Hood River – White Salmon BRIDGE REPLACEMENT PROJECT

Final Energy Technical Report

November 2020

Prepared for:

Port of Hood River

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LIST OF EXHIBITS

Attachments

ACRONYMS AND ABBREVIATIONS

ADT	annual daily traffic
API	area of potential impact
Btu	British thermal unit
Caltrans	California Department of Transportation
EIS	environmental impact statement
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
GHG	greenhouse gas
ICE	Infrastructure Carbon Estimator
I-	Interstate
lbs.	pounds
MATS	Mt. Adams Transportation Service
mmBtu	million British thermal unit
mph	miles per hour
NEPA	National Environmental Policy Act
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
OHWM	ordinary high-water mark
the Port	Port of Hood River
the Project	Hood River-White Salmon Bridge Replacement Project
SEDS	State Energy Data System
SEPA	State Environmental Policy Act
SR	State Route
TS&L	type, size, and location
U.S.	United States
WSDOT	Washington State Department of Transportation

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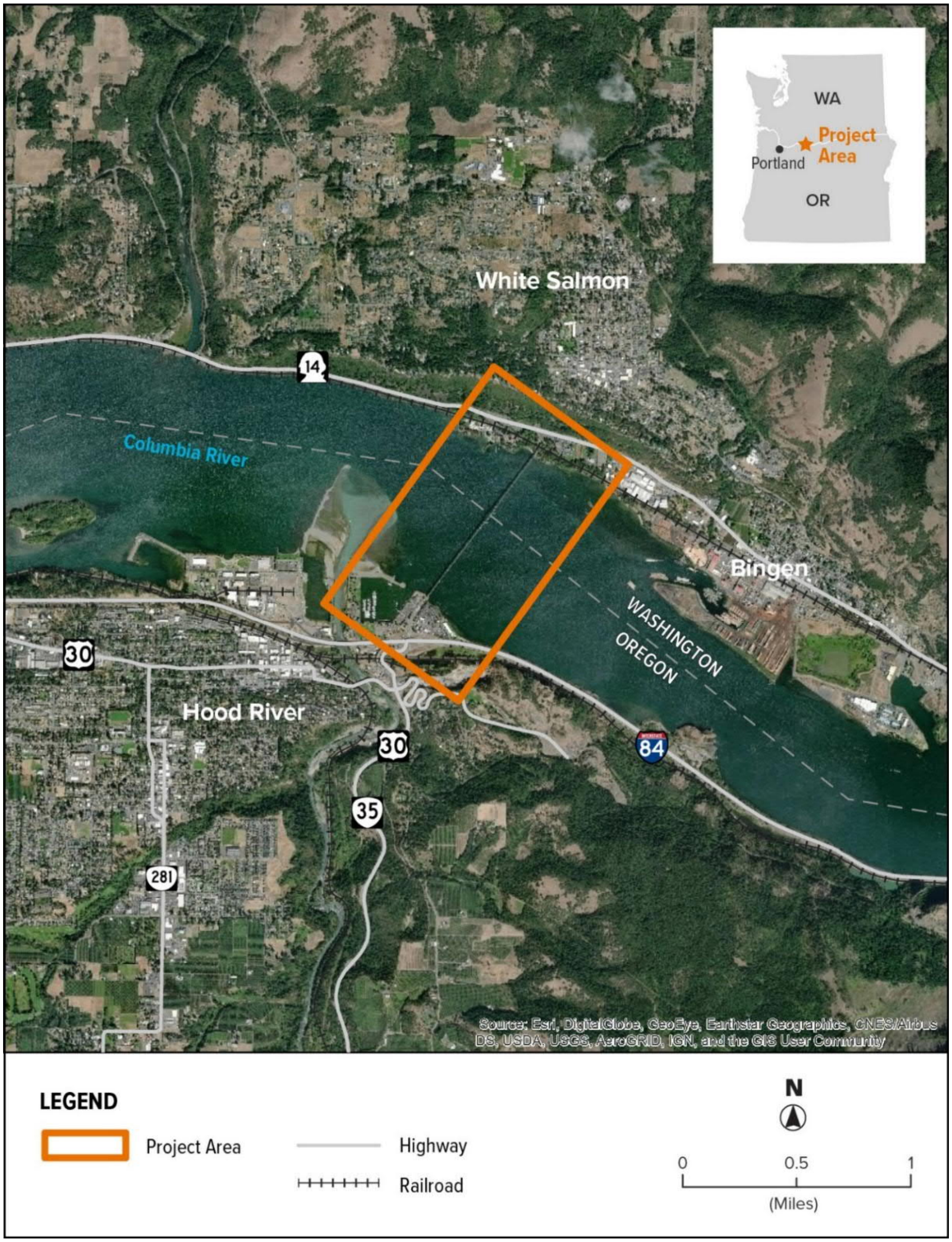
1. INTRODUCTION

The Hood River-White Salmon Bridge Replacement Project (the "Project," formerly named the SR-35 Columbia River Crossing Project) would construct a replacement bridge and then remove the existing Hood River Bridge between White Salmon, Washington, and Hood River, Oregon (Exhibit 1).The bridge is owned by the Port of Hood River (the Port), serving an average of over 4 million trips annually.

Exhibit 1. Project Area



The purpose of this Project is to improve multi-modal transportation of people and goods across the Columbia River between the communities of White Salmon and Bingen, Washington and Hood River, Oregon. The Project is intended to: a) improve traffic operations for current and future cross-river traffic and at connections to I-84 and SR 14; b) provide a cross-river connection for bicyclists and pedestrians; c) improve vehicle and freight travel safety by reducing real and perceived hazards; d) maintain and improve a transportation linkage between the White Salmon, Bingen, and Hood River communities, businesses, and services; e) fulfill the legislative directives tied to the Project funding; f) improve river navigation for vessels passing under the bridge; and g) improve the river crossing's seismic resiliency.

The overall need for the Project is to rectify current and future transportation inadequacies and deficiencies associated with the existing bridge. Specifically, these needs are to:

- Present Capacity: substandard width and operational issues are causing traffic congestion on the bridge and at both approaches
- Future Transportation Demand: the existing bridge is not designed to meet future travel demand for vehicles
- Bicycle and Pedestrian Facilities: lack of bicycle and pedestrian facilities limits multi-modal mobility
- Safety: narrow lanes and lack of shoulder create real and perceived safety hazards
- Social Demands/Economic Development: the existing bridge restricts the current and projected flow of goods, labor and consumers across the river
- Legislation: comply with federal funding obligation Transportation Equity Act for the 21st Century (TEA-21), the Washington State Legislature designation of the SR-35 corridor, and Oregon HB 2017
- River Navigation: the substandard horizontal clearance creates difficulties for safe vessel navigation
- Seismic Deficiencies: the existing bridge does not meet current seismic standards and is vulnerable to a seismic event

The Project began in 1999 with a feasibility study that ultimately resulted in the publication of the State Route (SR) 35 Columbia River Crossing Draft Environmental Impact Statement (EIS) in 2003, which identified the "EC-2 West Alignment" as the preliminary preferred alternative. In 2011, the Type, Size, and Location (TS&L) Study recommended a fixed-span concrete segmental box girder bridge as the recommended bridge type. In 2017, the Project was relaunched to complete the National Environmental Policy Act (NEPA) process. This report provides an update to the 2003 Energy Analysis Memorandum describing the existing conditions and anticipated construction, direct, and indirect impacts on energy. Measures to avoid, minimize, and/or mitigate these impacts are also identified in this report.

2. PROJECT ALTERNATIVES

Four alternatives are being evaluated to address the Project's purpose and need:

- No Action Alternative
- Preferred Alternative EC-2
- Alternative EC-1
- Alternative EC-3

Exhibit 2 shows the alignment of the existing bridge, which represents the No Action Alternative, and the three build alternatives. The build alternatives connect to SR 14 in White Salmon, Washington, and Button Bridge Road in Hood River, Oregon, just north of the Interstate 84 (I-84)/United States Highway 30 (US 30) interchange (Exit 64).

Each alternative is summarized in Exhibit 3 and described in more detail in the following sections. Exhibit 4 illustrates the navigational clearance for the existing bridge and the replacement bridge (same for each build alternative).

Exhibit 2. Location of the Preferred Alternative EC-2, Alternative EC-1, and Alternative EC-3

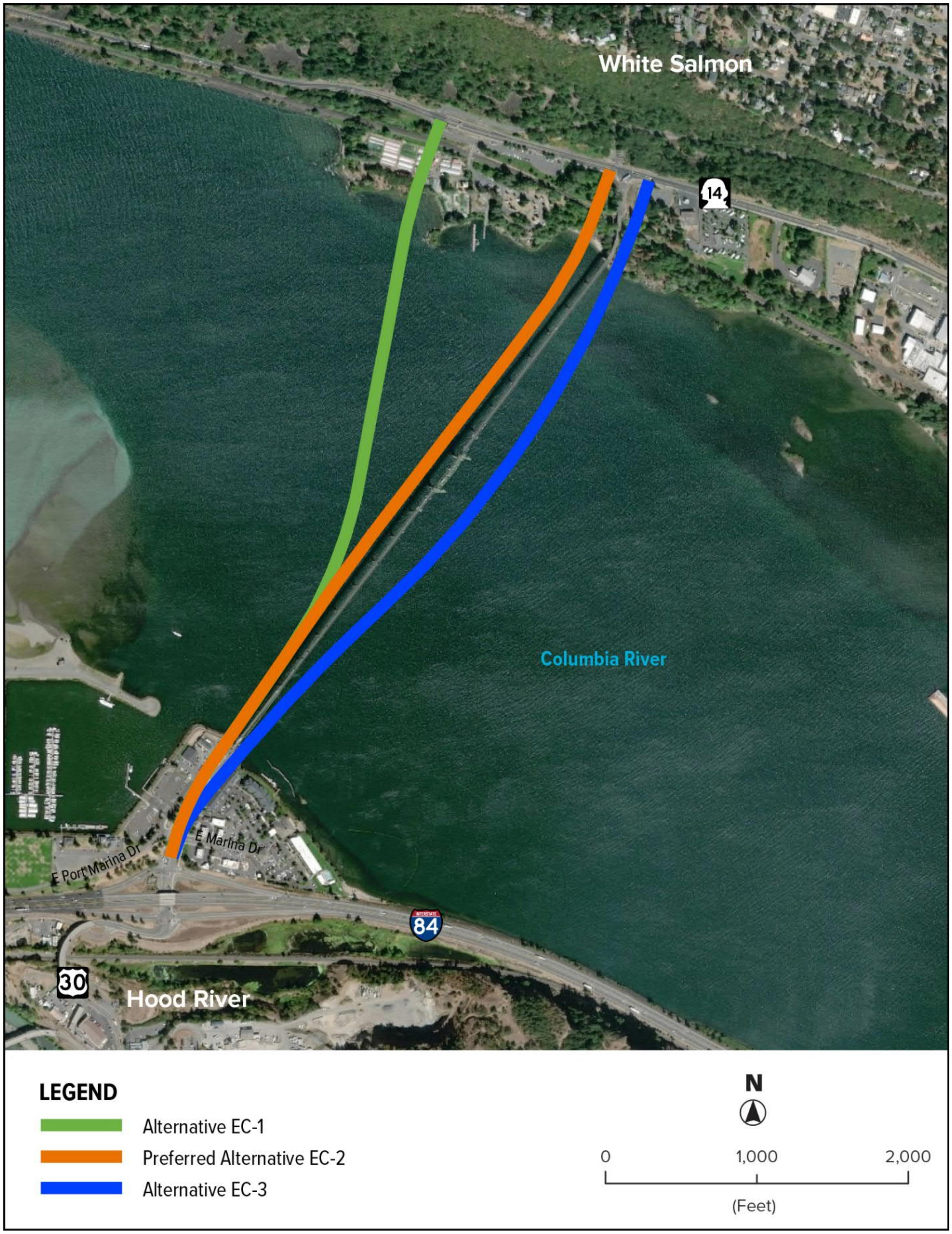
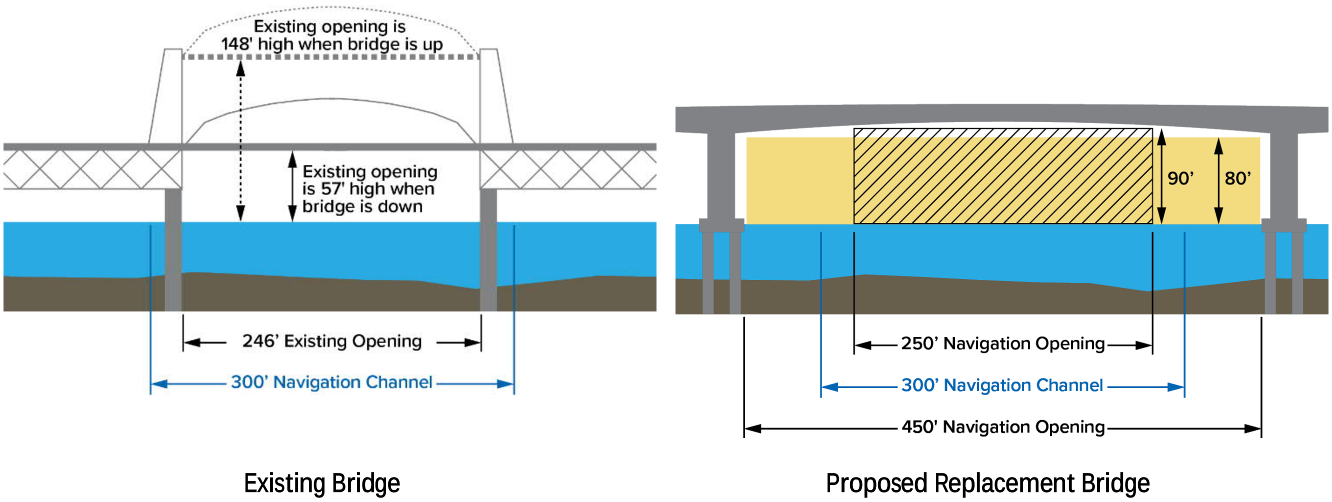


Exhibit 3. Summary Comparison of Key Elements of Alternatives

	No Action Alternative	Preferred Alternative EC-2	Alternative EC-1	Alternative EC-3
Bridge alignment	No change	Slightly west of existing	WA: West of existing OR: Slightly west of existing	Slightly east of existing
Bridge structure				
Bridge type	Steel deck truss bridge with vertical lift span	Segmental concrete box girder bridge (fixed span)		
Total number of piers (in water / on land)	28 (20 / 8)	13 (12 / 1)	13 (11 / 2)	13 (12 / 1)
Structure length	4,418 feet	4,412 feet	4,375 feet	4,553 feet
Travel lanes	9-foot 4.75-inch lanes	12-foot lanes		
Roadway shoulders	No shoulders	8-foot shoulders		
Vehicle height limit	14 feet-7 inches	None		
Shared Use Path	None	12-foot wide, only on west side with overlooks		
Bridge deck	Steel-grated	Concrete		
Vehicle Gross Weight Limit	80,000 pounds (lbs.); no trip permit allowance for overweight vehicles	> 80,000 lbs., with approved trip permit		
Design speed	Unknown	50 miles per hour (mph)		
Posted speed	25 mph	35 mph		
Toll collection	Toll booth on Oregon side	Electronic tolling/No toll booth		
Stormwater treatment	None	Detention and water quality treatment		
Navigation clearance	246 feet horizontal by 57 feet vertical when bridge is down and up to 148 feet vertical when lifted	450 feet horizontal x 80 feet vertical (maximum horizontal opening) 250 feet horizontal x 90 feet vertical (centered within maximum vertical opening)		
SR 14/Hood River Bridge intersection	Signalized intersection	Roundabout slightly west of existing intersection; SR 14 raised approximately 2 feet above existing road level	Roundabout with connection to N. Dock Grade Road west of existing intersection; SR 14 raised approximately 17 feet above existing road level	Roundabout slightly east of existing intersection; SR 14 remains at existing road level
Button Bridge Road/E. Marina Way intersection	Signalized intersection	Signalized intersection		
Anticipated construction duration	None	6 years (3 years to construct the replacement bridge and 3 years to remove the existing bridge)		

Exhibit 4. Navigation Clearance of Existing Bridge and Proposed Replacement Bridge



2.1. No Action Alternative

The No Action Alternative would retain the existing bridge in its existing condition and configuration. Routine operations would continue and maintenance would be implemented to continue operations. Under the No Action Alternative, elements of the existing bridge include:

- Alignment: The bridge would continue to span the Columbia River between its northern terminus at the SR 14/Hood River Bridge intersection in White Salmon, Washington, and its southern terminus at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon, as shown in the aerial photograph in Exhibit 2.
- Type: The bridge would continue to be a 4,418-foot steel deck truss bridge with a vertical lift span. The bridge would continue to have 20 piers in the Columbia River.
- Ownership: The bridge will continue to be owned and operated by the Port.
- Vehicle lanes: The bridge will continue to have one narrow (9 feet, 4.75 inches) travel lane in each direction and no shoulders.
- Bicycle and pedestrian facilities: The bridge would continue to have no pedestrian or bicycle facilities, and signage would continue to prohibit pedestrians and bicycles on the bridge.
- Speed: The posted speed limit on the bridge would continue to be 25 mph.
- Vehicle restrictions: Vehicles would continue to be weight-restricted to 80,000 lbs.; vehicles with approved trip permits would still not be allowed to use the bridge. Wide loads would continue to be prohibited without special arrangements, and large vehicles would be encouraged to turn their mirrors in. The height limit for vehicles would continue to be 14 feet, 7 inches where the lift span occurs.
- Tolling: The bridge would continue to be tolled for all vehicles with a toll booth on the south end of the bridge and electronic tolls collected through the Port's Breezeby system. Plans to shift to all ETC are being considered, but there is no certainty they will be implemented.

- Navigational clearance: The horizontal clearance for marine vessels would continue to be 246 feet, narrower than the navigation channel width of 300 feet, as shown Exhibit 4. The vertical clearance would continue to be 57 feet when the lift span is down and 148 feet when it is raised; vessels would continue to be required to request bridge lifts in advance. The lift span section would continue to use gate and signals to stop traffic for bridge lifts.
- Seismic resilience: The bridge would continue to be seismically vulnerable and would not be cost effective to be seismically retrofitted.
- Stormwater: No stormwater detention or water quality treatment would be provided for the bridge. Stormwater on the bridge would continue to drain directly into the Columbia River through the steel-grated deck.
- Roadway connections: The bridge would continue to connect to SR 14 on the Washington side at the existing signalized SR 14/Hood River Bridge intersection. On the Oregon side, the southern end of the bridge would continue to transition to Button Bridge Road, connecting to the local road network at the existing signalized Button Bridge Road/E. Marina Way intersection north of I-84. The bridge would continue to cross over the BNSF Railway tracks on the Washington side and over the Waterfront Trail along the Oregon shoreline.
- Bicycle and pedestrian connections: The bridge would continue not to provide bicycle or pedestrian connections across the Columbia River. Bicyclists and pedestrians wanting to cross the river would continue to need to use an alternate means of transportation, such as the Mt. Adams Transportation Service (MATS) White Salmon/Bingen to Hood River bus (buses provide bicycle racks), or a private vehicle.

The Supplemental Draft EIS considers two scenarios for the No Action Alternative:

- End of bridge lifespan: assumes that the existing Hood River Bridge would remain in operation through 2045[1] and would be closed sometime after 2045 when maintenance costs would become unaffordable. At such a time, the bridge would be closed to vehicles and cross-river travel would have to use a detour route approximately 21 miles east on SR 14 or 23 miles east on I-84 to cross the Columbia River using The Dalles Bridge (US 197). Alternatively, vehicles could travel 25 miles west on SR 14 or 21 miles west on I-84 to cross the Columbia River via the Bridge of the Gods. When the bridge would be closed, the lift span would be kept in a raised position to support large vessel passage that previously required a bridge lift or the existing bridge would be removed.
- Catastrophic event: addresses the possibility that an extreme event that damages or otherwise renders the bridge inoperable would occur prior to 2045. Such events could include an earthquake, landslide, vessel strike, or other unbearable loads that the bridge structure cannot support.

[1] The year 2045 is the design horizon for the Project. The design horizon is the year for which the Project was designed to meet anticipated needs.

2.2. Preferred Alternative EC-2

Alternative EC-2 would construct a replacement bridge west of the existing bridge. The existing bridge would be removed following construction of the replacement bridge. Under Alternative EC-2, elements of the replacement bridge would include:

- Alignment: The main span of the bridge would be approximately 200 feet west of the existing lift span. The bridge terminus in White Salmon, Washington, would be located approximately 123 feet west of the existing SR 14/Hood River Bridge intersection, while the southern terminus would be in roughly the same location at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon, as shown in Exhibit 5 and Exhibit 6.
- Type: The bridge would be a 4,412-foot fixed-span segmental concrete box girder bridge with a concrete deck and no lift span. The bridge would have 12 piers in the Columbia River and one land-based pier on the Washington side of the river.
- Ownership: While the Port may own and operate the replacement bridge, other options for the ownership and operation of the replacement bridge that may be considered include other governmental entities, a new bi-state bridge authority, and a public-private partnership, depending on the funding sources used to construct the replacement bridge.
- Vehicle lanes: The bridge would include one 12-foot travel lane in each direction, an 8-foot shoulder on each side, as shown in Exhibit 7.
- Bicycle and pedestrian facilities: The bridge would include a 12-foot wide shared use path separated from traffic with a barrier on the west side, as shown in Exhibit 7. In the middle of the bridge the shared use path would widen an additional 10 feet in two locations to provide two 40-foot long overlooks over the Columbia River and west into the CRGNSA with benches; the overlook locations are shown in Exhibit 5 and Exhibit 6. The cross-section of the overlooks is shown in Exhibit 7.
- Speed: The design speed for the bridge would be 50 mph with a posted speed limit of 35 mph.
- Vehicle restrictions: Vehicles would no longer be limited by height, width, or weight. Vehicles exceeding 80,000 lbs. that have approved trip permits could use the bridge.
- Tolling: Tolls for vehicles would be collected electronically so there would be no toll booth on either side of the bridge. No tolls would be collected from non-motorized users (e.g., pedestrians, bicyclists) who travel on the shared use path.
- Navigational clearance: Vertical clearance for marine vessels would be a minimum of 80 feet. The horizontal bridge opening for the navigation channel would be 450 feet, greater than the existing 300-foot wide federally recognized navigation channel, as shown in Exhibit 4. Centered within this 450-foot opening, there would be a 250-foot wide opening with a vertical clearance of 90 feet. Similar to the existing bridge, the replacement bridge would cross the navigation channel at roughly a perpendicular angle as shown in Exhibit 5 and Exhibit 6.
- Seismic resilience: The bridge would be designed to be seismically sound under a 1,000-year event and operational under a Cascadia Subduction Zone earthquake.

- Stormwater: Stormwater from the entire Project area (bridge and improved roadways) would be collected and piped to detention and treatment facilities on both sides of the bridge as shown in Exhibit 6. On the Washington side, separate stormwater facilities would be used for the roadways and the bridge.
- Roadway connections: The bridge would connect to SR 14 on the Washington side at a new two-lane roundabout slightly west of the existing SR 14/Hood River Bridge intersection, as shown in Exhibit 6. On the Oregon side, the southern end of the bridge would transition to Button Bridge Road, connecting to the local road network at the existing signalized Button Bridge Road/E. Marina Way intersection north of I-84. The private driveway on Button Bridge Road north of E. Marina Way may be closed under this alternative. Like the existing bridge, the replacement bridge would cross over the BNSF Railway tracks on the Washington side and over the Waterfront Trail along the Oregon shoreline.
- Bicycle and pedestrian connections: The new shared use path would connect to existing sidewalks along the south side of SR 14 in Washington and to roadway shoulders (for bicyclists) on both sides of SR 14 at the new roundabout with marked crosswalks, as shown in Exhibit 6. On the Oregon side, the shared use path would connect to existing sidewalks, bicycle lanes, and local roadways at the signalized Button Bridge Road/E. Marina Way intersection.
- Cost: Total Project construction cost is estimated to be $300 million in 2019 dollars.

Exhibit 5. Preferred Alternative EC-2 Alignment

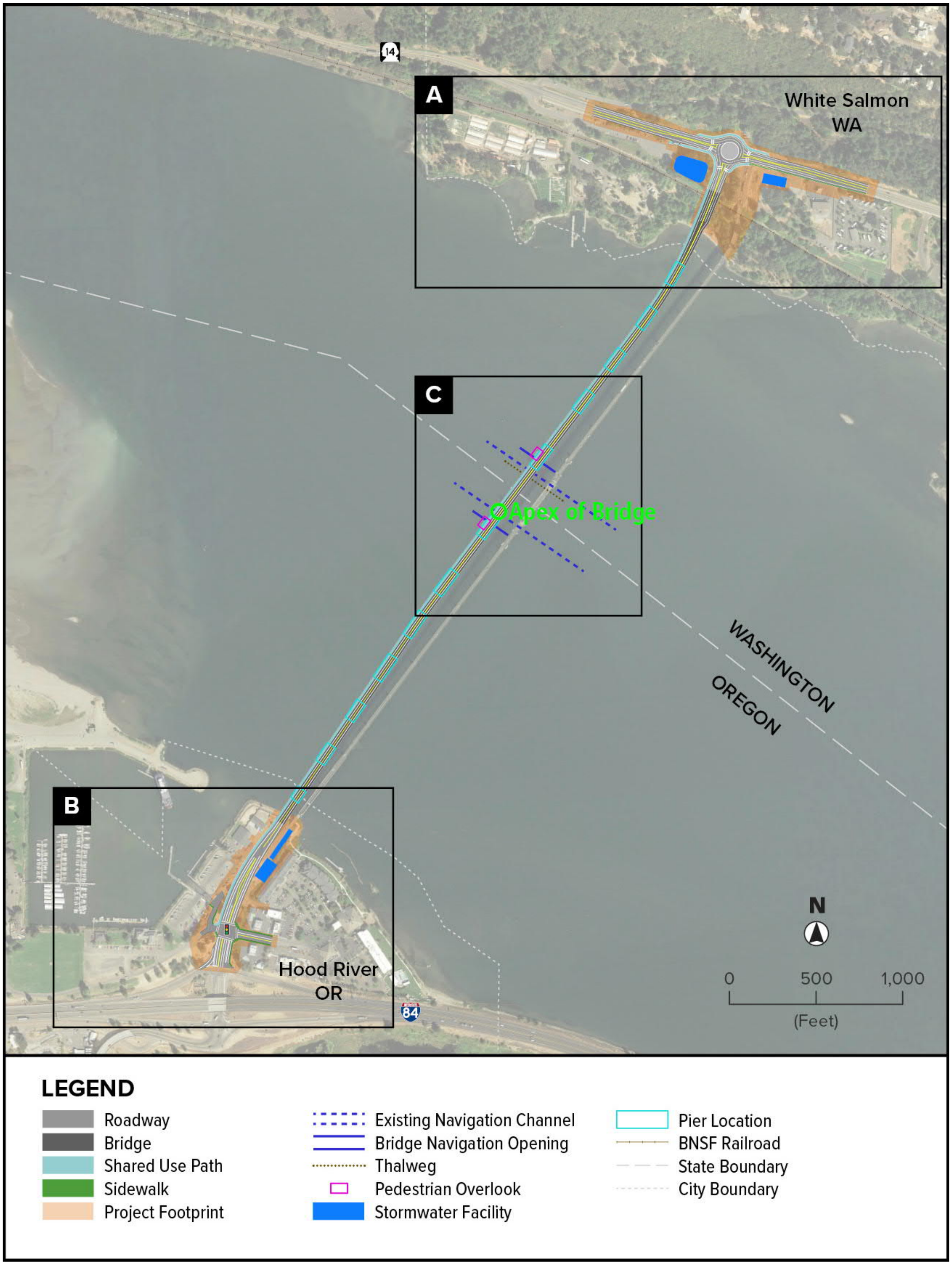


Exhibit 6. Preferred Alternative EC-2 Enlargements

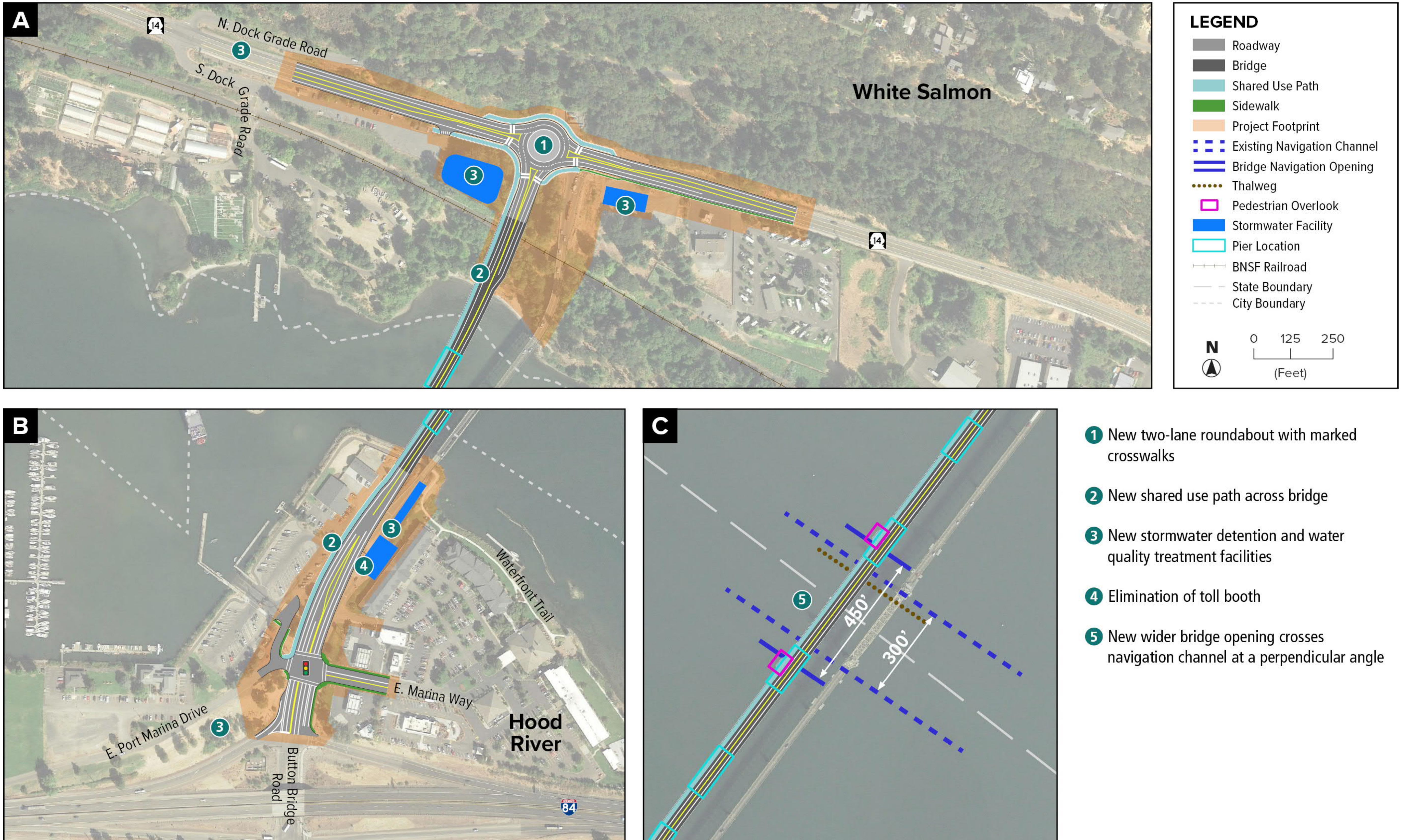


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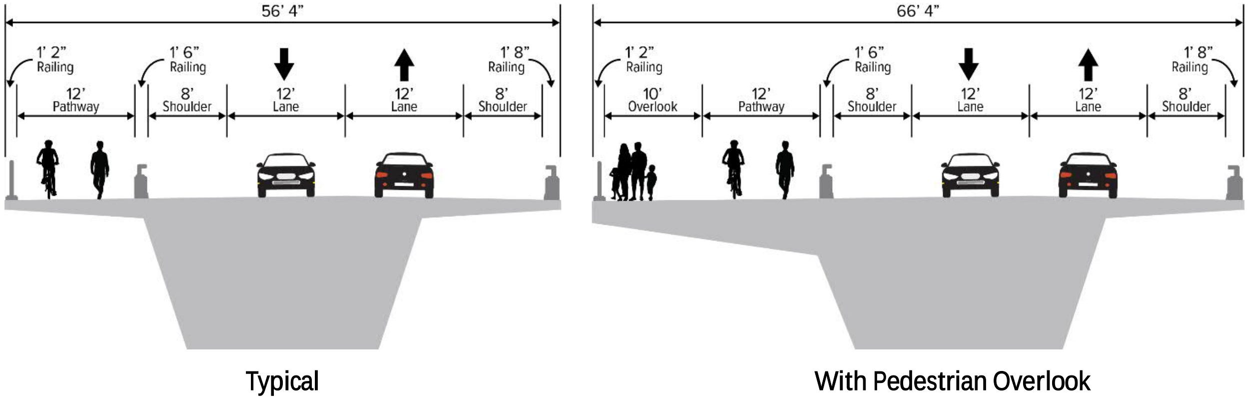
Exhibit 7. Replacement Bridge Typical Cross-Section



2.3. Alternative EC-1

Alternative EC-1 would construct a replacement bridge west of the existing bridge. Like Alternative EC-2, the existing bridge would be removed following construction of the replacement bridge. Exhibit 8 shows alignment of Alternative EC-1 and Exhibit 9 provides enlargements of the improvements that would be constructed under Alternative EC-1.

Under Alternative EC-1, elements of the replacement bridge would be the same as the elements described for Alternative EC-2 except:

- Alignment: The main span of the bridge would be approximately 700 feet west of the existing lift span. The bridge terminus in White Salmon, Washington, would be located approximately 2,309 feet west of the existing SR 14/Hood River Bridge intersection, while the southern terminus would be in roughly the same location as the existing terminus at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon.
- Type: The bridge would be a 4,375-foot fixed-span segmental concrete box girder bridge with a concrete deck and no lift span. The bridge would have 11 piers in the Columbia River.
- Navigational clearance: The navigational opening would be the same as Alternative EC-2, but the bridge would cross the navigation channel at a more skewed angle than under Alternative EC-2.
- Roadway connections: Connections to roadways would generally be the same as Alternative EC-2, but the bridge would connect to SR 14 on the Washington side at a new two-lane roundabout at the SR 14/Hood River Bridge/N. Dock Grade Road intersection west of the existing bridge. Access to S. Dock Grade Road would be provided via the driveway east of the Mt. Adams Chamber of Commerce and Heritage Plaza Park and Ride.
- Bicycle and pedestrian connections: Connections to bicycle and pedestrian facilities would generally be the same as Alternative EC-2, but the roundabout intersection with SR 14 on the Washington side would be located further west at N. Dock Grade Road.

Exhibit 8. Alternative EC-1 Alignment

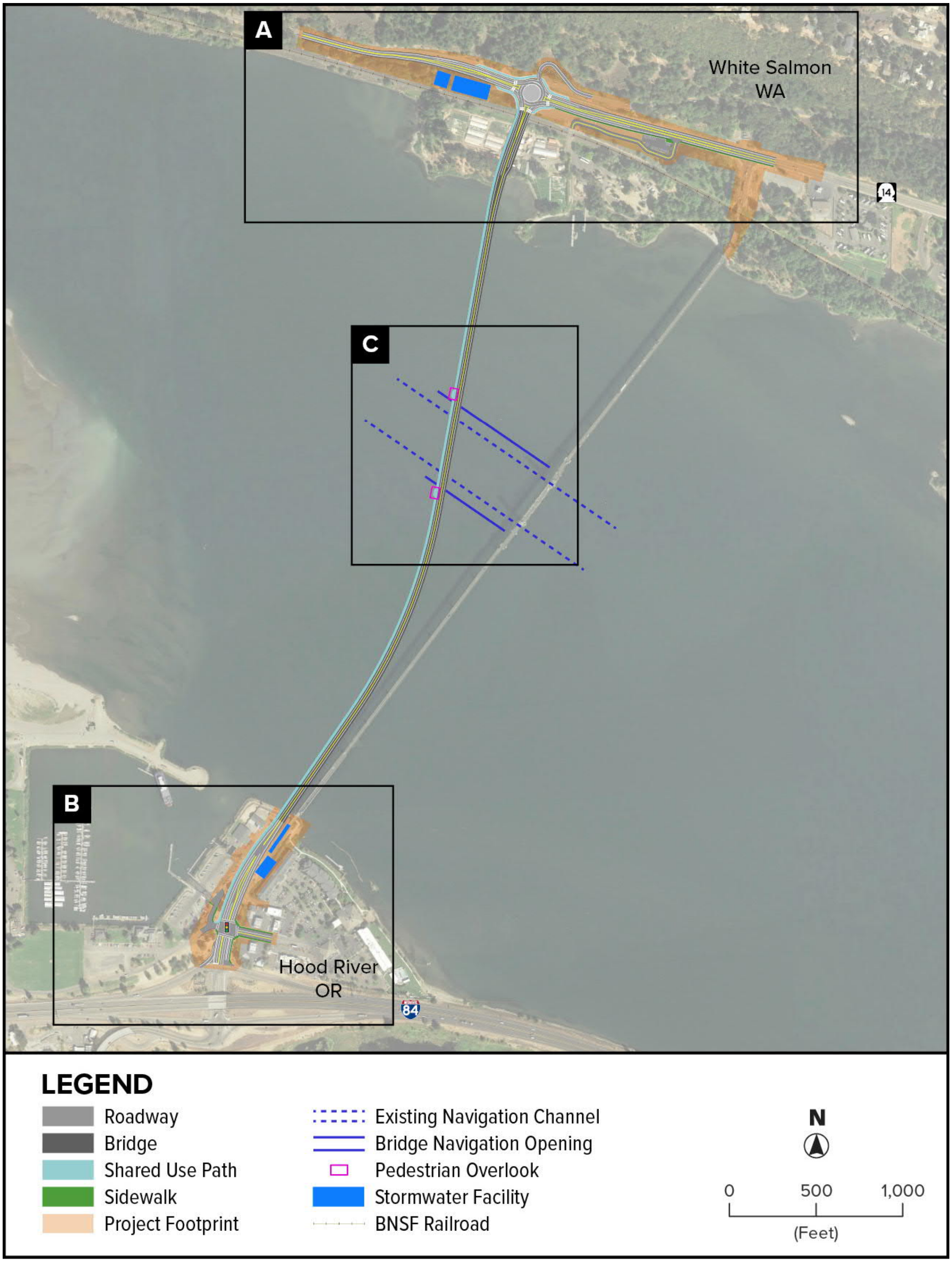
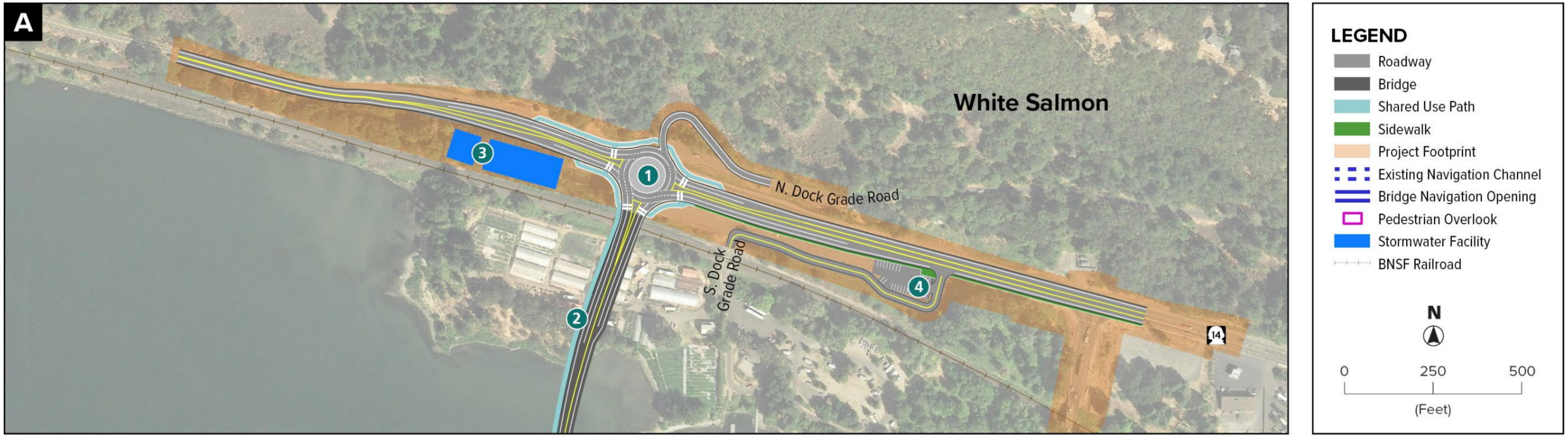
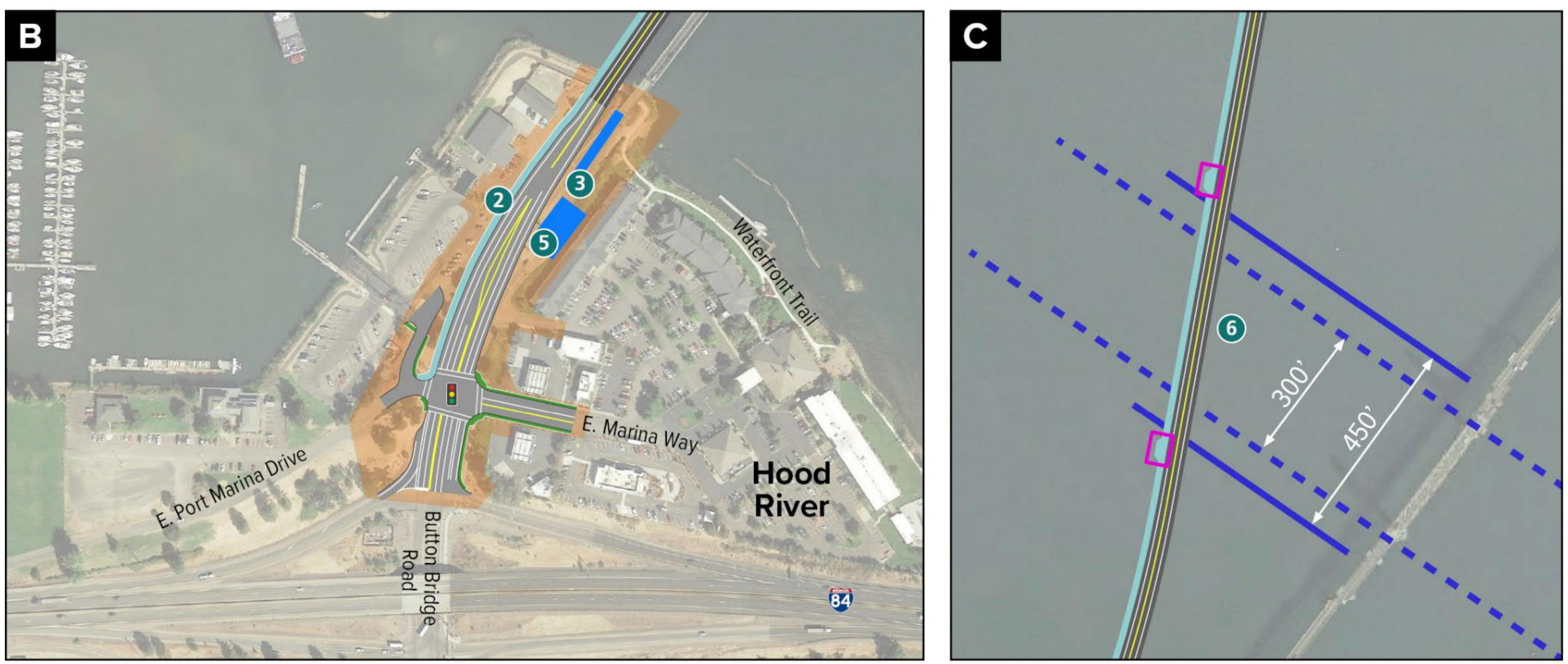


Exhibit 9. Alternative EC-1 Enlargements





1. New two-lane roundabout with marked crosswalks
2. New shared use path across bridge
3. New stormwater detention and water quality treatment facilities
4. Access to S. Dock Grade Road provided from eastern end of Heritage Plaza Park and Ride
5. Elimination of toll booth
6. New wider bridge navigation opening crosses navigation channel at a skewed angle

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2.4. Alternative EC-3

Alternative EC-3 would construct a replacement bridge east of the existing bridge. Like Alternative EC-2, the existing bridge would be removed following construction of the replacement bridge. Exhibit 10 shows alignment of Alternative EC-3 and Exhibit 11 provides enlargements of the improvements that would be constructed under Alternative EC-3.

Like Preferred Alternative EC-2, the total Project construction cost for Alternative EC-3 is estimated to be $300 million in 2019 dollars. Under Alternative EC-3, elements of the replacement bridge would be the same as the elements described for Alternative EC-2 except:

- Alignment: The main span of the bridge would be approximately 400 feet east of the existing lift span. The bridge terminus in White Salmon, Washington, would be located approximately 140 feet east of the existing SR 14/Hood River Bridge intersection, while the southern terminus would be roughly the same as the existing terminus at the Button Bridge Road/E. Marina Way intersection in Hood River, Oregon.
- Type: The bridge would be a 4,553-foot fixed-span segmental concrete box girder bridge with a concrete deck and no lift span. Like Alternative EC-2, the bridge would have 12 piers in the Columbia River and one land-based pier on the Washington side of the river.
- Roadway connections: Connections to roadways would generally be the same as Alternative EC-2, but the bridge would connect to SR 14 on the Washington side at a new two-lane roundabout slightly east of the existing SR 14/Hood River Bridge intersection. On the Oregon side, improvements extend slightly further south to the Button Bridge Road/I-84 on and off ramps. The private driveway on Button Bridge Road north of E. Marina Way would be closed under this alternative.
- Bicycle and pedestrian connections: Connections to bicycle and pedestrian facilities would generally be the same as Alternative EC-2, but the roundabout intersection with SR 14 on the Washington side would be located approximately 264 feet further east than under Alternative EC-2.

Exhibit 10. Alternative EC-3 Alignment

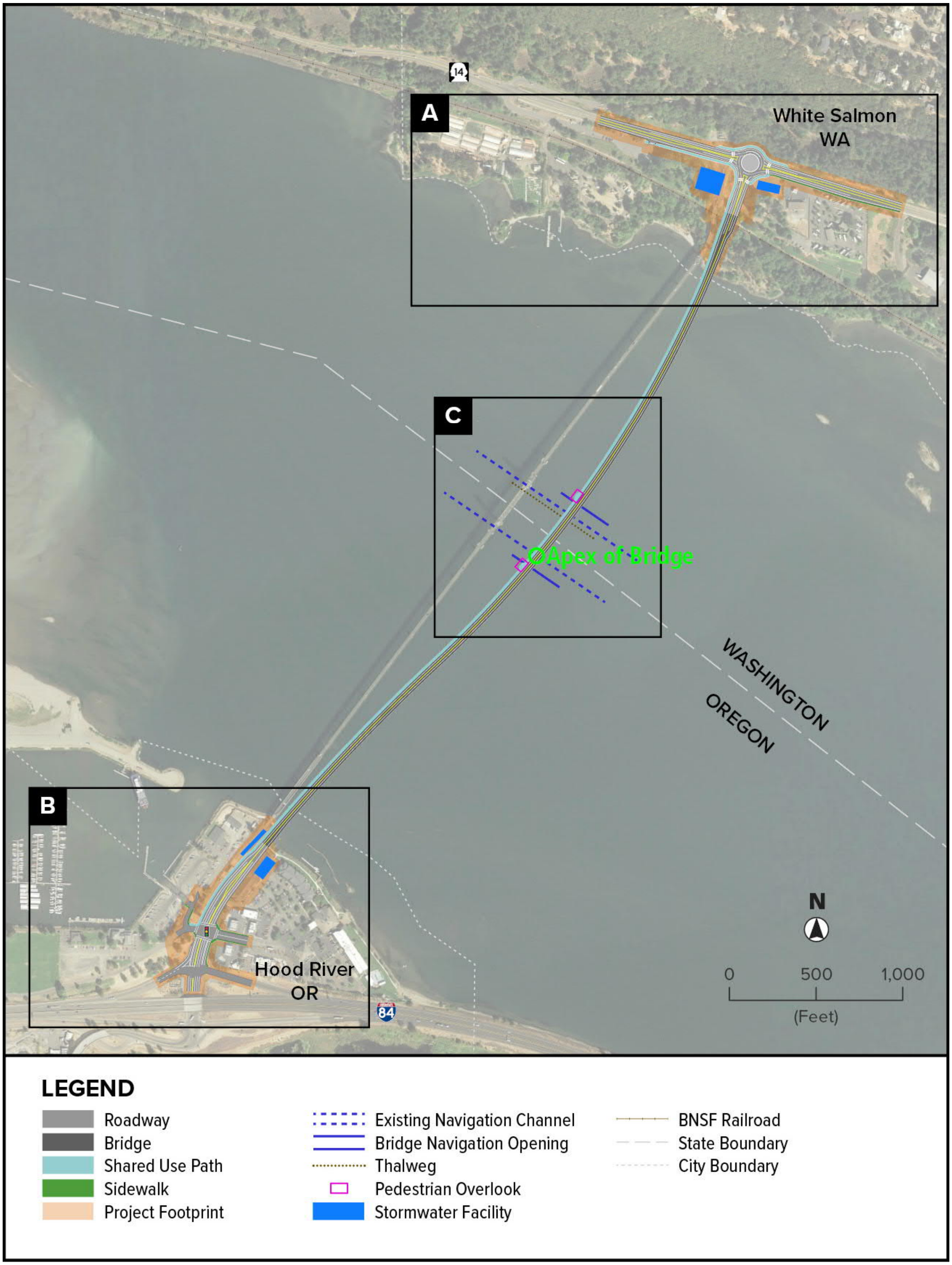
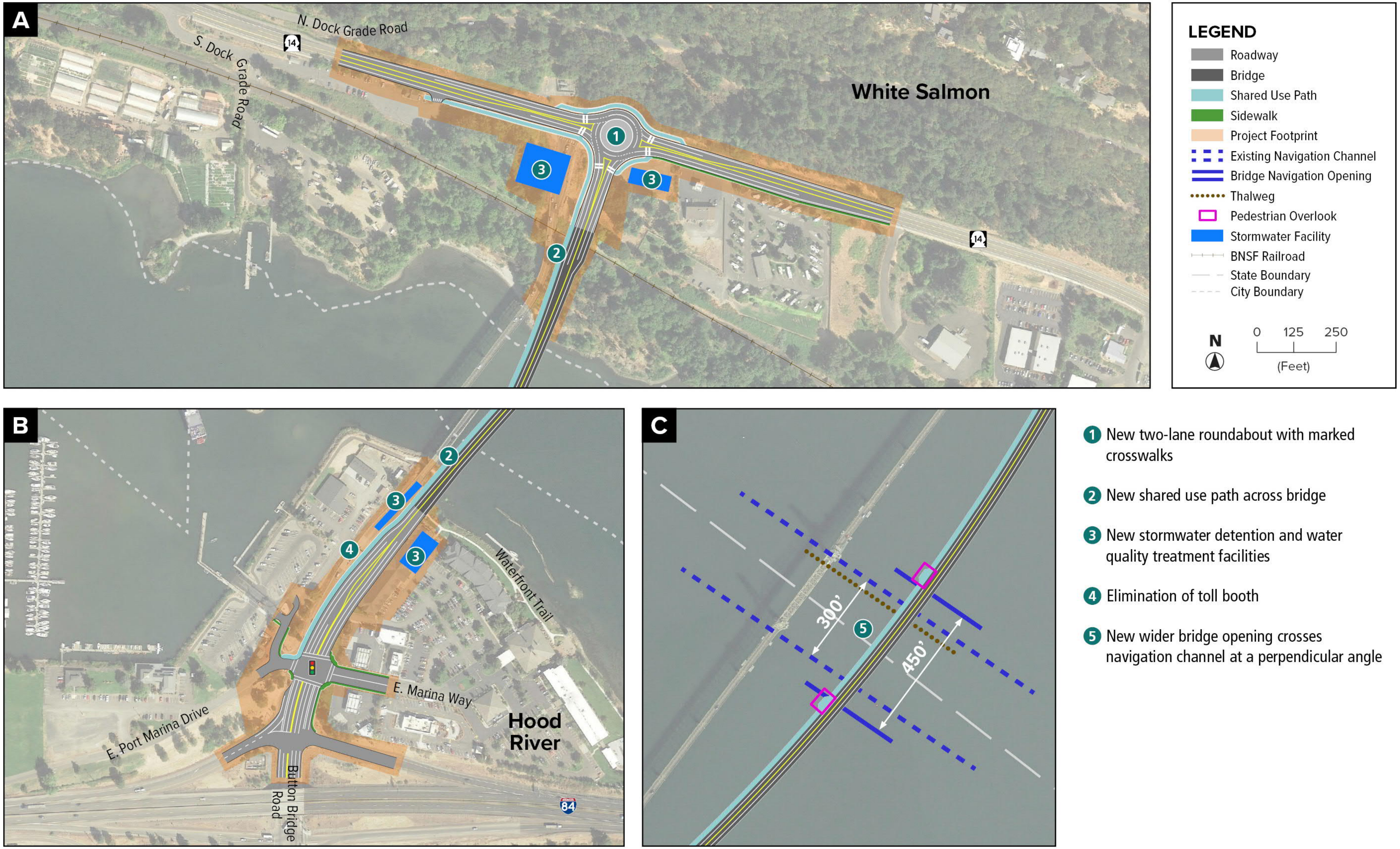


Exhibit 11. Alternative EC-3 Enlargements



1. New two-lane roundabout with marked crosswalks
2. New shared use path across bridge
3. New stormwater detention and water quality treatment facilities
4. Elimination of toll booth
5. New wider bridge opening crosses navigation channel at a perpendicular angle

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2.5. Construction of the Build Alternatives

Construction of the build alternatives would be similar in duration and approach.

- Timeline and sequencing: The NEPA process is anticipated to be complete in 2021; subsequent phases of the Project would be dependent on funding availability. Construction would take approximately 6 years and would require work during approximately six IWWWs. Approximately three IWWWs would be necessary to construct the replacement bridge, and approximately three additional IWWWs would be necessary to complete the removal of the existing bridge.
- In-water work window: Certain construction and removal activities conducted below the OHWM of the Columbia River would be restricted to an IWWW established for the Project. The IWWW would be established in permits for the Project through inter-agency coordination including Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), NOAA Fisheries, and USFWS. Preliminary discussions with these agencies indicate that the authorized IWWW would likely be October 1-March 15 of each year. In-water work activities that would be restricted to this IWWW would include vibratory and impact pile installation, installation of drilled shaft casings, installation of cofferdams, and unconfined wiresaw removal of the existing pier foundations. Vibratory pile removal would not be restricted to the IWWW.
- Mobilization and site preparation: The contractor would likely mobilize equipment to the construction site via barges and trucks. Erosion control measures (e.g., silt fences, etc.) and debris containment devices (i.e., floating debris booms) would be installed and clearing and grubbing limits would be established prior to vegetation removal. Barges would require anchoring, tethering, and spudding.
- Construction staging: At least two staging areas would be necessary for staging and storage of materials and equipment; the location of these areas would be determined later in the design process, including obtaining all relevant environmental permits and land use approvals. It is estimated that a minimum of 2 acres would be necessary for staging and storage of materials and equipment. Materials arriving by barge may be offloaded to upland staging areas or may be temporarily stored on barges. All staging areas and equipment fueling areas would be located above the OHWM and outside of environmentally sensitive areas. Staging and temporary access areas will occur in upland locations, on areas that are either already disturbed or that will be restored post-Project.
- Temporary work structures: The Project would likely require the installation of several temporary in-water structures during construction and removal of the existing bridge. These structures would include temporary work bridges, cofferdams, drilled shaft casings, and temporary piles. These temporary features would be designed by the contractor after a contract is awarded, but prior to construction.

  Three temporary work bridges would likely be installed to support construction activities. One temporary work bridge would be installed at each end of the replacement bridge alignment. A third temporary work bridge would be constructed on the Washington side of the river to support the removal of the existing bridge. These temporary structures would likely be supported by 24-inch steel pipe piles.

  Additional temporary piles would be necessary throughout construction and removal of the existing bridge for a variety of purposes, including supporting falsework and formwork, pile templates, reaction piles, and for barge mooring. These temporary piles would also likely be 24-inch steel pipe piles.

Barges would be used as platforms to conduct work activities and to haul materials and equipment to and from the work site. Three barges would typically be needed at each pier during drilled shaft construction, and at least one barge would remain at each pier after shaft construction to support column and superstructure construction.

Temporary cofferdams would likely be installed to create isolated in-water work areas for certain activities. A temporary cofferdam would likely be installed to create an isolated in-water work area for construction of a spread footing foundation on the Washington shoreline. Sheet pile cofferdams may also be installed at one or more piers on the existing bridge to create an isolated work area for removal of the existing bridge foundations.

Drilled shaft shoring casings would also be installed as temporary work structures to create isolated work areas for drilled shaft construction. An outer steel casing, with a diameter approximately 12-inches larger than that of the finished drilled shaft, would be installed to act as an isolation structure. The outer cases will be 84 inches in diameter for the 72-inch shafts, and 108 inches in diameter for the 96-inch shafts.

- Work area isolation and fish salvage: To minimize impacts to fish, fish salvage measures would be employed to remove fish from temporarily isolated in-water work areas during and after the installation of drilled shaft shoring casings and cofferdams. Fish salvage would follow the BMPs established in the biological opinion for FHWA and ODOT's Federal Aid Highway Program programmatic consultation and would be supervised by a fish biologist. A fish biologist with the experience and competence to ensure the safe capture, handling, and release of all fish would supervise all fish capture and release. To minimize take, efforts would be made to capture ESA-listed fish known or likely to be present in an in-water isolated work area using methods that are effective, minimize fish handling, and minimize the potential for injury. Attempts to seine and/or net fish, or the use of minnow traps shall precede the use of electrofishing equipment. Isolation structures would be installed such that they would not be overtopped by high water. A reasonable effort would be made to re-locate threatened or endangered fish using methods that minimize the risk of injury.
- Bridge foundation installation: The foundations for the replacement bridge would consist of three different foundation types: 1) pile-supported foundations; 2) drilled-shaft-supported foundations; and 3) spread footings. In general, pile-supported foundations would be used at locations where the depths to bedrock are relatively deep (greater than 50 feet below ground surface) while drilled shaft-supported foundations would be more economical in locations where depths to bedrock are nearer to the surface (less than 50 feet below ground surface). Spread footings would be used where bedrock is located at or near the surface and deep foundations are not required.

  Pile-supported foundations would be supported by 48-inch diameter steel pipe piles. The typical in-water foundation would require 25 piles, where-as smaller terrestrial pile-supported foundations would require fewer piles. Piles would be installed with a vibratory hammer to the extent practicable, as a means of minimizing impacts associated with underwater noise. An impact hammer would be used to drive the piles to the final tip elevation, and/or to proof the piles to verify load-bearing capacity.

  Drilled shaft-supported foundations would be supported by either 72-inch-diameter drilled shafts or 96-inch-diameter drilled shafts. The larger-diameter drilled shafts would be used on the bents that flank the navigation channel. Installation of drilled shafts would be conducted by first oscillating an outer steel casing to a specified design depth. As the casing is being advanced to the design depth, soil would be removed from inside the casing using an auger and clamshell. Excavated soils would be temporarily placed onto a barge with appropriate containment and ultimately placed at an approved upland site. Once the interior of the casing has been excavated to the design depth, an interior steel casing of the finished diameter of the shaft would be installed. This casing would be installed either with an oscillator or vibratory hammer. Once the interior casing has been installed to final depth, a steel reinforcement cage would be installed within the casing, and the shaft would be filled with concrete.

Construction of spread footing foundations below the OHWM of the river would be conducted within a temporarily dewatered work area within a cofferdam. Once the cofferdam is installed and the work area established, formwork would be installed for the spread footing, steel reinforcing would be installed within the forms, and the concrete for the footing would be poured. The cofferdam would remain in place until the concrete is fully cured to allow the concrete to cure in a dewatered environment. Once the concrete for the footing is fully cured, the formwork would be removed followed by the temporary cofferdam.

- Bridge superstructure construction: Once the foundation piles and drilled shafts are installed, a concrete pile cap would be installed atop the shafts at the waterline, and the concrete pier and superstructure would be installed atop the pile cap. Pile caps may be either precast or cast-in-place.

  The superstructure would consist of both precast and cast-in-place concrete segments. Additional finish work would also be conducted, including surfacing, paving, and installation of other finish features, such as striping and signage.

  Work on the superstructure would be conducted either from the bridge deck, from the deck of temporary work bridges, or from barges. It is anticipated that the superstructure would be constructed using a balanced cantilever method that uses paired sets of form travelers to build outwards from each pier. It is assumed that a contractor may operate up to four pairs of form travelers at a given time to expedite the construction of the superstructure.

  Many of the bridge superstructure components would be composed of precast concrete. Precast elements would likely include bridge columns, beams, girders, and deck panels. Precast bridge elements would be constructed in upland controlled environments and would be transported to the Project site by either barge or truck.

- Dismantling and removal of the existing bridge: The existing bridge would remain open until the replacement bridge is constructed and operational, at which point it would be dismantled and removed. This work would be conducted via barges and/or temporary work platforms and may require in-water isolation.

  Removal of the superstructure would most likely be conducted by barge-mounted cranes. Removal of the superstructure would likely begin with removal of the counterweights, followed by the lift towers and the individual truss sections. The lift towers and truss sections would be cut into manageable pieces and loaded onto barges or trucks by a crane. Each section would then be either transported to an upland site for further dismantling or disposed of directly at an appropriately permitted upland facility.

  Removal of the existing foundations would be conducted by one of the following two methods:

  - Wiresaw removal to mudline, without a cofferdam. A diamond wire/wire saw would be used to cut the foundation into manageable pieces that would be transported to a barge and disposed of in a permitted off site upland location. The foundations would be removed to the mudline and the substrate would be naturally restored with surrounding sediments.
  - Wiresaw or conventional pier removal techniques within a cofferdam. Conventional removal techniques consist of using a hydraulic ram to break the piers into rubble, and torches or other cutting methods to cut reinforcement. Materials would then be transported to a barge and disposed of in a permitted off site upland location. The foundations would be removed to the mudline and the substrate would be naturally restored with surrounding sediments.

  It is assumed that the cofferdam removal option would be used at both piers that flank the navigation channel, but may also be used in other pier locations. At the two navigation channel piers, once cofferdams are installed and fish salvage has occurred, approximately 7,800 cubic yards of existing riprap would be removed. Riprap would be removed via a barge mounted clamshell, and loaded onto barges, and disposed of at an off-site permitted upland location. Once riprap has been removed, the existing piers would either be removed using one of the methods described above.

- Post-Project site restoration: Construction of the Project would result in temporary impacts to native and non-native vegetation on both the Oregon and Washington sides of the river. Areas temporarily disturbed during construction would be restored upon completion of the Project consistent with state and local regulations.

  On the Oregon side of the river, most temporary disturbance would occur within areas that are either impervious or already developed. Temporary disturbance would occur within areas that consist of landscaping, lawns, or similar heavily managed vegetation. Post-Project site restoration in these areas would likely consist of replacement landscaping with similar ornamental species. No native plant communities would be disturbed on the Oregon side of the river.

  On the Washington side of the river, vegetation would be cleared within temporary work zones to allow construction equipment to access the site, to construct the replacement bridge abutments and stormwater treatment facilities, and to remove the existing bridge. A portion of the area to be cleared would be within a forested riparian area that is within the 200-foot shoreline jurisdiction of the Columbia River, and is regulated by the City of White Salmon under its Shoreline Master Program (City of White Salmon 2016). A large oak tree that is present east of the existing bridge would be preserved and would not be affected.

  Temporarily disturbed areas within ODOT and WSDOT rights-of-way would be replanted consistent with applicable ODOT and WSDOT requirements and design standards. Temporarily disturbed vegetation within the riparian shoreline buffer on the Washington side of the river would be conducted consistent with requirements in the City of White Salmon Critical Areas Ordinance (White Salmon Municipal Code (WSMC) Chapter 18.10) and Shoreline Master Program (City of White Salmon 2016).

- Compensatory Mitigation: The Project would result in permanent impacts to wetland and aquatic habitats, and a compensatory mitigation plan would likely be required by federal, state and local regulations to offset these permanent impacts. The compensatory mitigation plan would be developed during the permitting phase of the Project. The mitigation plan would identify the amount, type, and specific locations of any proposed compensatory mitigation actions, specific impact avoidance and minimization measures to be implemented, as well as the goals, objectives, and performance standards for measuring success. Full implementation of the compensatory mitigation plan would be a condition of the applicable permits of the agencies with jurisdiction (i.e., USACE Section 404 permit, the Oregon Department of Environmental Quality [DEQ] and the Washington State Department of Ecology [Ecology] Section 401 permits, the Oregon Department of State Lands [DSL] Removal-Fill permit, WDFW Hydraulic Project Approval, and City of White Salmon Shorelines and Critical Areas permits), and the mitigation would comply fully with all applicable permit terms and conditions.

The method of delivery for Project final design and construction has not been determined at this time. Traditional delivery methods, such as design-bid-build, and alternative delivery methods, such as design-build and public-private-partnerships to name a few, will continue to be considered by the Port. As part of Oregon's HB 2017, the Port was provided legal authority by the state to enter into a public-private-partnership.

3. METHODOLOGY

Energy consumption was previously analyzed in the Project's Draft EIS and Energy Analysis Memorandum (Parsons Brinckerhoff 2002). The energy assessment was updated to incorporate updated methodology.

3.1. Area of Potential Impact

The area of potential impact (API) for the energy analysis is shown below in Exhibit 12. The API encompasses the area anticipated for direct impacts to energy consumption resulting from the Project. The API, which extends 100-feet outside of the construction limits for the Project's build alternatives, generally lies between SR 14 to the north and I-84 to the south. This area represents the location of construction activity and operational changes to vehicle traffic that are the source of direct impacts to energy consumption. The API for indirect impacts to energy consumption is much larger, encompassing upstream material and energy processes.

Exhibit 12. Energy API

3.2. Regulations, Standards, and Guidelines

Applicable federal and state regulations, standards, and guidelines are listed below.

- Federal Highway Administration (FHWA) Technical Advisory T 6640.8
- NEPA of 1969
- Statewide Planning Goals: Goal 13 (Oregon Administrative Rules (OAR) 660-015-0000(13))
- Transportation Planning Rule (OAR 660-12-035)
- Washington Department of Transportation (WSDOT) Project-Level Greenhouse Gas (GHG) Evaluations under NEPA and Washington State Environmental Policy Act (SEPA)

Oregon Department of Transportation's (ODOT) Energy Regulations, Guidelines, and Policies provides a summary of regulations and guidelines that require ODOT to evaluate energy consumption, but it does not recommend a specific methodology. Energy consumption is addressed by WSDOT in the Project-Level GHG Evaluations under NEPA and SEPA. The WSDOT guidance was last updated in February 2018, and it includes updated methodology to calculate energy consumption during construction using the FHWA Infrastructure Carbon Estimator (ICE) tool. The ICE Final Report and User's Guide states that the material and energy factors in the model do not apply to bridge projects greater than 1,000 feet in length (FHWA 2014); therefore, the construction energy consumptions was estimated based on construction costs, consistent with the Draft EIS. ICE was used to determine construction impacts from energy consumption from vehicle delay and direct impacts from routine maintenance of the new road surfaces.

WSDOT guidance requires a quantitative analysis of operational impacts for EIS documents; however, discussions with ODOT and WSDOT have indicated that a qualitative discussion of the impacts of project operation will be sufficient for the scope of this project. The qualitative discussion to address project operation compared vehicle volumes and speeds in the API as provided in the traffic study. This data was compared for the existing year and the Project design year for build and no action.

3.3. Sources of Existing Data

Data used for the energy analysis was obtained from the Project description, design drawings, and the traffic study. Energy usage trends are discussed using data available from the Washington Department of Commerce and the Oregon Department of Energy.

3.4. Data Collection or Development

Data used for the energy analysis was obtained from the Project description, design drawings, and the traffic study. FHWA default assumptions are included within the tool used for impacts due to upstream activity.

3.5. Impact Analysis Techniques

3.5.1. Construction Impacts

Impacts during construction were estimated based on the estimated construction cost of $300 million dollars for the Project. This value was used for all build alternatives, as a more refined estimate has not been developed. Energy consumption to complete a project is proportional to the cost of the project. California Department of Transportation (Caltrans) estimated construction energy consumption for steel girder bridge construction to be 30,400 Btu per 1977 dollars (Caltrans 1983). The cost factor was adjusted to 2017 dollars using data from Caltrans' Price Index for Selected Highway Construction Items (Caltrans 2017).

Impacts due to vehicle delay during construction were calculated using FHWA's ICE spreadsheet tool (FHWA 2019), which incorporates project features and construction traffic delays to calculate energy consumption from construction equipment, materials, and routine maintenance. ICE provides construction energy consumption estimates based on details about the project type and size. The tool includes assumptions based on a nationwide database of construction bid documents, data collected from state department of transportations, and consultation with transportation engineers and lifecycle analysis experts.

Inputs to the ICE tool are summarized in Exhibit 13, and these values are consistent with the air quality analysis. Copies of the spreadsheet tool are included in Attachment A. The same inputs and assumptions were used for all build alternatives. The actual length of the new bridge and roadway would vary slightly by alternative, but the tool is not meant to be used to that level of detail. The bridge inputs in ICE were not used because the model calculations do not apply to bridges projects greater than 1,000 feet in length.

Exhibit 13. ICE Inputs

Inputs	No Action Alternative	Build Alternatives
Infrastructure location	Oregon	Oregon
Analysis timeframe (years)	20	20
Average daily traffic per lane mile – for facilities that will be reconstructed or resurfaced	25,410[a]	25,410[a]
Total existing centerline miles	1	1
Total existing lane miles	2	2
Facility type of reconstructed or resurfaced roadway	Rural principal arterial	Rural principal arterial
Miles of new off-street bicycle or pedestrian path	0	1
Total project days of lane closure	0	2
Average daily traffic per directional segment for facilities requiring lane closure	0	8,250[b]
Percentage of facility lanes closed during construction	0	50%

Notes:
[a] 25,410 ADT in 2045 was calculated by adding 54 percent growth factor to 16,500 ADT in 2018
[b] 8,250 ADT per directional segment is equal to half of 16,500 ADT in 2018

The existing (2018) annual daily traffic (ADT) for the Hood River Bridge is approximately 16,500 (WSP 2019). Future ADT for 2045 was estimated by an annual linear growth rate of 2.0 percent, equating to a 54 percent increase in volume from 2018 to 2045, consistent with the traffic analysis (WSP 2019). The existing structure would remain in place during construction, and there would be minimal disruption to traffic during the construction phase. Two days of closure were assumed in the model, as the exact number of days of closure has not yet been determined.

3.5.2. Direct Impacts

Direct impacts to energy consumption are from vehicle operations on the facility. These impacts are discussed qualitatively, based on the changes in traffic volumes and speeds presented in the traffic study between the no action and build scenarios. ICE provides direct energy use estimates from equipment performing routine maintenance on the facility, which were considered direct impacts.

3.5.3. Indirect Impacts

Indirect impacts to energy consumption includes upstream activities related to the materials and fuels used during construction of the Project. These indirect impacts are included in the calculation used for construction energy consumption. Other sources of indirect energy consumption are from the production of energy required for long-term operation of the facility, such as lighting, ramp-metering or variable message signs. These indirect impacts would be minor and are not estimated by ICE or the Caltrans methodology.

3.6. Agency Coordination

The Project team coordinated with ODOT and WSDOT to confirm the combination of qualitative and quantitative analyses are appropriate for this Project.

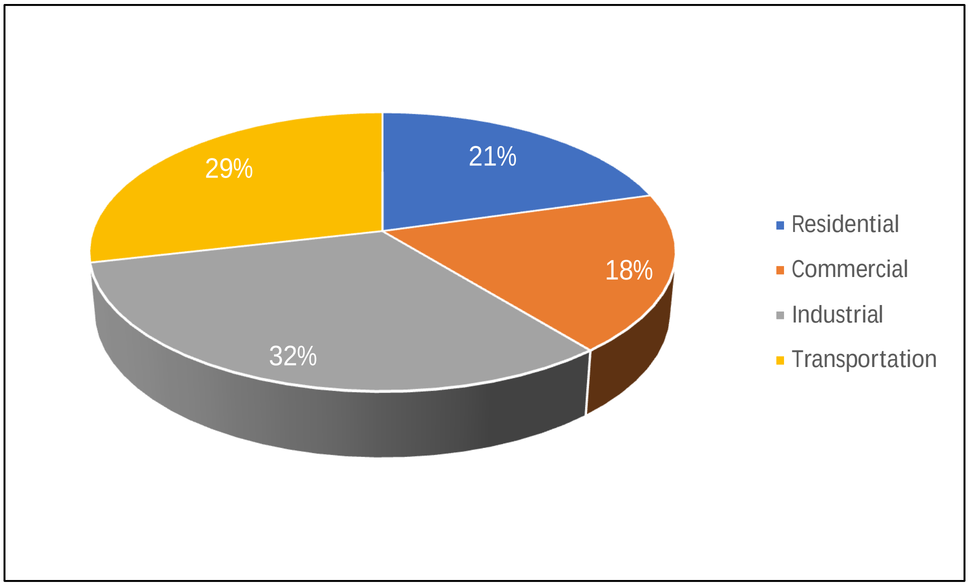
4. AFFECTED ENVIRONMENT

4.1. Existing Conditions

Energy is consumed during the construction and operation of transportation projects. Energy is used during construction to manufacture materials, transport materials, and operate construction machinery. Operational energy consumption includes fuel consumed by vehicles using the Project, and a negligible amount of energy for signals and lighting. Operational energy consumption impacts are evaluated by qualitatively comparing vehicle fuel consumption between alternatives. Energy is commonly measured in terms of British thermal units (Btus). A Btu is defined as the amount of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

Transportation accounts for a major portion of the energy consumed in the U.S. As shown in Exhibit 14, transportation accounted for approximately 29 percent of energy consumption in the U.S. in 2016. Transportation is the second-largest consumer of energy in the U.S. after the industrial sector, which accounted for 32 percent of energy consumption in the U.S. in 2016. The residential and commercial sectors accounted for 21 percent and 18 percent of energy consumption in the U.S. in 2016, respectively.

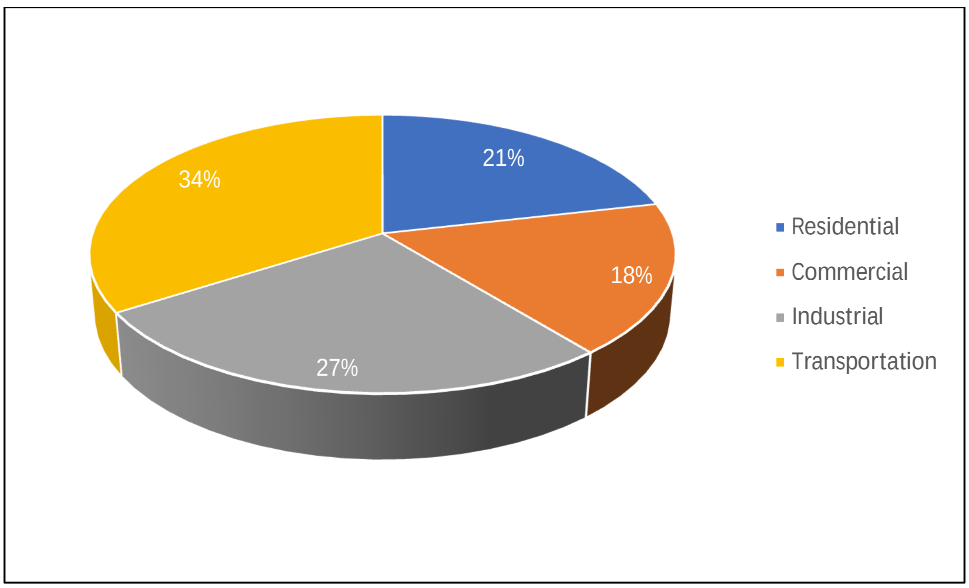
Exhibit 14. U.S. Energy Consumption by End-Use Sector, 2016



Source: EIA 2019

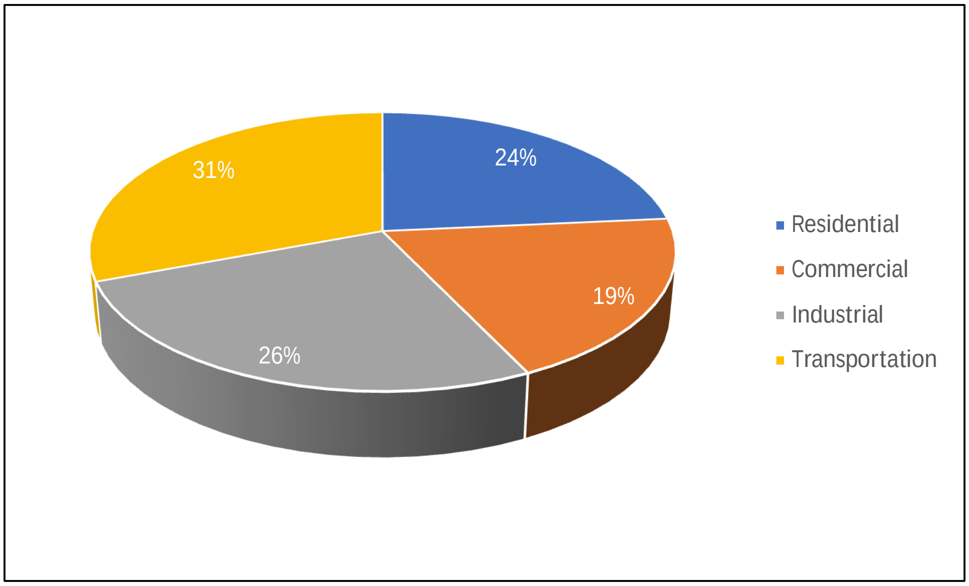
Transportation also accounts for a major portion of the energy consumed in Washington and Oregon, at approximately 34 percent and 31 percent, respectively (Exhibit 15 and Exhibit 16). Petroleum (e.g., gasoline, diesel fuel, jet fuel) was the predominant source of transportation energy consumption in Washington and Oregon in 2016, at approximately 98 percent in both states (EIA 2019). Natural gas and electric vehicles accounted for the remaining 2 percent of transportation energy consumption.

Exhibit 15. Washington Energy Consumption by End-Use Sector, 2016



Source: EIA 2019

Exhibit 16. Oregon Energy Consumption by End-Use Sector, 2016



Source: EIA 2019

Washington ranks number 13 of the 50 states in terms of transportation energy consumption, with 700.1 trillion Btu of transportation energy consumed in the year 2016, and Oregon ranks number 30 with 300 trillion Btu (EIA 2019). In comparison, the state of Texas ranked number one with the consumption of approximately 3,270 trillion Btu of transportation energy in 2016.

On a per capita basis, Washington ranks number 19 of the 50 states in terms of transportation energy consumption, at approximately 96.2 million Btu (mmBtu) consumed per capita in 2016, and Oregon ranks number 40 with approximately 73.5 mmBtu consumed per capita. In comparison, the state of Alaska ranked first at 225 mmBtu of transportation energy consumed per capita in 2016. The state of Rhode Island ranked last, with 55 mmBtu of transportation energy consumed per capita in 2016.

5. ENVIRONMENTAL CONSEQUENCES

5.1. No Action Alternative

5.1.1. Direct Impacts

Vehicle fuel consumption dominates the energy use for each alternative, and is largely determined by daily crossings and average travel speed. Under the No Action Alternative, there would be an increase in the design year ADT as compared to existing conditions, which could result in increased energy consumption. However, this increase in ADT could be somewhat offset by the continued improvements in fuel economy resulting from the U.S. Environmental Protection Agency's (EPA) national control programs.

Energy use from routine maintenance of the roadway calculated using FHWA's ICE spreadsheet tool. This analysis was based on the inputs outlined in Exhibit 13. The complete results summary is included in Attachment A. The direct impacts from routine maintenance are presented in Exhibit 17.

Exhibit 17. No Action Alternative Annual Energy Use

Energy Source	Energy Use (mmBtu)
Direct Energy • Routine maintenance	 50

Source: ICE tool output, see Attachment A
Notes: mmBtu = million British thermal units

Direct impacts to energy use were evaluated assuming the No Action Alternative retains the existing bridge in its existing condition and configuration. If the bridge were to close in the future when it surpasses its operational life, or if a catastrophic event such as an earthquake or a barge strike occurs prior to the end of its operational life, vehicles would have to travel 21 miles to 25 miles to an alternative route, which would cause an increase in energy consumption from vehicles, as compared to continued operation of the bridge.

5.1.2. Indirect Impacts

Indirect impacts include upstream activities related to energy production needed for facility signals, lighting, and other tollbooth operations, which would be minor and is not estimated by ICE. Upstream energy use would also result from energy production needed for bridge lifts, but this activity is not estimated by ICE.

If the bridge were to fail or close and vehicles were required to travel a farther distance to cross the Columbia River, there could be an increase in indirect energy required to process the additional fuel needed by the vehicles. Future energy consumption from vehicles is expected to be lower than present levels as a result of EPA's national control programs that are projected to improve fuel economy.

5.2. Preferred Alternative EC-2

5.2.1. Construction Impacts

Energy would be consumed during construction of any of the alternatives to extract or manufacture materials, transport materials, and operate construction equipment. Energy consumption from construction of the Project was calculated based on the estimated construction cost of $300 million for the Project. The construction energy formula was applied as follows:

$$E = C \times DEF \times DC$$

Where:

E = energy consumed (Btu)
C = cost of a particular construction activity (current year dollars)
DEF = dollar-to-energy factor (Btu/1973$)
DC = dollar conversion (1973$/current year dollars)

The calculation is presented in more detail in Exhibit 18.

Exhibit 18. Construction Energy Use

Energy Source	Preliminary Construction Cost	Dollar-to-Energy Factor (Btu/1977$)[1]	2017 Price Escalation[2]	Energy Use (mmBtu)
Direct Energy • Construction equipment • Construction impacts to vehicle delay	 $300,000,000 N/A	 30,400 N/A	 0.1052 N/A	 959,823 18[3]
Total				959,841

Sources:
[1] Caltrans 1983, Table C:20, Bridge Steel Girder
[2] Caltrans 2017, Exhibit A, 1973$/2017$ = 11.4/108.32 = 0.1052
[3] ICE tool output, see Attachment B
Notes: mmBtu = million British thermal units, N/A = not applicable

FHWA's ICE tool was used to estimate energy consumption from vehicle delay caused by construction activities, which included the assumption of 2 days of lane closures. The results are summarized in Exhibit 18, and the complete model output is included in Attachment B. The tool did not account for the potential energy consumption from vehicles detoured to a different bridge. Energy use could increase from detoured vehicles that traveled a longer distance they would have without the detour, but this period of increased energy use would only last for the duration of lane closures (assumed to be 2 days).

5.2.2. Direct Impacts

Vehicle fuel consumption dominates the energy use for each build alternative, and is largely determined by daily crossings and average travel speed. The proposed bridge would not significantly increase motor vehicle capacity compared to the No Action Alternative, and it is not expected to substantially impact inter-city vehicle demand or routing of longer distance trips crossing the Columbia River at other bridges as compared to the No Action Alternative. The transportation report forecasted traffic volumes of 25,410 ADT in 2045, regardless of alternative (WSP 2019).

The proposed bridge is expected have a 35 mph posted speed compared to the 25 mph speed on the existing bridge (WSP 2019). The Project is expected to increase traffic flow, which should reduce operational energy use as compared to the No Action Alternative. The Project, therefore, would not substantially impact energy consumption during operation.

Energy use from routine maintenance of the roadway was calculated with the ICE tool. As shown in Exhibit 19, 63 mmBtu per year of energy would be consumed by vehicles used in maintenance activities such as street sweeping, snow removal, and landscaping. This value is slightly higher than the energy use estimated for routine maintenance of the No Action Alternative because of the addition of the bicycle and pedestrian trail, and the model does not account for the two lane miles on the existing bridge that would be removed.

Exhibit 19. Alternative EC-2 Annual Energy Use

Energy Source	Annualized Energy Use (mmBtu)
Direct Energy • Routine maintenance	63.0

Source: ICE tool output, see Attachment B
Notes: mmBtu = million British thermal units

5.2.3. Indirect Impacts

Indirect impacts to energy consumption include upstream activities related to energy production and the materials used to construct the Project. Indirect impacts from construction were included in the calculations in Exhibit 18. Indirect impacts from Project operations include upstream activities related to energy production needed for facility signals, lighting, and electronic tolling, which would be minor and is not estimated by the ICE tool or Caltrans method. Upstream energy use would also result from energy production needed for bridge lifts, but this activity is not estimated by ICE or the Caltrans method.

5.3. Alternative EC-1

5.3.1. Construction Impacts

Construction impacts would be the same as those described for Alternative EC-2.

5.3.2. Direct Impacts

Direct impacts would be the same as those described for Alternative EC-2.

5.3.3. Indirect Impacts

Indirect impacts would be the same as those described for Alternative EC-2.

5.4. Alternative EC-3

5.4.1. Construction Impacts

Construction impacts would be the same as those described for Alternative EC-2.

5.4.2. Direct Impacts

Direct impacts would be the same as those described for Alternative EC-2.

5.4.3. Indirect Impacts

Indirect impacts would be the same as those described for Alternative EC-2.

5.5. Summary of Impacts by Alternative

Exhibit 20 provides a comparison of anticipated energy impacts by alternative.

Exhibit 20. Summary of Energy Impacts by Alternative

Impacts	No Action Alternative	Preferred Alternative EC-2	Alternative EC-1	Alternative EC-3
Construction Impacts	• None	• 959,841 mmBtu from construction activities and vehicle delays during construction, approximately 383,936 mmBtu per year		
Direct Impacts	• 50.0 mmBtu from routine maintenance • Decreased energy consumption in design year 2045 from vehicle fuels • Potential for an increase in energy consumption from vehicles finding alternative routes if the bridge closed or failed	• 63.0 mmBtu from routine maintenance • Decreased energy consumption in design year 2045 from vehicle fuels • Operational energy reduced compared to No Action Alternative due to increased speed limit for build alternatives		
Indirect Impacts	• Potential for an increase in indirect energy required to process the additional fuel needed by vehicles finding alternative routes if the bridge closed or failed	• Upstream energy consumption from raw materials extraction, transportation, and productions is included in direct construction impacts.		

6. AVOIDANCE, MINIMIZATION, AND/OR MITIGATION MEASURES

6.1. Construction Impacts

The following measures would be implemented by the bridge owner to avoid, minimize, or mitigate construction impacts to energy resources:

Contractors would be required to comply with WSDOT standard specifications Section 1-07.5(4) and ODOT standard specifications Section 290 that have requirements for environmental protection, which include air pollution control measures. These control measures include vehicle and equipment idling limitations, which would reduce energy usage as well.

6.2. Long-Term Impacts

No mitigation to long-term impacts is proposed.

Conservation of energy could be achieved in facility planning, construction, operation, and maintenance. Conservation could also be applied to recycling pavements, signals, and other hardware items, using indigenous plants for landscaping, and applying Best Management Practices in maintenance. Other measures that could be applied include using high pressure sodium vapor lamps for light, solar powered lighting, promoting carpools, vanpools, buses, and bicycle projects.

7. PREPARERS

Individuals involved in preparing this technical report are identified in Exhibit 21.

Exhibit 21. List of Preparers

Name	Role	Education	Years of Experience
Rebecca Frohning	Air Quality and Energy Technical Lead	BS, Earth and Atmospheric Science	19
Ginette Lalonde	Air Quality and Energy Technical QC	BS, Civil engineering	20
Angela Findley	Project Manager; QC	MS, Forest Resources BA, Mathematics	25
Scott Polzin	Environmental Task Lead; QC	MCRP, Planning BS, Finance	24

8. REFERENCES

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WSP 2019. Draft Transportation Technical Report. April 2019.

ATTACHMENT A

ICE Inputs and Results – No Action Alternative

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Project Inputs

Mitigation Inputs | Results Summary | Impacts on Vehicle Operation

Instructions:

1. Using information from the project or plan you want to analyze, complete the inputs on this page and on the Mitigation Inputs page by entering information in the cells that are shaded orange. Gray cells display results; do not change the information in these cells. (The tool uses the term "project" not just to refer to individual projects, but also to long-range transportation plans or other plans that consist of a suite of projects.)

2. Click on the gray buttons at the top of the page to navigate between input pages, the results page, and the impacts on vehicle operation page.

3. For further instructions, refer to the accompanying user guide for detailed descriptions of factors and assumptions used in this tool.

Key to Cell Colors
User Input
Results Automatically Calculated

General Information

Infrastructure location (state)	OR
Analysis timeframe (years)	20

Average daily traffic per lane mile - for facilities that will be reconstructed or resurfaced	25,410

Roadway System	
Total existing centerline miles	1
Total existing lane miles	2
Total newly-constructed centerline miles	0
Total newly-constructed lane miles	0

Rail, Bus, and Bicycle Infrastructure	
Total existing track miles of light rail	0
Total existing track miles of heavy rail	0
Total newly-constructed track miles of rail	0
Total existing lane miles of bus rapid transit	0
Total newly-constructed lane miles of bus rapid transit	0
Total existing lane miles of bicycle lanes	0
Total newly-constructed lane miles of bicycle lanes	0

Roadways

Roadway Projects	
Roadway Construction	Roadway Rehabilitation

Accounting for the Full Roadway Lifespan

The estimator tool accounts for construction, rehabilitation, routine maintenance, and preventive maintenance in different ways:

Facility type	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Re-Alignment (lane miles)	Lane Widening (lane miles)	Shoulder Improvement (centerline miles)	Re-construct Pavement (lane miles)	Resurface Pavement (lane miles)
Rural Interstates	0	0	0	0	0	0	0
Rural Principal Arterials	0	0	0	0	0	0	0
Rural Minor Arterials	0	0	0	0	0	0	0
Rural Collectors	0	0	0	0	0	0	0
Urban Interstates / Expressways	0	0	0	0	0	0	0
Urban Principal Arterials	0	0	0	0	0	0	0
Urban Minor Arterials / Collectors	0	0	0	0	0	0	0

Parking	
Surface Parking (spaces)	0
Structured Parking (spaces)	0

Options	
% roadway construction on rocky / mountainous terrain	0%

and preventive maintenance in different ways.

- **New Construction (user provided):** The user enters lane miles of construction projects.
- **Rehabilitation (user provided):** The user enters expected reconstruction and resurfacing projects on all existing and new roadways for the length of the analysis period. As a general rule of thumb, new roadways require resurfacing after 15 years and reconstruction after 30 years.
- **Routine Maintenance (automatically estimated):** The tool automatically estimates routine maintenance activity, such as sweeping, striping, bridge deck repair, litter pickup, and maintenance of appurtenances, per lane mile of existing and new roadway.
- **Preventive Maintenance (user provided):** The user has the option to specify a preventive maintenance program as a mitigation strategy (in the Mitigation Inputs tab). Preventive maintenance techniques include crack sealing, patching, chip seals, and micro-surfacing.

Example: The user enters new construction of 10 lane miles of new freeway, with an analysis period of 40 years. Assuming that all construction takes place in year 1, the user enters 10 lane miles of freeway resurfacing (assumed to take place in year 15) and 10 lane miles of freeway reconstruction (assumed to take place in year 30). The tool automatically includes routine maintenance of the 10 newly constructed lane miles. The user has the option of specifying a preventive maintenance strategy, which will increase the longevity of the pavement surface and therefore reduce the amount of energy and emissions associated with resurfacing and rehabilitation.

Bridge Structures

Bridge Structure	Construct New Bridge: Number of bridges	Construct New Bridge: Average number of spans per bridge	Construct New Bridge: Average number of lanes per bridge	Construct New Bridge: Total number of lane-spans	Reconstruct Bridge: Number of bridges	Reconstruct Bridge: Average number of spans per bridge	Reconstruct Bridge: Average number of lanes per bridge	Reconstruct Bridge: Total number of lane-spans	Add Lane to Bridge: Number of bridges	Add Lane to Bridge: Average number of spans per bridge	Add Lane to Bridge: Average number of new lanes per bridge	Add Lane to Bridge: Total number of lane-spans
Single-Span	0	1	0	0	0	1	0	0	0	1	0	0
Two-Span	0	2	0	0	0	2	0	0	0	2	0	0
Multi-Span (over land)	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Span (over water)	0	0	0	0	0	0	0	0	0	0	0	0

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Rail, bus, bicycle, and pedestrian facilities

Rail construction		
Project Type	Light rail	Heavy rail
New construction (underground - hard rock) - track miles	0	0
New construction (underground - soft soil) - track miles	0	0
New construction (elevated) - track miles	0	0
New construction (at grade) - track miles	0	0
Converted or upgraded existing facility - track miles	0	N/A
New rail station (underground) - stations	0	0
New rail station (elevated) - stations	0	0
New rail station (at grade) - stations	0	0

Bus rapid transit construction	
New lane or right-of-way - lane miles	0
Converted or upgraded lane/facility - lane miles	0
New BRT Stations	0

Bicycle and Pedestrian Facilities			
Project Type	New Construction	Resurfacing	Restriping
Off-Street Bicycle or Pedestrian Path - miles	0	0	N/A
On-Street Bicycle Lane - lane miles	0	0	0
On-Street Sidewalk - miles	0	N/A	N/A

Construction - Delay

Total project-days of lane closure	
Average daily traffic per directional segment for facilities requiring lane closure	
Percentage of facility lanes closed during construction	

Impacts on Vehicle Operation

Estimating Project-Days of Lane Closure

Estimates of project-days of lane closure may be available from project documents. The tool assumes that lane closures occur in one-mile increments. Average values for construction schedules (e.g., daytime versus overnight) are incorporated in the calculations. Estimates of emissions from construction delay are meant to provide a rough sense of the scale of emissions relative to the construction processes themselves, and are not meant to replace estimates derived from traffic modeling software. Planned construction projects that will result in significant lane closures on high volume roads should be evaluated using traffic modeling software.

Results Summary

Project Inputs | **Mitigation Inputs** | **Impacts on Vehicle Operation**

	Annualized energy use (mmBTUs), per year over 20 years											
	Unmitigated						Mitigated					
	Roadway - new construction	Roadway-rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total	Roadway - new construction	Roadway-rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total
Upstream Energy												
Materials	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy												
Construction Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Routine Maintenance						50						50
Total	-	-	-	-	-	50	-	-	-	-	-	50

Note: To convert mmBTU to the equivalent gallons of US conventional diesel, use the conversion factor of 7.785 gallons of diesel / mmBTU. Please keep in mind that this conversion represents the equivalent amount of energy required, which can be useful for informational purposes, but it does not necessarily represent actual gallons of diesel required.

	Annual GHG emissions (MT CO2e), per year over 20 years											
	Unmitigated						Mitigated					
	Roadway - new construction	Roadway-rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total	Roadway - new construction	Roadway-rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total
Upstream Emissions												
Materials	-	-	-	-	-	-	-	-	-	-	-	-
Direct Emissions												
Construction Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Routine Maintenance						4						4
Total	-	-	-	-	-	4	-	-	-	-	-	4

Impacts on Vehicle Operation

Project Inputs

Note: In addition to increasing energy use and GHG emissions associated with constructions and mainte
also affect the energy use and emissions associated with vehicles using the roadway. This module estim
delay associated with construction projects and increased pavement smoothness following resurfacing a
not comparable with those shown in the other modules of the tool because they come from a different s
materials and construction and maintenance vehicles that are the focus of the other modules in the tool
the context of a comprehensive evaluation of a plan or project's impact on roadway vehicles, including n
patterns and demand.

Construction delay	Result	Energy use (mmBTUs)	GHG emissions (MT CO2e)
Total project-days of construction/lane closure	0		
Project lifetime (years)	20		
Additional energy use / emissions due to delay (per project-day)		#N/A	#N/A
Total energy use / GHG emissions due to construction delay		#N/A	#N/A
Annual energy use / GHG emissions due to construction delay, per year		#N/A	#N/A

Pavement smoothness	Result	Energy use (mmBTUs)	GHG emissions (MT CO2e)
Total lane miles of roadway reconstruction / resurfacing	0		
Project lifetime (years)	20		
Reduced Energy use / GHG emissions due to smooth pavement		0	0
Annual energy / emissions savings due to pavement smoothness		0.0	0.0

Note: Energy and emis
savings from pavemer
smoothness are auton
calculated for all resur
and reconstruction pr
Savings accrue after p
completion.

Total	Energy use (mmBTUs)	GHG emissions (MT CO2e)
Total Annualized Delay and Pavement Smoothness Impacts	#N/A	#N/A

ATTACHMENT B

ICE Inputs and Results – Build Alternatives

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Project Inputs

Mitigation Inputs | Results Summary | Impacts on Vehicle Operation

Instructions:

1. Using information from the project or plan you want to analyze, complete the inputs on this page and on the Mitigation Inputs page by entering information in the cells that are shaded orange. Gray cells display results; do not change the information in these cells. (The tool uses the term "project" not just to refer to individual projects, but also to long-range transportation plans or other plans that consist of a suite of projects.)

2. Click on the gray buttons at the top of the page to navigate between input pages, the results page, and the impacts on vehicle operation page.

3. For further instructions, refer to the accompanying user guide for detailed descriptions of factors and assumptions used in this tool.

Key to Cell Colors
User Input
Results Automatically Calculated

General Information

Infrastructure location (state)	OR
Analysis timeframe (years)	20

Average daily traffic per lane mile - for facilities that will be reconstructed or resurfaced	25,410

Roadway System	
Total existing centerline miles	1
Total existing lane miles	2
Total newly-constructed centerline miles	0
Total newly-constructed lane miles	0

Rail, Bus, and Bicycle Infrastructure	
Total existing track miles of light rail	0
Total existing track miles of heavy rail	0
Total newly-constructed track miles of rail	0
Total existing lane miles of bus rapid transit	0
Total newly-constructed lane miles of bus rapid transit	0
Total existing lane miles of bicycle lanes	1
Total newly-constructed lane miles of bicycle lanes	0

Roadways

Roadway Projects		
	Roadway Construction	Roadway Rehabilitation

Accounting for the Full Roadway Lifespan

The estimator tool accounts for construction, rehabilitation, routine maintenance, and preventive maintenance in different ways:

Facility type	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Re-Alignment (lane miles)	Lane Widening (lane miles)	Shoulder Improvement (centerline miles)	Re-construct Pavement (lane miles)	Resurface Pavement (lane miles)
Rural Interstates	0	0	0	0	0	0	0
Rural Principal Arterials	0	0	0	0	0	0	0
Rural Minor Arterials	0	0	0	0	0	0	0
Rural Collectors	0	0	0	0	0	0	0
Urban Interstates / Expressways	0	0	0	0	0	0	0
Urban Principal Arterials	0	0	0	0	0	0	0
Urban Minor Arterials / Collectors	0	0	0	0	0	0	0

and preventive maintenance in different ways.

- **New Construction (user provided):** The user enters lane miles of construction projects.
- **Rehabilitation (user provided):** The user enters expected reconstruction and resurfacing projects on all existing and new roadways for the length of the analysis period. As a general rule of thumb, new roadways require resurfacing after 15 years and reconstruction after 30 years.
- **Routine Maintenance (automatically estimated):** The tool automatically estimates routine maintenance activity, such as sweeping, striping, bridge deck repair, litter pickup, and maintenance of appurtenances, per lane mile of existing and new roadway.
- **Preventive Maintenance (user provided):** The user has the option to specify a preventive maintenance program as a mitigation strategy (in the Mitigation Inputs tab). Preventive maintenance techniques include crack sealing, patching, chip seals, and micro-surfacing.

Example: The user enters new construction of 10 lane miles of new freeway, with an analysis period of 40 years. Assuming that all construction takes place in year 1, the user enters 10 lane miles of freeway resurfacing (assumed to take place in year 15) and 10 lane miles of freeway reconstruction (assumed to take place in year 30). The tool automatically includes routine maintenance of the 10 newly constructed lane miles. The user has the option of specifying a preventive maintenance strategy, which will increase the longevity of the pavement surface and therefore reduce the amount of energy and emissions associated with resurfacing and rehabilitation.

Parking	
Surface Parking (spaces)	0
Structured Parking (spaces)	0

Options	
% roadway construction on rocky / mountainous terrain	0%

Bridge Structures

Bridge Structure	Construct New Bridge				Reconstruct Bridge				Add Lane to Bridge			
	Number of bridges	Average number of spans per bridge	Average number of lanes per bridge	Total number of lane-spans	Number of bridges	Average number of spans per bridge	Average number of lanes per bridge	Total number of lane-spans	Number of bridges	Average number of spans per bridge	Average number of new lanes per bridge	Total number of lane-spans
Single-Span	0	1	0	0	0	1	2	0	0	1	0	0
Two-Span	0	2	0	0	0	2	0	0	0	2	0	0
Multi-Span (over land)	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Span (over water)	0	0	0	0	0	0	0	0	0	0	0	0

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Rail, bus, bicycle, and pedestrian facilities

Rail construction		
Project Type	Light rail	Heavy rail
New construction (underground - hard rock) - track miles	0	0
New construction (underground - soft soil) - track miles	0	0
New construction (elevated) - track miles	0	0
New construction (at grade) - track miles	0	0
Converted or upgraded existing facility - track miles	0	N/A
New rail station (underground) - stations	0	0
New rail station (elevated) - stations	0	0
New rail station (at grade) - stations	0	0

Bus rapid transit construction	
New lane or right-of-way - lane miles	0
Converted or upgraded lane/facility - lane miles	0
New BRT Stations	0

Bicycle and Pedestrian Facilities			
Project Type	New Construction	Resurfacing	Restriping
Off-Street Bicycle or Pedestrian Path - miles	0	0	N/A
On-Street Bicycle Lane - lane miles	0	0	0
On-Street Sidewalk - miles	0	N/A	N/A

Construction - Delay

Total project-days of lane closure	2
Average daily traffic per directional segment for facilities requiring lane closure	8,250
Percentage of facility lanes closed during construction	50%

Impacts on Vehicle Operation

Estimating Project-Days of Lane Closure

Estimates of project-days of lane closure may be available from project documents. The tool assumes that lane closures occur in one-mile increments. Average values for construction schedules (e.g., daytime versus overnight) are incorporated in the calculations. Estimates of emissions from construction delay are meant to provide a rough sense of the scale of emissions relative to the construction processes themselves, and are not meant to replace estimates derived from traffic modeling software. Planned construction projects that will result in significant lane closures on high volume roads should be evaluated using traffic modeling software.

Results Summary

Project Inputs | Mitigation Inputs | Impacts on Vehicle Operation

	Annualized energy use (mmBTUs), per year over 20 years											
	Unmitigated						Mitigated					
	Roadway - new construction	Roadway- rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total	Roadway - new construction	Roadway- rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total
Upstream Energy												
Materials	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy												
Construction Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Routine Maintenance						63						63
Total	-	-	-	-	-	63	-	-	-	-	-	63

Note: To convert mmBTU to the equivalent gallons of US conventional diesel, use the conversion factor of 7.785 gallons of diesel / mmBTU. Please keep in mind that this conversion represents the equivalent amount of energy required, which can be useful for informational purposes, but it does not necessarily represent actual gallons of diesel required.

	Annual GHG emissions (MT CO2e), per year over 20 years											
	Unmitigated						Mitigated					
	Roadway - new construction	Roadway- rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total	Roadway - new construction	Roadway- rehabilitation	Roadway - total	Bridges	Rail, bus, bicycle, ped.	Total
Upstream Emissions												
Materials	-	-	-	-	-	-	-	-	-	-	-	-
Direct Emissions												
Construction Equipment	-	-	-	-	-	-	-	-	-	-	-	-
Routine Maintenance						5						5
Total	-	-	-	-	-	5	-	-	-	-	-	5

Impacts on Vehicle Operation

Project Inputs

Note: In addition to increasing energy use and GHG emissions associated with constructions and mainte
also affect the energy use and emissions associated with vehicles using the roadway. This module estim
delay associated with construction projects and increased pavement smoothness following resurfacing a
not comparable with those shown in the other modules of the tool because they come from a different s
materials and construction and maintenance vehicles that are the focus of the other modules in the tool
the context of a comprehensive evaluation of a plan or project's impact on roadway vehicles, including n
patterns and demand.

Construction delay	Result	Energy use (mmBTUs)	GHG emissions (MT CO2e)
Total project-days of construction/lane closure	2		
Project lifetime (years)	20		
Additional energy use / emissions due to delay (per project-day)		9.2	0.8
Total energy use / GHG emissions due to construction delay		18	2
Annual energy use / GHG emissions due to construction delay, per year		**0.9**	**0.1**

Pavement smoothness	Result	Energy use (mmBTUs)	GHG emissions (MT CO2e)
Total lane miles of roadway reconstruction / resurfacing	0		
Project lifetime (years)	20		
Reduced Energy use / GHG emissions due to smooth pavement		0	0
Annual energy / emissions savings due to pavement smoothness		**0.0**	**0.0**

Note: Energy and emi
savings from pavemer
smoothness are auton
calculated for all resur
and reconstruction pr
Savings accrue after p
completion.

Total	Energy use (mmBTUs)	GHG emissions (MT CO2e)
Total Annualized Delay and Pavement Smoothness Impacts	**0.9**	**0.1**

Mitigation Inputs

Results Summary

nance vehicles and materials, transportation projects can
ıates energy and GHG emissions impacts due to vehicle
and reconstruction projects. However, these results are
source - roadway vehicles - rather than the construction
l. The results shown in this sheet should be considered in
ıot only delay and pavement smoothness, but also travel

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ojects.
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