamas, Columbia and Multnomah counties in Oregon and Clark and Skamania counties in Washington.

Adjacent Oregon counties (near PMSA) are defined to include: Washington, Yamhill, Polk, Marion, Linn, Wasco, Hood River and Sherman counties.

Adjacent Washington counties (near PMSA) are defined to include: Cowlitz, Lewis, Yakima and Klickitat counties.

A forecast for large sailboats was prepared by the project team based upon a projection of boat ownership per capita. The forecast implies that large sailboat ownership could increase at approximately 0.5 percent per year between 2012 and 2040, or about half of the population gain that is expected in this region. As shown in Exhibit 7.4-3, there could be 7 more sailboats 46 feet long or longer. Sailboats that are 46 feet long could be constrained by the 95-foot CRC option, assuming a mast height to length ratio of 1.5 and a margin of 26 feet (16 feet of water above CRD and an air gap of 10 feet). If the mast is shorter (1.2 or 1.0 times the length) or if the depth of water and/or air gap are reduced, the sailboat may not be constrained.

Exhibit 7.4-3 Forecast of Large Sailboat Ownership in the Portland Area, 2012-2040

Length	46'+	47'+	48'+	49'+	50'+	55'+	60'+	65'+	70'+	71'+	72'+	73'+

[23] Source: Oregon State Marine Board and Washington State Department of Licensing.

2012	48	36	30	30	25	11	6	5	2	1	1	-
2040	55	41	34	34	28	12	6	5	2	1	1	-

Source: Project team using data from Oregon State Marine Board, Washington State Department of Licensing, Washington State Office of Financial Management and Woods and Poole.

Construction equipment

Bridge transits by marine contractors are dependent upon their home location and the location of the construction project. Three marine contractors are located upriver of the I-5 Bridge (including JT Marine, Mark Marine Services and SDS Lumber Company). These contractors transit beneath the I-5 Bridge for downriver construction projects or to pick up supplies from downriver locations. Contractors that are located downriver of the I-5 bridges must transit the bridges for projects located upriver of the bridges.

As discussed previously in this report, the BNSF Celilo Bridge, located 95 miles upstream of the CRC, has a lower vertical clearance than that proposed for the CRC, and any marine construction project upstream of the Celilo Bridge will not be height-constrained by the proposed I-5 bridges. Therefore the only marine construction projects that would be constrained by the proposed I-5 bridges are jobs located between the CRC and Celilo Bridge that are performed by firms based downstream of the CRC, and jobs located downstream of the CRC that are performed by firms based upstream of the CRC.

According to interviews with port personnel, most of the marine construction at the upriver ports is conducted by land based equipment to the extent possible. Recent examples include the Port of Cascade Locks (recent boarding float replacement), Hood River (groin and riprap slope protection repair), Arlington (piling and boat ramp), Pasco (seawall upgrade) and Whitman County (repaired sheet pile dock and removed rock from a berth). Work that has involved water based equipment includes a commercial dock at The Dalles, pile driving and dolphin construction for the Port of Arlington, and docks and barges slips at the Port of Morrow.

The volume of marine construction located between the CRC and Celilo Bridge in the future will be limited by the amount of property available for development. As discussed under the Future Land Use Analysis, most of this area is in the Columbia River Gorge National Scenic Area, which strictly limits the types of development that may occur. Downstream of the National Scenic Area there are a limited number of sites available for water-dependent development.

Future projects between the CRC and Celilo Bridge that may require water-based construction equipment could include bridge replacements, or work on dams or locks.

Based on past trends and future land use, future marine construction is not expected to exceed past averages. A number of marine construction companies were contacted to determine the highest fixed points of their equipment. Air drafts for construction equipment ranged from 20 feet to 131.

Many but not all of the marine construction vessels will be able to transit the proposed options under consideration for the CRC, given the current figuration of the equipment. Equipment that, as currently configured, is not able to pass under the proposed I-5 bridges is not precluded from working on projects past the CRC, but may require a temporary or permanent modification to transit the bridge.

Dredges

A wide variety of vessel types and configurations are used for dredging, including barges mounted with suction equipment, barges that use clamshell buckets, and ships equipped with suction equipment or clamshell buckets.

The navigation channel that runs beneath the proposed Columbia River Crossing extends nearly 230 miles along the Columbia River to Richland/Kennewick/Pasco, Washington, and also runs along 140 miles of the Snake River from the confluence at Pasco to Lewiston, Idaho. Along this channel there are numerous berthing facilities for cargo barges and navigation locks, all of which require regular maintenance dredging.

The amount of dredging that occurs above the proposed I-5 bridges is unlikely to be substantially different than in past years.

No dredge equipment that would be constrained by the BNSF Celilo Falls Bridge will be constrained by the proposed I-5 bridges, therefore only dredge work between the CRC and the Celilo Falls Bridge is potentially impacted.

As discussed above, because the USACE vessel *Yaquina* is the dredge that most frequently requires bridge openings at I-5, most of the impact of the will be to the *Yaquina*. As noted previously, USACE has stated that the height of the *Yaquina* is 92 feet at light draft. The Port of Portland dredge *Oregon* sometimes performs maintenance dredging on the Columbia River for USACE. The air draft of the *Oregon* with spuds raised is 103 feet. It has been reported that if there is adequate water depth, the spuds could be lowered approximately 10 feet thus reducing the air draft to 93 feet.

Future vessels deployed for maintenance dredging would be built to pass through locks and bridge that would limit navigation clearances in place at the time.

Government Vessels

Government vessels include Coast Guard, U.S. Navy, Tongue Point Job Corps Center, and other government-owned vessels, excluding dredges.

Two vessels operated by the Tongue Point Job Corps Center in Astoria accounted for 18 out of 21 bridge openings from 2002 through 2011. The remaining three openings were for US Coast Guard Vessels.

Prior to 2000 the majority of government vessels that required bridge openings were Coast Guard cutters or Navy supply ships. No Navy ships have required bridge lifts since before 2000. There is no known reason to project an increase in the number of government vessels passing through the CRC.

Passenger Vessels

The tall ships discussed in this section are sailing ships that are replicas or historical vessels. Three tall ships have been reported as requiring openings of the I-5 bridge: Lady Washington, *Hawaiian Chieftain*, and *Lynx*.

Cruise and passenger vessels include vessels that operate only on the Columbia and Snake Rivers, as well as though that offer seasonal itineraries. Included in this category are sightseeing boats and overnight cruise vessels.

Future passenger vessels are expected to remain at the heights of existing passenger vessel that transit the area. The cruise and passenger vessels that regularly operate in this area are constrained by other bridges; it is in the best interest of the operators to use vessels that can clear all of the bridges in the region. For example, the new Sellwood Bridge in Portland has a vertical clearance lower than that proposed for the CRC. In order to operate above the Sellwood Bridge, vessels will necessarily be able to clear the proposed I-5 bridges. The BNSF Celilo Bridge 95 miles upstream of the CRC has a vertical clearance significantly lower than the CRC, and bridges on the Snake River are even lower. Any cruise vessel operating up to Lewiston now will be able to clear the proposed I-5 bridges.

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8. Temporary Effects

The discussion below presents potential temporary effects on navigation. Actual construction methods may vary from what is described below, and result in different effects on navigation. The USCG prefers the continuous passage of tugs and tows throughout the construction process. Due to the possibility of alternate construction staging being used, the USCG will separately evaluate construction operations for their effects on navigation.

8.1 Main Span Columbia River

The replacement bridges over the Columbia River must be constructed in stages because they occupy some of the same area the existing bridges occupy. Over the existing navigation channel, the pier locations for the new bridges will be further apart than the existing bridges. Although vessels will navigate, temporarily, through a longer clearance envelope, it is not anticipated that this will create an adverse impact to navigation or safety levels.

The impact to navigation during the construction of the bridges is of key interest. Due to an anticipated length of construction of several years, it is imperative to accommodate frequent users, such as tugs and tows, during construction. Most vessels that currently use the navigation channel would be able to continue to use the channel throughout most of the construction period. If necessary, it may be possible to temporarily restrict infrequent or recreational vessels.

During construction, the height and width of the navigation envelope will be reduced due to construction equipment and pier placement prior to removal of the existing I-5 bridges. A temporary construction navigation envelope (height and width of unobstructed clearance for navigation) of 75 feet (vertical) by 200 feet (horizontal) will be provided, which meets the vessel clearance needs of the tugs and tows. However, there could be some temporary restrictions due to blockages from barges and cranes used to construct piers and lift bridge segments into place. The length of the navigation channel underneath structures will temporarily increase when the new Columbia River Bridges are under construction and the existing I-5 bridges are still in use. A potential construction staging sequence is presented in Section 9 that maintains the required temporary construction clearance envelope. The replacement bridges do not overlap the existing bridges adjacent piers, enabling the piers of adjacent bridges to be constructed together, reducing construction time.

During construction, some of the new bridge piers, outside of the navigation channel, would not line up with the existing bridge piers. While the new crossing is under construction and the existing crossing is still operational, this would result in more obstacles in the river and more difficulty in navigation. Also during construction, the project will establish navigational haul routes, on the river, for the movement of construction materials and equipment. See Chapter 9 for discussion of construction methods and staging schemes to minimize and mitigate temporary navigation impacts.

8.2 North Portland Harbor

The bridges that will be built over North Portland Harbor (NPH) will match or exceed, in height, the vertical clearance of the existing bridge over NPH. Short duration in-water work windows and constructability issues suggest that the new structures over NPH would most likely incorporate bridge elements that use prefabricated superstructure elements such as steel girders or precast segmental girders. These types of construction would eliminate the need for extensive supports in NPH. However, some temporary restrictions may be necessary due to barges and cranes used to lift bridge segments into place. Since extensive temporary supports are not likely, the navigation clearance will not be significantly reduced from today's clearance envelope, therefore navigation will not be adversely affected. See Chapter 9 for discussion of construction methods and staging schemes to minimize and mitigate temporary navigation impacts.

9. Potential Mitigation for Long-term Effects

9.1 Introduction

This section identifies potential mitigation for vessel transit impacts that would result from a "worst case" set of conditions regarding bridge height, air gap and river water level. Those assumed conditions were:

- A 95-foot-high bridge alternative
- A 10-foot-high air gap between the highest part of the vessel and the bridge
- A 16-foot CRD river level. Over the past 40 years, the river level at the I-5 bridges has been below 16 feet CRD, more than 98 percent of the time.

Each bridge height above 95 feet would further minimize vessel clearance impacts, as discussed in Chapter 7 and summarized below.

9.1.1 Avoidance and Minimization Overview

Avoidance and minimization measures typically precede the consideration or at least commitment of mitigation measures. Chapter 7 considered a variety of avoidance and minimization measures, primarily in the form of different bridge heights. The analysis in Chapter 7 demonstrated that the 95-foot fixed span bridge would impact up to 53 vessels under the assumed conditions, and up to 22 vessels under slightly less conservative assumptions (regarding water levels and air gap). Most of the impacted vessels could still pass at some time of the year although some would be too tall to pass at any time of year without mitigation.

Chapter 7 evaluated avoidance options defined by bridges that would match the 178 feet of vertical clearance under the existing bridges, thus avoiding any additional navigation impacts beyond existing conditions. Minimization options evaluated included bridge heights ranging from 100 to 135 feet. Each of these options would minimize vessel impacts compared to the 95-foot bridge described in the ROD. Compared to the 95-foot bridge, the 100-foot bridge would reduce the number of vessels impacted under the assumed conditions by 19 percent. The 105-foot bridge would reduce the number of vessels impacted by 49 percent compared to the 95-foot bridge. The 110-foot bridge would reduce it by 62 percent, and the 115-foot bridge would reduce it by 75 percent, compared to the 95-foot bridge. The 120-foot and 125-foot bridges would reduce the number of vessels impacted under the assumed conditions by 83 and 85 percent, respectively, compared to the 95-foot bridge.

Other minimization considered included modifying the "impact threshold", as defined by river level and air gap. As demonstrated in Chapter 7, with a less conservative air gap (5 feet rather than 10 feet) and slightly less conservative expectations for passage frequency (as defined by river levels achieved at least 80 percent of the days per year rather than at least 98 percent of the days per year), the number of vessels impacted (those prevented from passing at least part of the year) by a 95-foot bridge could be reduced by 58 percent (dropping from 53 vessels to 22). The percent reduction varies for a given bridge height, ranging from a reduction of 25 percent to a reduction of 63 percent.

The actual river level is below the “worst case” conditions assumed for analytical purposes (16 feet CRD) more than 98 percent of the year. Very few impacted vessels need to pass this frequently. About 90 percent of the potentially impacted vessel owners reported that their vessels transit just two or fewer times per month.[24] In addition, many vessels would not actually require a 10 foot air gap. If a vessel’s height, plus air gap is not significantly higher than the height of the bridge, it would be possible to schedule the transit under the bridges when river level stages permit. This type of scheduling may not always be possible for each vessel, but is a potential minimization measure to consider.

9.1.2 Mitigation Timeline and Overview

This chapter discusses potential mitigation measures that could be used to further reduce vessel impacts. When a final bridge height is determined, the mitigation options described below will be evaluated for each of the applicable impacts (described in Chapter 7) that would occur with the selected bridge height. Mitigation determinations will also consider the transit frequency needs of the vessels identified as impacted. Vessel owners have self-reported their transit frequency needs; most report that they do not need to transit 98 percent of the days in a given year. In addition, many would likely not require a 10-foot air gap. Less conservative assumptions may provide reasonable navigation needs for some vessels, while others would still need additional mitigation. The Project will further explore the mitigation measures with affected vessel owners and develop commitments after the bridge height is determined. Mitigation discussions with affected owners and commitments to mitigation will advance through the re-evaluation and permitting processes. For each impacted vessel owner, mitigation discussions and documentation will include the following:

- Identify proposed clearance being discussed for mitigation
- Describe the proposed mitigation for impacted users
- Evaluate the viability of the mitigation
- Develop statements from both parties to document status of mitigation discussions at key milestones.

The coordination and documentation would lead to specific mitigation commitments and mitigation work plans.

For this analysis, mitigation options are discussed for each vessel group rather than each individual vessel. Individual vessel mitigation requires understanding more about the specific vessel’s operations, navigating constraints and vessel architecture and is not generally included for each impacted vessel. However, there are several exceptions where this chapter describes mitigation specific to individual vessels. Potential mitigation measures are listed here for all impacted vessels to inform further evaluation once the bridge height is determined and the individual vessel situation is fully understood. No recommendation is made at this time as to who would be responsible for funding or executing the mitigation. It is assumed that this would be determined as part of the permitting process.

[2424] Source: Appendix B-1

The mitigation described below is for impacts associated with vessel transit on the main channel under the proposed I-5 bridges. No mitigation was developed for the proposed North Portland Harbor bridges as no impacts were identified or concerns raised by river users regarding these bridges. The vertical and horizontal clearances for the proposed bridges over North Portland Harbor meet or exceed the clearance of the existing North Portland Harbor Bridge. In addition, users in the vicinity of the proposed North Portland Harbor bridges are primarily recreational with clearance requirements that would not be impacted. It is also possible to reach the area upriver of the existing and proposed North Portland Harbor bridges without passing under those bridges since North Portland Harbor connects directly to the main channel of the Columbia River at both its upriver and downriver ends. North Portland Harbor bridges may be required to have navigation aids such as vertical clearance gauges, lighting, or other navigation aids, as determined by the USCG.

9.2 Potential Mitigation by Vessel Class

9.2.1 Commercial Tugs and Tows

No tugs or tows were identified as having difficulties transiting under the assumed conditions, therefore no mitigation opportunities were identified for these vessels.

9.2.2 Recreational Sailboats and Powerboats

No recreational powerboats were identified as having issues transiting under the assumed conditions. Seven existing sailboats and two identified future sailboats were identified as not being able to transit year round under the assumed conditions. Recreational sailboat masts are one-piece masts that cannot be easily disassembled, and they cannot be stepped down like those of the passenger sailing vessels. They almost always have antenna or other weather or GPS equipment that extends above the tops of their masts.

Mitigation Option 1 – Lower equipment higher than the mast

Sailboats with masts that allow them to transit under the assumed conditions, but that have antenna or other equipment that no longer make this possible, may have the option to lower the antenna or equipment prior to transiting under the new bridges. An alternative would be to accept an air gap less than 10 feet.

Mitigation Option 2 – Transport the sailing vessel over land to the other side of the bridge

If transiting underneath the new bridges is not possible, an alternative means to get to the other side of the bridge would be to haul the vessel out of the water and onto land, lower the mast, transport the vessel over land to the other side of the bridge, raise the mast, and then place the vessel back in the water. This option is only feasible when the need to get to the other side of the bridge is infrequent and it would realistically only be implemented for sailing trips that will result in the vessel remaining on the other side of the bridge for an extended period of time.

Mitigation Option 3 – Permanently relocate the vessel to the preferred side of the bridge

Sailing vessels that remain on one side of the bridge or the other and do not need or desire to transit under the bridge may be permanently berthed on that side of the bridge. If they are not already on their preferred side of the bridge, the vessel could be relocated.

Mitigation Option 4 – Provide replacement mast and sails

It may be possible to reconfigure the sailing vessel by providing smaller masts and sails. The services of a naval architect would be needed to determine if this is possible for the sailing vessel in question. This is not normally performed because mast and sails are matched with the vessel and alteration could significantly affect vessel performance.

Mitigation Option 5 – Acquire the vessel

This option entails the acquisition of the sailing vessel and taking it out of service so that the user no longer has a vessel that needs to transit under the new bridges.

9.2.3 Marine Contractors

The analysis identified up to 35 contractor vessels as not being able to transit year-round under the assumed conditions, depending on the height of the proposed bridge. These include primarily crane and spud barges. This is the largest group of vessels that is potentially impacted by the proposed bridge replacement.

Marine contractors transit under the bridge while traveling to work sites. Of the vessels identified as being potentially impacted, some may not transit under the bridge in a given year, whereas others may transit multiple times. Given that there are numerous contractors and that marine construction services will continue to be needed on both sides of the bridge, acquisition of crane barges is not considered a mitigation option.

Ballasting the barge, while possible, will not provide enough additional air gap to make a significant height difference. Ballasting can be used when only a couple of feet are all that is needed to clear the bridge. Ballasting is usually performed on the end of the barge that supports the crane so the height of the crane is lowered along with the freeboard.

Mitigation Option 1 – Remove the spuds

Many of the crane barges have height limitations caused by traveling with raised spuds. The spuds need to be raised high enough to prevent grounding during transit, not only in the navigational channel but along the route to the desired destination. The spud heights are typically 70 to 90 feet high. Removing the spuds prior to transit will reduce the vessel height to the next lowest point on the crane barge, typically a gantry or slightly elevated boom. A number of users indicated that it would take one half to one day to remove the spuds and similar time to replace the spuds. Removing spuds is an activity that is possible, although not always preferred by the operator, especially for those users that cannot self-remove them or need to travel only short distances. For instance, if the barge's own crane cannot lift the spuds out and lay them on the deck, another crane would be needed to perform this work. If the barge is not tied up to a dock or to shore when the spuds are removed, the barge will have to either anchor or have a tug assist it by holding the barge in place.

Mitigation Option 2 – Boom removal

If the boom tip is the highest point of the vessel, the boom can be removed prior to transit. This requires a considerable amount of work because all of the rigging needs to be removed, and another crane needs to be used to lift off the boom. If the boom is especially long and the barge it is removed from is too short, the boom may need to be transported on a separate barge.

Mitigation Option 3 – Gantry removal

If the gantry is the highest point of the vessel, it can be removed prior to the transit. This activity can take up to a week to lower the gantry and another week to raise it. It is a labor and equipment intensive activity and cannot be done frequently. It is not feasible for crane barges that need to transit under the bridge several times a month or more.

Mitigation Option 4 – Crane reconfiguration

The crane gantry may be modified to reduce its height. The modification would require the services of a naval architect working with the crane barge owner to redesign the crane to ensure it can achieve the same lifting capacity and reach.

Mitigation Option 5 – Use mobile cranes mounted on barges upriver of the bridge

If crane barges cannot transit under the bridge, it may be possible to transport a deck barge upriver, then load a land-based mobile crane from shore once the deck barge is upriver of the bridge. This is not a solution to getting an existing floating crane barge under the bridge, but rather an alternate method to getting equipment to work locations. Given the size of the mobile crane needed, there may be issues transporting the mobile crane over the highways and to the loading area.

Mitigation Option 6 – Station one or more crane barges permanently upriver of the bridge

A crane barge or barges may be acquired and stationed permanently upriver of the bridge for use by contractors. This option comes with many issues that would need to be addressed and resolved. These issues include developing a maintenance program, establishing maintenance and operating budgets and addressing liability issues. The number of crane barges stationed upriver may restrict the number of large projects constructed in any given year.

9.2.4 Federal Government

The Federal government grouping includes the USACE hopper dredge *Yaquina*, Tongue Point Job Corps *Ironwood* and the USN YTT 10 Battle Point. All three vessels can pass under the bridge under the assumed conditions at some but not all of the bridge heights considered. The following are potential mitigation options.

Mitigation Option 1 – Modify the mast structure and appurtenances (*Yaquina*)

Modifying the antenna and mast so that it could be lowered would reduce the air draft of the *Yaquina*. Everything higher than the crow’s nest would need to be removed, the mast outfitted with a hinge, then reinstalled. Whenever the *Yaquina* transits under the bridge the mast could be unhinged and lowered either manually or electrically.

Mitigation Option 2 – Purchase a smaller dredge (*Yaquina*)

Replace the hopper dredge with one that has a smaller air draft than that required to pass under the bridge, taking into account the 16-foot river level and 10-foot air gap. To replace the *Yaquina*, the new dredge would, at a minimum, require the same capacity and capabilities as the existing dredge.

Mitigation Option 3 – Contract dredging to private dredges (*Yaquina*)

Contracting with private dredging contractors to perform upstream maintenance dredging that can be conducted with smaller dredges would eliminate the need for the *Yaquina* to pass under the new I-5 bridges. Due to occasional emergency situations, the contractors would have to be available on short notice and have the properly sized hopper dredge. In addition, USACE would need to have expedited contracting methods in order to select and contract with a contractor on short notice.

Mitigation Option 4 – Lower upper antenna (M/V *Ironwood*)

The M/V *Ironwood* is a retired USCG buoy tender. The upper mast of the vessel, containing antennas, anemometers, and radar, could be reconfigured to reduce the overall height such that the vessel could pass under the assumed conditions. It may be possible to provide a hinged mast similar that described for the *Yaquina*.

Mitigation Option 5 – Travel during times when river level permits (M/V *Ironwood*)

The M/V Ironwood's full height (with existing antenna) is 77 feet. With a 10-foot safety gap and a 95 foot bridge, up to an 8-foot river stage would allow safe passage for the vessel. The river state is at or below 8 feet approximately 75 percent of the year, so trips could be scheduled, based on historical river levels.

Mitigation Option 6 – Lower Mast (YTT 10 *Battle Point*)

The USN YTT 10 *Battle Point* is equipped with a stepped-down mast. When the mast is lowered, the air draft is 58 feet allowing safe passage under the assumed conditions for all bridge heights considered. According to the Navy, the normal practice when transiting the river is with a stepped-down mast configuration.

9.2.5 Passenger Cruise

The only two passenger vessels identified as having difficulties with transiting under the assumed conditions are the Lady Washington and *Hawaiian Chieftain*. Acquisition of the vessels is not considered a viable alternative.

Mitigation Option 1 – Lower the highest mast

Both the *Lady Washington* and the *Hawaiian Chieftain* have the capability of lowering their upper masts to reduce their overall height. This would allow both vessels to transit the new I-5 bridges under the assumed conditions. To lower the *Lady Washington's* mast takes approximately 3 days, with the same amount of time needed to raise it. To lower the *Hawaiian Chieftain's* mast takes approximately 2 days, with the same amount of time to raise it. This option is only realistic for extended upriver trips.

Mitigation Option 2 – Travel during times when river level permits

Both the Lady Washington and *Hawaiian Chieftain* visit ports and points upriver on a scheduled contract basis. Knowing that the river level may impact the ability of the vessels to get under the new bridges, schedules could be arranged so that transits take place during lower river level stages.

9.2.6 Marine Industries and Fabricators

As noted in Chapter 7, occasional historical and anticipated future shipments from the three major upriver fabricators (Thompson Metal Fab, Oregon Iron Works, and Greenberry) would not pass under any of the bridge height alternatives considered. Discussions with each fabricator are underway to identify and evaluate mitigation options to address potential impacts to their operations. Options may vary depending on the bridge height alternative considered.

9.3 Mitigation for Unavoidable Short-term Effects

Mitigation for temporary effects on navigation will be addressed, in large part, by the construction methods and staging. The following sections describe several of many possible construction staging schemes that could be used to construct the bridges while maintaining sufficient clearance to minimize adverse effects on navigation.

9.3.1 Main Span Columbia River

A construction staging scheme will be developed to provide a 200 feet wide and 75 feet tall navigation at nearly all times, which meets the vessel clearance needs of the tugs and tows.

The construction staging is generally as follows:

Phase I – Construct the new Columbia River Bridges to the west of the existing bridges. Exhibit 9.3-1 illustrates the construction sequence.

Stage 1 – Construct Piers 2, 3, 4 for all bridges

- Existing Primary Channel- In service, no navigation encroachment
- Existing Barge Channel – In service, no navigation encroachment
- Existing Alt. Barge Channel- Out of service due to adjacent pier construction

The Alternate Barge Channel is out of service due to the adjacent construction of Pier 4. This may cause some inconvenience, however both existing Primary and Barge Channels are in full service. The impact to vessel navigation is considered minimal.

Stage 2 – Construct Piers 6, 7, Spans at Piers 2,3,4,7 for all bridges

- Existing Primary Channel- In service, some navigation encroachment
- Existing Barge Channel – In service, no navigation encroachment
- Existing Alt. Barge Channel- In service, some navigation encroachment

Both the existing Primary and Alternate Barge channels have construction activity overhead and vessels may experience some inconvenience. With the Barge channel in full service, the impact to vessel navigation is considered minimal.

Stage 3 – Construct the remainder of the piers and spans: Pier 5, Spans at Piers 5, 6 for all bridges

- Existing Primary Channel- In service, some navigation encroachment
- Existing Barge Channel – Out of service, significant navigation encroachment
- Existing Alt. Barge Channel- In service. Existing piers are in line with new Pier 4, but vessels should be angling away from Pier 4 as they start to align with the BNSF Railroad swing span.

Both the existing Primary and Alternate Barge channels are in service. The existing Primary channel has some overhead construction activity, but it is not anticipated to interrupt service. The construction of Pier 5 eliminates the use of the Barge channel. Vessels that cannot (or choose not to) use the Alternate Barge channel may experience some delays, as the lift span restriction periods are still present.

At the conclusion of Stage 3, the new Columbia River Bridges are fully constructed.

Phase II – Traffic switched to new bridges, remove existing bridges.

Stage 4 – Demolition and removal of existing I-5 bridges' piers between new Piers 5 and 6.

- Until the existing piers between the new Piers 5 and 6 are completely removed, the impact to vessel navigation is the same as construction Stage 3.
- Once the existing piers between the new Piers 5 and 6 are removed, the new Primary Channel is in full service and the existing channels can be removed from "official" service.

In summary, the locations of the proposed piers cause no apparent significant adverse impact to the route that vessel pilots must take to traverse this portion of the Columbia River during the construction of the permanent bridges. This is possible because all of the in-water work could be completed at once without complicated staging.

In addition to construction staging, communication of closures and clearance restrictions will users will be critical reduce impacts on users.

Additional tugs may be needed to assist vessels through areas of reduced clearance, especially during times of high water. The USCG would review construction plans to determine potential effects.

9.3.2 North Portland Harbor

Construction staging schemes will be devised that minimize adverse effects to navigation on North Portland Harbor. However, construction activities will temporarily reduce available clearances at some times. It will be essential to communicate restrictions or temporary closures of the navigation channel to the surrounding homes and moorages as these are the primary users of North Portland Harbor at this crossing.

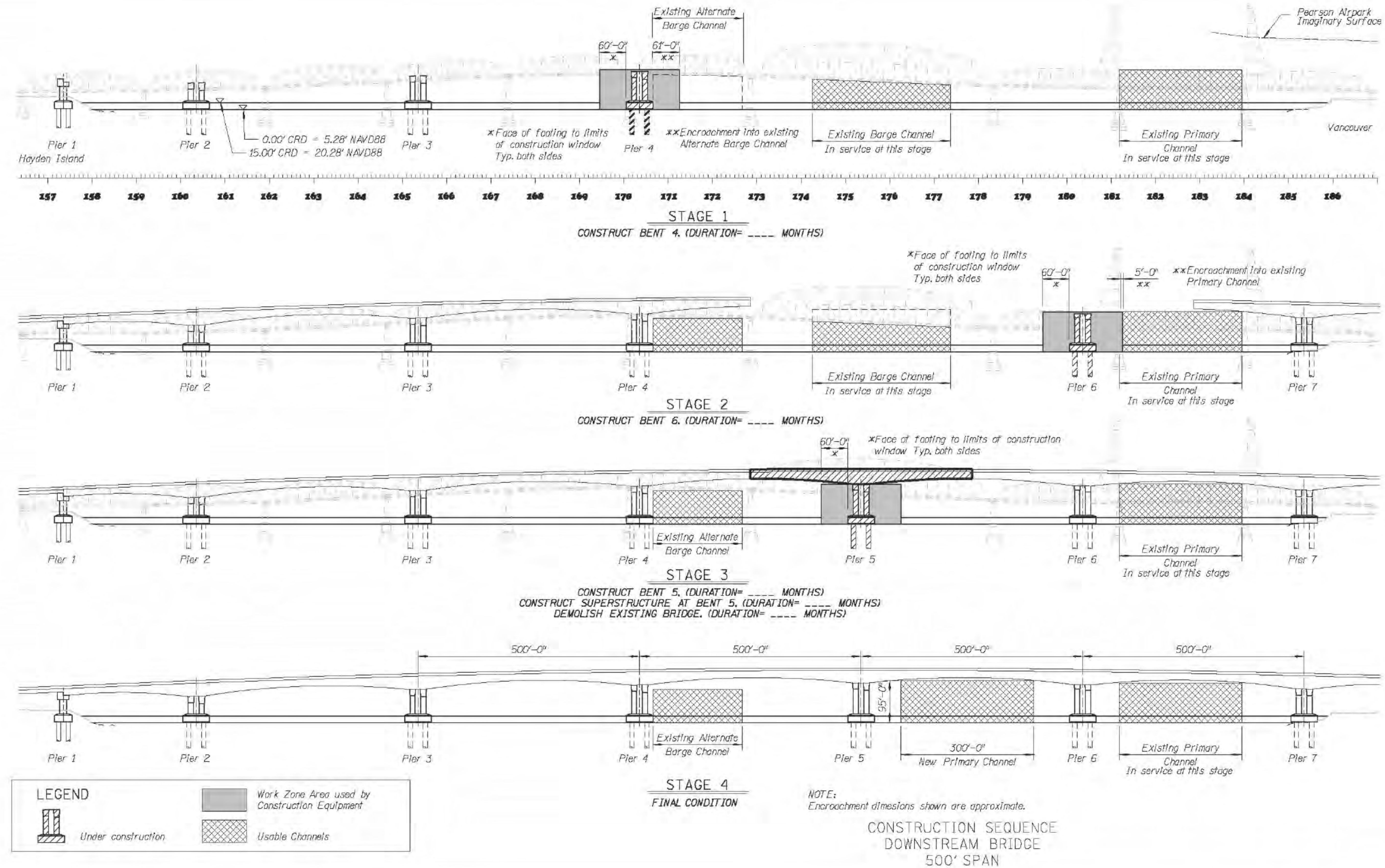

Exhibit 9.3-1
Proposed Replacement Columbia River Bridge Construction Sequence

Columbia River CROSSING

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