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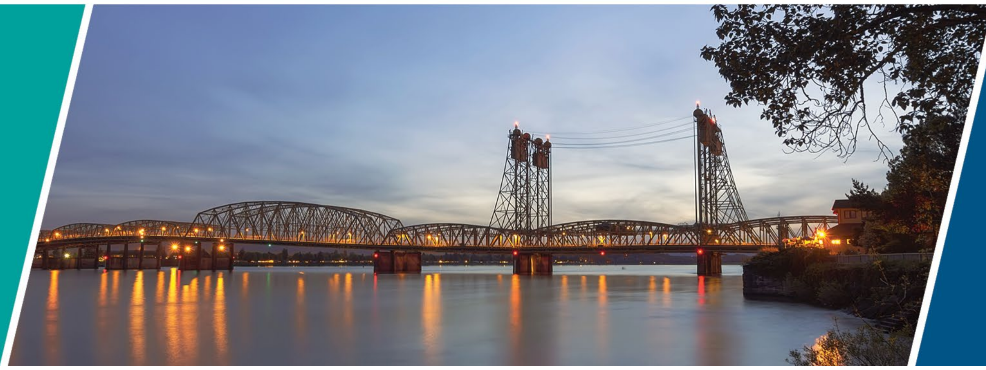

Energy Technical Report

September 2024

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Energy Technical Report

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ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
BRT	bus rapid transit
Btu	British thermal units
CAFE	Corporate Average Fuel Economy
CO_2e	carbon dioxide equivalent
CRC	Columbia River Crossing
CTR	Commute Trip Reduction
C-TRAN	Clark County Public Transit Benefit Area Authority
CY	cubic yards
DEQ	Oregon Department of Environmental Quality
Ecology	Washington Department of Ecology
EIA	U.S. Energy Information Administration
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPD	Environmental Product Declaration
FHWA	Federal Highway Association
FSCR	Flood Safe Columbia River
FTA	Federal Transit Administration
gal/cf	gallons per cubic foot
gal/lb	gallons per pound
GHG	greenhouse gas
I-5	Interstate 5
IBR	Interstate Bridge Replacement

Acronym/Abbreviation	Definition
ICE	Infrastructure Carbon Estimator
kg CO_2e/CY	kilograms carbon dioxide equivalent per cubic yard
kg CO_2e/lb	kilograms carbon dioxide equivalent per pound
ksi	kilopound force per square inch
LPA	Locally Preferred Alternative
LRT	light-rail transit
LRV	light-rail vehicle
MAX	Metropolitan Area Express
Metro	Oregon Metro
MOVES	MOtor Vehicle Emission Simulator
MT	Metric tons
NAVD 88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NHTSA	National Highway Traffic Safety Administration
NO_X	nitrogen oxide
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
OTC	Oregon Transportation Commission
PMLS	Portland Metro Levee System
PNCD	Preliminary Navigation Clearance Determination
ROD	Record of Decision
RTP	Regional Transportation Plan
SAFE	Safer Affordable Fuel-Efficient

Acronym/Abbreviation	Definition
SEIS	Supplemental Environmental Impact Statement
SEPA	Washington State Environmental Policy Act
SOV	single-occupancy vehicle
SR	State Route
TriMet	Tri-County Metropolitan Transportation District of Oregon
UFSWQD	Urban Flood Safety and Water Quality District
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
VMT	vehicle miles traveled
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation
WSTC	Washington State Transportation Commission

1. PROGRAM OVERVIEW

This technical report identifies, describes, and evaluates the existing energy consumption and trends within the study area and the long-term and temporary effects on energy consumption and greenhouse gas (GHG) emissions from the Interstate Bridge Replacement (IBR) Program. It also provides mitigation measures for potential effects on energy and GHG emissions when avoidance is not feasible.

The purpose of this report is to satisfy applicable portions of the National Environmental Policy Act (NEPA) 42 United States Code (USC) 4321 "to promote efforts which will prevent or eliminate damage to the environment." Information and potential environmental consequences described in this report will be used to support the Draft Supplemental Environmental Impact Statement (SEIS) for the IBR Program pursuant to 42 USC 4332.

The objectives of this report are to:

- Define the study area and the methods of data collection and evaluation (Chapter 2).
- Describe the existing energy consumption and GHG emissions within the study area (Chapter 3).
- Discuss potential long-term, temporary, and indirect effects on energy consumption and GHG emissions resulting from construction and operation of the Modified Locally Preferred Alternative (LPA) compared to the No-Build Alternative (Chapters 4, 5, and 6).
- Provide proposed avoidance and mitigation measures to help prevent, eliminate, or minimize energy and GHG impacts from the Modified LPA (Chapter 7).

The IBR Program is a continuation of the previously suspended Columbia River Crossing (CRC) project with the same purpose to replace the aging Interstate 5 (I-5) Bridge across the Columbia River with a modern, seismically resilient multimodal structure. The proposed infrastructure improvements are located along a 5-mile stretch of the I-5 corridor that extends from approximately Victory Boulevard in Portland to State Route (SR) 500 in Vancouver as shown in Figure 1-1.

The Modified LPA is a modification of the CRC LPA, which completed the NEPA process with a signed Record of Decision (ROD) in 2011 and two re-evaluations that were completed in 2012 and 2013. The CRC project was discontinued in 2014. This Technical Report is evaluating the effects of changes in project design since the CRC ROD and re-evaluations, as well as changes in regulations, policy, and physical conditions.

Figure 1-1. IBR Program Location Overview

1.1 Components of the Modified LPA

The basic components of the Modified LPA include:

- A new pair of Columbia River bridges—one for northbound and one for southbound travel—built west of the existing bridge. The new bridges would each include three through lanes, safety shoulders, and one auxiliary lane (a ramp-to-ramp connection on the highway that improves interchange safety by providing drivers with more space and time to merge, diverge, and weave) in each direction. When all highway, transit, and active transportation would be moved to the new Columbia River bridges, the existing Interstate Bridge (both spans) would be removed.
  - Three bridge configurations are under consideration: (1) double-deck truss bridges with fixed spans, (2) single-level bridges with fixed spans, and (3) single-level bridges with movable spans over the primary navigation channel. The fixed-span configurations would provide up to 116 feet of vertical navigation clearance, and the movable-span configuration would provide 178 feet of vertical navigation clearance in the open position. The primary navigation channel would be relocated approximately 500 feet south (measured by channel centerline) of its existing location near the Vancouver shoreline.
  - A two auxiliary lane design option (two ramp-to-ramp lanes connecting interchanges) across the Columbia River is also being evaluated. The second auxiliary lane in each direction of I-5 would be added from approximately Interstate Avenue/Victory Boulevard to SR 500/39th Street.
- A 1.9-mile light-rail transit (LRT) extension of the current Metropolitan Area Express (MAX) Yellow Line from the Expo Center MAX Station in North Portland, where it currently ends, to a terminus near Evergreen Boulevard in Vancouver. Improvements would include new stations at Hayden Island, downtown Vancouver (Waterfront Station), and near Evergreen Boulevard (Evergreen Station), as well as revisions to the existing Expo Center MAX Station. Park and rides to serve LRT riders in Vancouver could be included near the Waterfront Station and Evergreen Station. The Tri-County Metropolitan Transportation District of Oregon (TriMet), which operates the MAX system, would also operate the Yellow Line extension.
  - Potential site options for park and rides include three sites near the Waterfront Station and two near the Evergreen Station (up to one park and ride could be built for each station location in Vancouver).
- Associated LRT improvements such as traction power substations, overhead catenary system, signal and communications support facilities, an overnight light-rail vehicle (LRV) facility at the Expo Center, 19 new LRVs, and an expanded maintenance facility at TriMet's Ruby Junction.
- Integration of local bus transit service, including bus rapid transit (BRT) and express bus routes, in addition to the proposed new LRT service.
- Wider shoulders on I-5 from Interstate Avenue/Victory Boulevard to SR 500/39th Street to accommodate express bus-on-shoulder service in each direction.
- Associated bus transit service improvements would include three additional bus bays for eight new electric double-decker buses at the Clark County Public Transit Benefit Area Authority (C-

TRAN) operations and maintenance facility (see Section 1.1.7, Transit Operating Characteristics, for more information about this service).

- Improvements to seven I-5 interchanges and I-5 mainline improvements between Interstate Avenue/ Victory Boulevard in Portland and SR 500/39th Street in Vancouver. Some adjacent local streets would be reconfigured to complement the new interchange designs, and improve local east-west connections.
  - An option that shifts the I-5 mainline up to 40 feet westward in downtown Vancouver between the SR 14 interchange and Mill Plain Boulevard interchange is being evaluated.
  - An option that eliminates the existing C Street ramps in downtown Vancouver is being evaluated.
- Six new adjacent bridges across North Portland Harbor: one on the east side of the existing I-5 North Portland Harbor bridge and five on the west side or overlapping with the existing bridge (which would be removed). The bridges would carry (from west to east) LRT tracks, southbound I-5 off-ramp to Marine Drive, southbound I-5 mainline, northbound I-5 mainline, northbound I-5 on-ramp from Marine Drive, and an arterial bridge for local traffic with a shared-use path for pedestrians and bicyclists.
- A variety of improvements for people who walk, bike, and roll throughout the study area, including a system of shared-use paths, bicycle lanes, sidewalks, enhanced wayfinding, and facility improvements to comply with the Americans with Disabilities Act. These are referred to in this document as *active transportation* improvements.
- Variable-rate tolling for motorists using the river crossing as a demand-management and financing tool.

The transportation improvements proposed for the Modified LPA and the design options are shown in Figure 1-2. The Modified LPA includes all of the components listed above. If there are differences in environmental effects or benefits between the design options, those are identified in the sections below.

Figure 1-2. Modified LPA Components

Section 1.1.1, Interstate 5 Mainline, describes the overall configuration of the I-5 mainline through the study area, and Sections 1.1.2, Portland Mainland and Hayden Island (Subarea A), through Section 1.1.5, Upper Vancouver (Subarea D), provide additional detail on four geographic subareas (A through D), which are shown on Figure 1-3. In each subarea, improvements to I-5, its interchanges, and the local roadways are described first, followed by transit and active transportation improvements. Design options are described under separate headings in the subareas in which they would be located.

Table 1-1 shows the different combinations of design options analyzed in this Technical Report. However, **any combination of design options is compatible**. In other words, any of the bridge configurations could be combined with one or two auxiliary lanes, with or without the C Street ramps, a centered or westward shift of I-5 in downtown Vancouver, and any of the park-and-ride location options. Figures in each section show both the anticipated limit of ground disturbance, which includes disturbance from temporary construction activities, and the location of permanent infrastructure elements.

Figure 1-3. Modified LPA – Geographic Subareas

Table 1-1. Modified LPA and Design Options

Design Options	Modified LPA	Modified LPA with Two Auxiliary Lanes	Modified LPA Without C Street Ramps	Modified LPA with I-5 Shifted West	Modified LPA with a Single-Level Fixed-Span Configuration	Modified LPA with a Single-Level Movable-Span Configuration
Bridge Configuration	**Double-deck fixed-span***	Double-deck fixed-span	Double-deck fixed-span	Double-deck fixed-span	**Single-level fixed-span***	**Single-level movable-span***
Auxiliary Lanes	**One***	**Two***	One	One	One	One
C Street Ramps	**With C Street ramps***	With C Street ramps	**Without C Street Ramps***	With C Street ramps	With C Street ramps	With C Street ramps
I-5 Alignment	**Centered***	Centered	Centered	**Shifted West***	Centered	Centered
Park-and-Ride Options	**Waterfront**:* 1. Columbia Way (below I-5); 2. Columbia Street/SR 14; 3. Columbia Street/Phil Arnold Way **Evergreen**:* 1. Library Square; 2. Columbia Credit Union					

Bold text with an asterisk (*) indicates which design option is different in each configuration.

1.1.1 Interstate 5 Mainline

Today, within the 5-mile corridor, I-5 has three 12-foot-wide through lanes in each direction, an approximately 6- to 11-foot-wide inside shoulder, and an approximately 10- to 12-foot-wide outside shoulder with the exception of the Interstate Bridge, which has approximately 2- to 3-foot-wide inside and outside shoulders. There are currently intermittent auxiliary lanes between the Victory Boulevard and Hayden Island interchanges in Oregon and between SR 14 and SR 500 in Washington.

The Modified LPA would include three 12-foot through lanes from Interstate Avenue/Victory Boulevard to SR 500/39th Street and a 12-foot auxiliary lane from the Marine Drive interchange to the Mill Plain Boulevard interchange in each direction. Many of the existing auxiliary lanes on I-5 between the SR 14 and Main Street interchanges in Vancouver would remain, although they would be reconfigured. The existing auxiliary lanes between the Victory Boulevard and Hayden Island interchanges would be replaced with changes to on- and off-ramps and interchange reconfigurations. The Modified LPA would also include wider shoulders (12-foot inside shoulders and 10- to 12-foot outside shoulders) to be consistent with ODOT and WSDOT design standards. The wider inside shoulder would be used by express bus service to bypass mainline congestion, known as “bus on shoulder” (refer to Section 1.1.7, Transit Operating Characteristics). The shoulder would be available for express bus service when general-purpose speeds are below 35 miles per hour (mph).

Figure 1-4 shows a cross section of the collector-distributor (C-D)[1] roadways, Figure 1-5 shows the location of the C-D roadways, and Figure 1-6 shows the proposed auxiliary lane layout. The existing Interstate Bridge over the Columbia River does not have an auxiliary lane; the Modified LPA would add one auxiliary lane in each direction across the new Columbia River bridges.

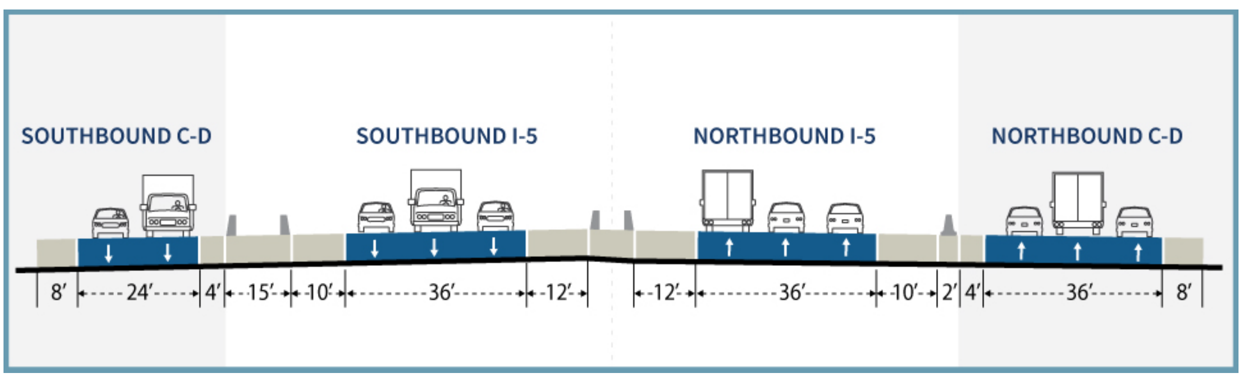
On I-5 northbound, the auxiliary lane that would begin at the on-ramp from Marine Drive would continue across the Columbia River bridge and end at the off-ramp to the C-D roadway, north of SR 14 (see Figure 1-5). The on-ramp from SR 14 westbound would join the off-ramp to the C-D roadway, forming the northbound C-D roadway between SR 14 and Fourth Plain Boulevard. The C-D roadway would provide access from I-5 northbound to the off-ramps at Mill Plain Boulevard and Fourth Plain Boulevard. The C-D roadway would also provide access from SR 14 westbound to the off-ramps at Mill Plain Boulevard and Fourth Plain Boulevard, and to the on-ramp to I-5 northbound.

On I-5 northbound, the Modified LPA would also add one auxiliary lane beginning at the on-ramp from the C-D roadway and ending at the on-ramp from 39th Street, connecting to an existing auxiliary lane from 39th Street to the off-ramp at Main Street. Another existing auxiliary lane would remain between the on-ramp from Mill Plain Boulevard to the off-ramp to SR 500.

On I-5 southbound, the off-ramp to the C-D roadway would join the on-ramp from Mill Plain Boulevard to form a C-D roadway. The C-D roadway would provide access from I-5 southbound to the off-ramp to SR 14 eastbound and from Mill Plain Boulevard to the off-ramp to SR 14 eastbound and the on-ramp to I-5 southbound.

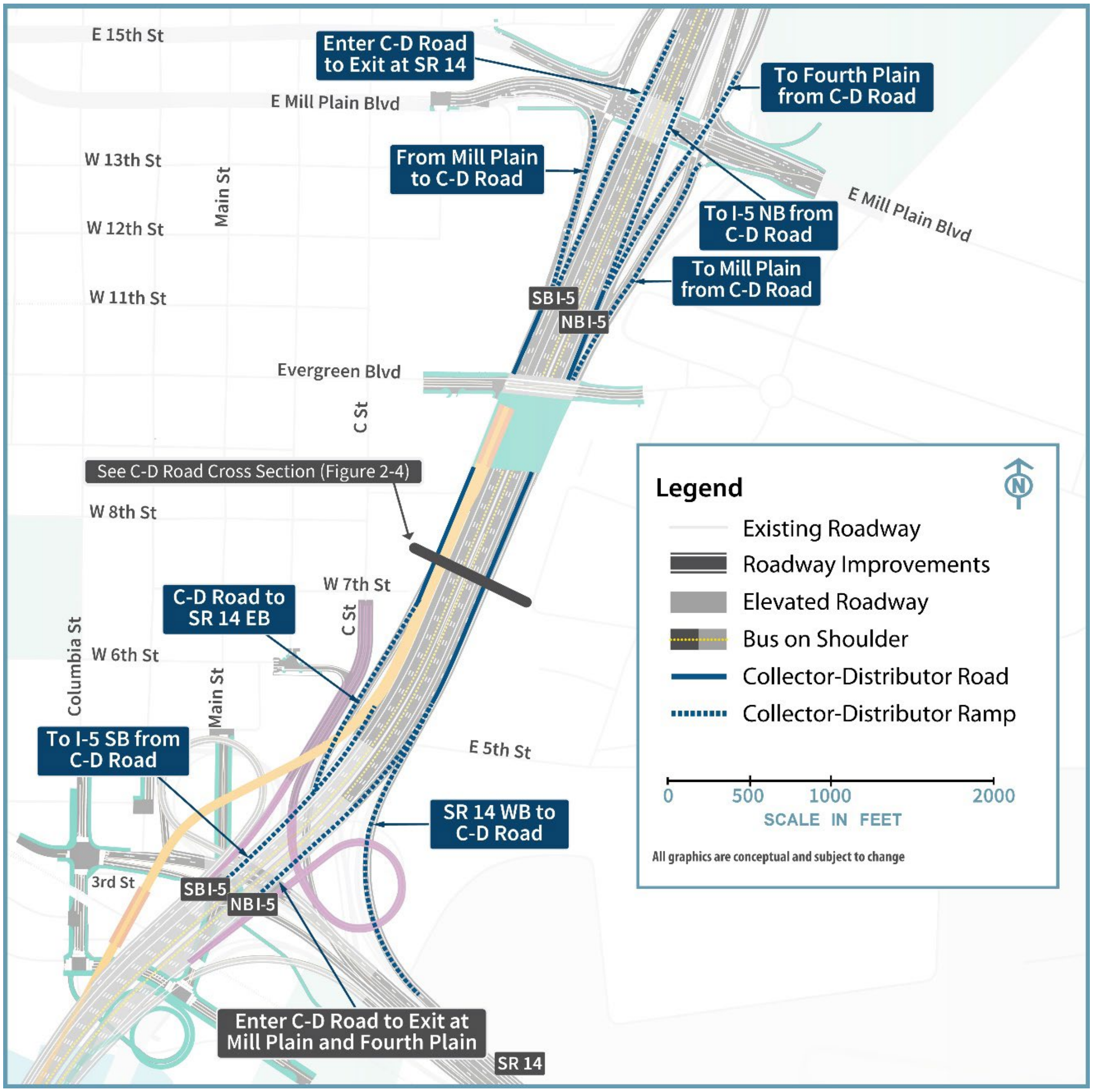
On I-5 southbound, an auxiliary lane would begin at the on-ramp from the C-D roadway and would continue across the southbound Columbia River bridge and end at the off-ramp to Marine Drive. The combined on-ramp from SR 14 westbound and C Street would merge into this auxiliary lane.

Figure 1-4. Cross Section of the Collector-Distributor Roadways



[1] A collector-distributer roadway parallels and connects the main travel lanes of a highway and frontage roads or entrance ramps.

Figure 1-5. Collector-Distributor Roadways



C-D = collector-distributor; EB = eastbound; NB = northbound; SB = southbound; WB = westbound

1.1.1.1 Two Auxiliary Lane Design Option

This design option would add a second 12-foot-wide auxiliary lane in each direction of I-5 with the intent to further optimize travel flow in the corridor. This second auxiliary lane is proposed from the Interstate Avenue/Victory Boulevard interchange to the SR 500/39th Street interchange.

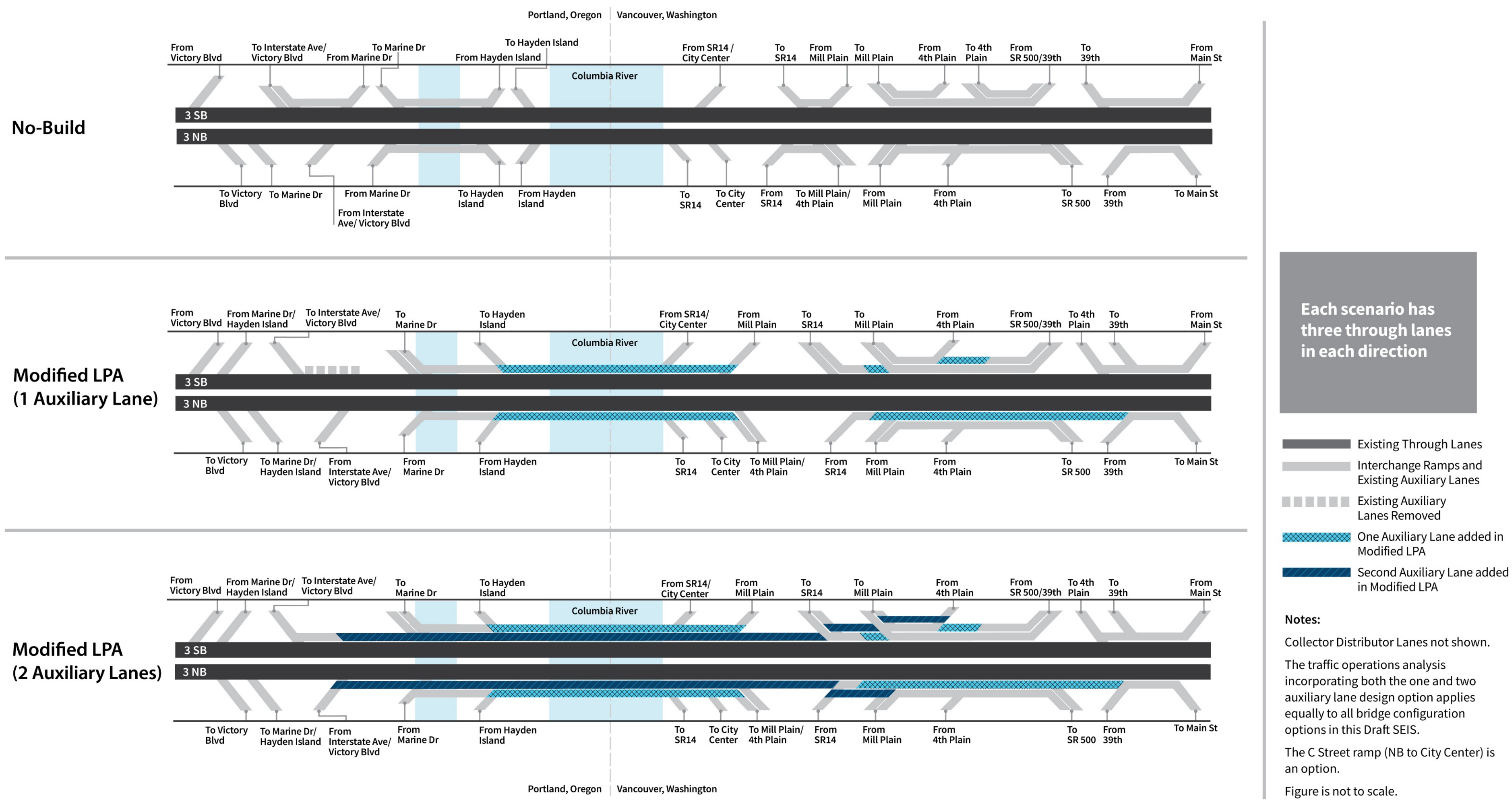
On I-5 northbound, one auxiliary lane would begin at the combined on-ramp from Interstate Avenue and Victory Boulevard, and a second auxiliary lane would begin at the on-ramp from Marine Drive. Both auxiliary lanes would continue across the northbound Columbia River bridge, and the on-ramp from Hayden Island would merge into the second auxiliary lane on the northbound Columbia River bridge. At the off-ramp to the C-D roadway, the second auxiliary lane would end but the first auxiliary lane would continue. A second auxiliary lane would begin again at the on-ramp from Mill Plain Boulevard. The second auxiliary lane would end at the off-ramp to SR 500, and the first auxiliary lane would connect to an existing auxiliary lane at 39th Street to the off-ramp at Main Street.

On I-5 southbound, two auxiliary lanes would begin at the on-ramp from SR 500. Between the on-ramp from Fourth Plain Boulevard and the off-ramp to Mill Plain Boulevard, one auxiliary lane would be added to the existing two auxiliary lanes. The second auxiliary lane would end at the off-ramp to the C-D roadway, but the first auxiliary lane would continue. A second auxiliary lane would begin again at the southbound I-5 on-ramp from the C-D roadway. Both auxiliary lanes would continue across the southbound Columbia River bridge, and the combined on-ramp from SR 14 westbound and C Street would merge into the second auxiliary lane on the southbound Columbia River bridge. The second auxiliary lane would end at the off-ramp to Marine Drive, and the first auxiliary lane would end at the combined off-ramp to Interstate Avenue and Victory Boulevard.

Figure 1-6 shows a comparison of the one auxiliary lane configuration and the two auxiliary lane configuration design option. Figure 1-7 shows a comparison of the footprints (i.e., the limit of permanent improvements) of the one auxiliary lane and two auxiliary lane configurations on a double-deck fixed-span bridge. For all Modified LPA bridge configurations (described in Section 1.1.3, Columbia River Bridges (Subarea B)), the footprints of the two auxiliary lane configurations differ only over the Columbia River and in downtown Vancouver. The rest of the corridor would have the same footprint. For all bridge configurations analyzed in this document, the two auxiliary lane option would add 16 feet (8 feet in each direction) in total roadway width compared to the one auxiliary lane option due to the increased shoulder widths for the one auxiliary lane option.[2] The traffic operations analysis incorporating both the one and two auxiliary lane design options applies equally to all bridge configurations in this Technical Report.

[2] Under the one auxiliary lane option, the width of each shoulder would be approximately 14 feet to accommodate maintenance of traffic during construction. Under the two auxiliary lane option, maintenance of traffic could be accommodated with 12-foot shoulders because the additional 12-foot auxiliary lane provides adequate roadway width. The total difference in roadway width in each direction between the one auxiliary lane option and the two auxiliary lane option would be 8 feet (12-foot auxiliary lane – 2 feet from the inside shoulder – 2 feet from the outside shoulder = 8 feet).

Figure 1-6. Comparison of Auxiliary Lane Configurations



Notes:

Collector Distributor Lanes not shown.

The traffic operations analysis incorporating both the one and two auxiliary lane design option applies equally to all bridge configuration options in this Draft SEIS.

The C Street ramp (NB to City Center) is an option.

Figure is not to scale.

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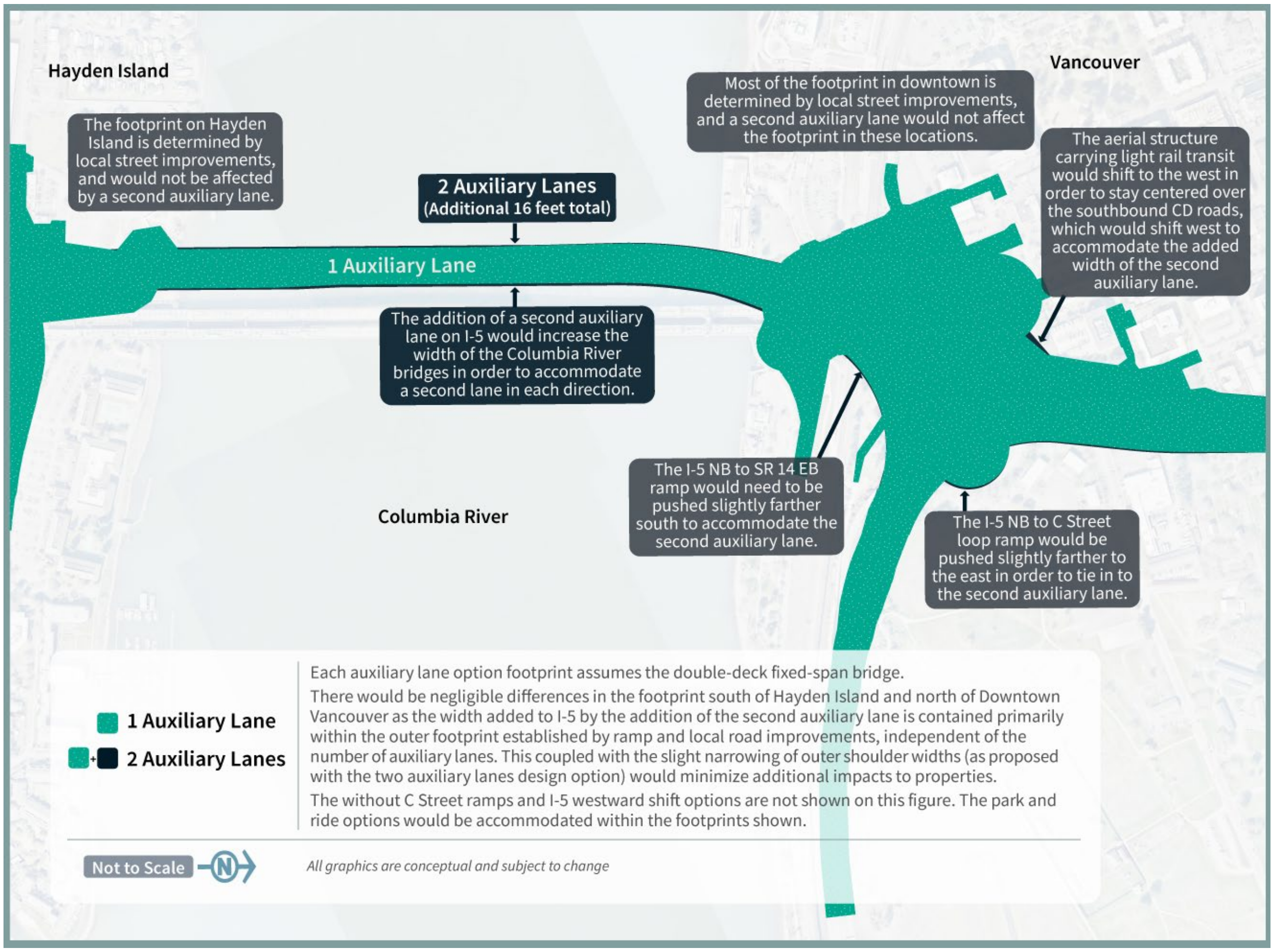
Figure 1-7. Auxiliary Lane Configuration Footprint Differences



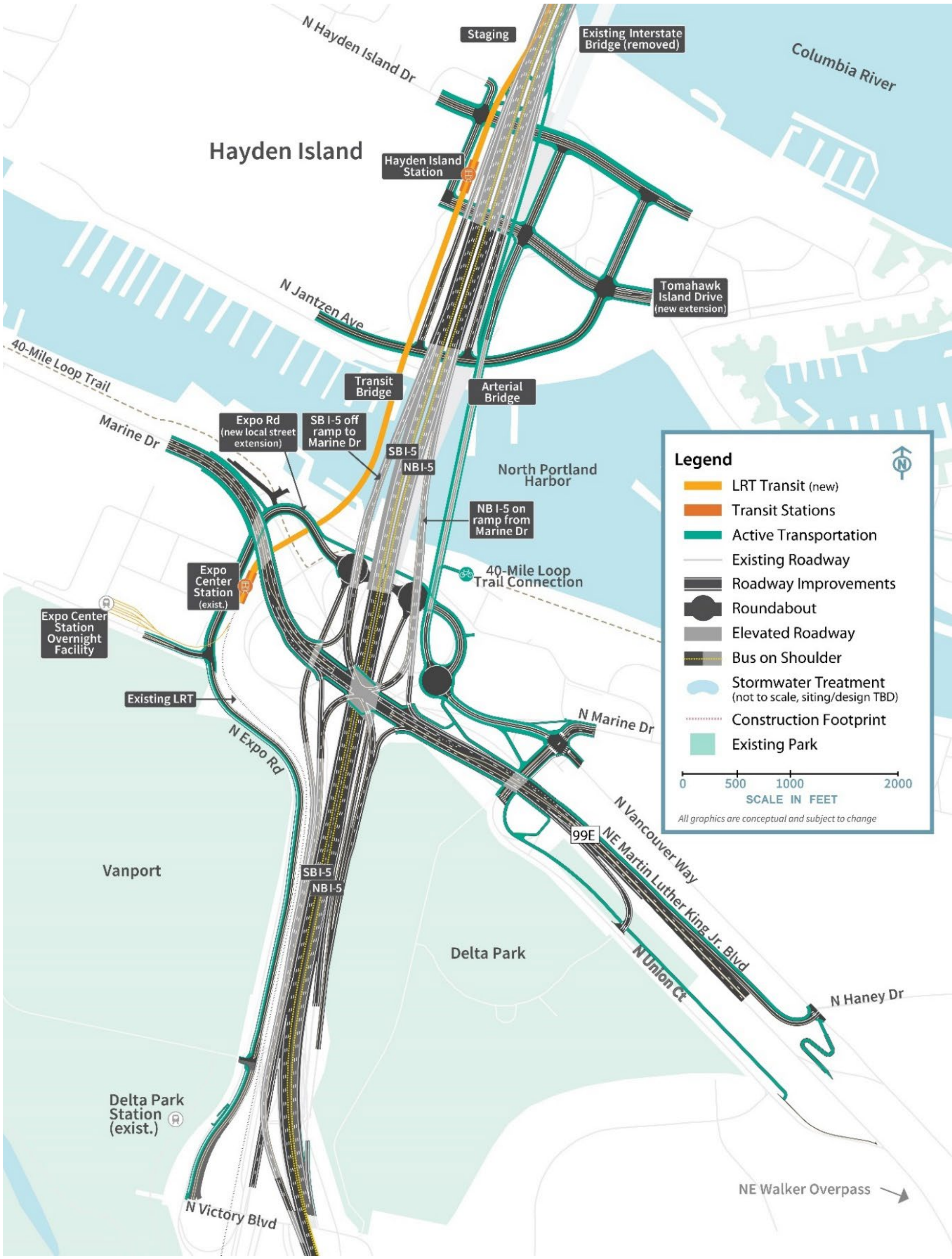
1.1.2 Portland Mainland and Hayden Island (Subarea A)

This section discusses the geographic Subarea A shown in Figure 1-3. See Figure 1-8 for highway and interchange improvements in Subarea A, including the North Portland Harbor bridge. Figure 1-8 illustrates the one auxiliary lane design option; please refer to Figure 1-6 and the accompanying description for how two auxiliary lanes would alter the Modified LPA's proposed design. Refer to Figure 1-3 for an overview of the geographic subareas.

Within Subarea A, the IBR Program has the potential to alter three federally authorized levee systems:

- The Oregon Slough segment of the Peninsula Drainage District Number 1 levee (PEN 1).
- The Oregon Slough segment of the Peninsula Drainage District Number 2 levee (PEN 2).
- The PEN1/PEN2 cross levee segment of the PEN 1 levee (Cross Levee).

Figure 1-8. Portland Mainland and Hayden Island (Subarea A)



LRT = light-rail transit; NB = northbound; SB = southbound; TBD = to be determined

The levee systems are shown on Figure 1-9, and intersections with Modified LPA components are described throughout Section 1.1.2, Portland Mainland and Hayden Island (Subarea A), where appropriate. Within Subarea A, the IBR Program study area intersects with PEN 1 to the west of I-5 and with PEN 2 to the east of I-5. PEN 1 and PEN 2 include a main levee along the south side of North Portland Harbor and are part of a combination of levees and floodwalls. PEN 1 and PEN 2 are separated by the Cross Levee that is intended to isolate the two districts if one of them fails. The Cross Levee is located along the I-5 mainline embankment, except in the Marine Drive interchange area where it is located on the west edge of the existing ramp from Marine Drive to southbound I-5.[3]

There are two concurrent efforts underway that are planning improvements to PEN1, PEN2, and the Cross Levee to reduce flood risk:

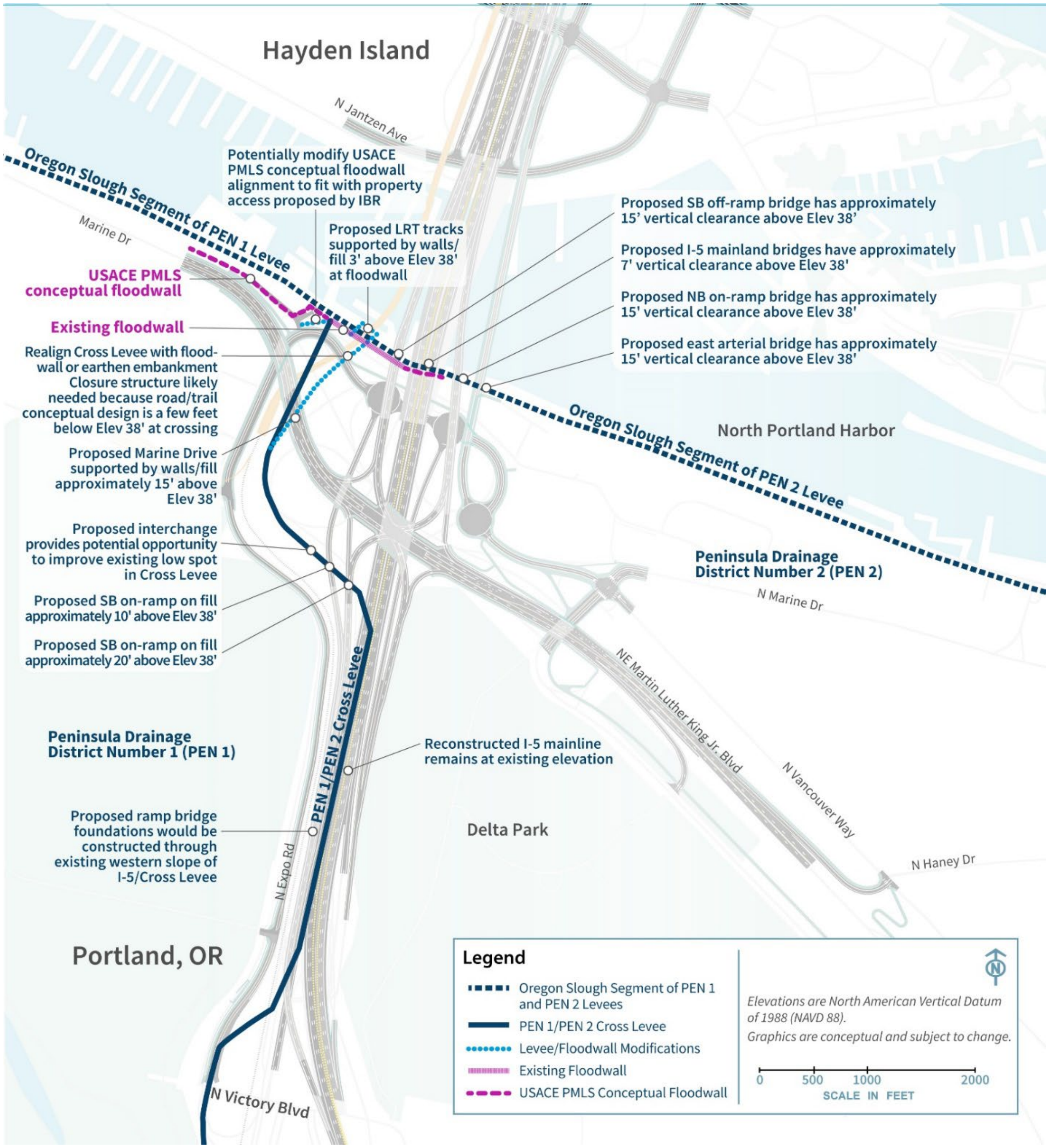
- The U.S. Army Corps of Engineers (USACE) Portland Metro Levee System (PMLS) project.
- The Flood Safe Columbia River (FSCR) program (also known as "Levee Ready Columbia").

The Urban Flood Safety and Water Quality District (UFSWQD)[4] is working with the USACE through the PMLS project, which includes improvements at PEN 1 and PEN 2 (e.g., raising these levees to elevation 38 feet North American Vertical Datum of 1988 [NAVD 88]).[5] Additionally, as part of the FSCR program, UFSWQD is studying raising a low spot in the Cross Levee on the southwest side of the Marine Drive interchange.

The IBR Program is in close coordination with these concurrent efforts to ensure that the IBR Program's design efforts consider the timing and scope of the PMLS and the FSCR proposed modifications. The intersection of the IBR Program proposed actions to both the existing levee configuration and the anticipated future condition based on the proposed PMLS and FSCR projects are described below, where appropriate.

[3] The portion of the original Denver Avenue levee alignment within the Marine Drive interchange area is no longer considered part of the levee system by UFSWQD.
[4] UFSWQD includes PEN 1 and PEN 2, Urban Flood Safety and Water Quality District No. 1, and the Sandy Drainage Improvement Company.
[5] NAVD 88 is a vertical control datum (reference point) used by federal agencies for surveying.

Figure 1-9. Levee Systems in Subarea A



1.1.2.1 Highways, Interchanges, and Local Roadways

VICTORY BOULEVARD/INTERSTATE AVENUE INTERCHANGE AREA

The southern extent of the Modified LPA would improve two ramps at the Victory Boulevard/Interstate Avenue interchange (see Figure 1-8). The first ramp improvement would be the southbound I-5 off-ramp to Victory Boulevard/ Interstate Avenue; this off-ramp would be braided below (i.e., grade separated or pass below) the Marine Drive to the I-5 southbound on-ramp (see the Marine Drive Interchange Area section below). The other ramp improvement would lengthen the merge distance for northbound traffic entering I-5 from Victory Boulevard and from Interstate Avenue.

The existing I-5 mainline between Victory Boulevard/Interstate Avenue and Marine Drive is part of the Cross Levee (see Figure 1-9). The Modified LPA would require some pavement reconstruction of the mainline in this area; however, the improvements would mostly consist of pavement overlay and the profile and footprint would be similar to existing conditions.

MARINE DRIVE INTERCHANGE AREA

The next interchange north of the Victory Boulevard/Interstate Avenue interchange is at Marine Drive. All movements within this interchange would be reconfigured to reduce congestion for motorists entering and exiting I-5. The new configuration would be a single-point urban interchange. The new interchange would be centered over I-5 versus on the west side under existing conditions. See Figure 1-8 for the Marine Drive interchange's layout and construction footprint.

The Marine Drive to I-5 southbound on-ramp would be braided over I-5 southbound to the Victory Boulevard/Interstate Avenue off-ramp. Martin Luther King Jr. Boulevard would have a new more direct connection to I-5 northbound.

The new interchange configuration would change the westbound Marine Drive and westbound Vancouver Way connections to Martin Luther King Jr. Boulevard. An improved connection farther east of the interchange (near Haney Street) would provide access to westbound Martin Luther King Jr. Boulevard for these two streets. For eastbound travelers on Martin Luther King Jr. Boulevard exiting to Union Court, the existing loop connection would be replaced with a new connection farther east (near the access to the East Delta Park Owens Sports Complex).

Expo Road from Victory Boulevard to the Expo Center would be reconstructed with improved active transportation facilities. North of the Expo Center, Expo Road would be extended under Marine Drive and continue under I-5 to the east, connecting with Marine Drive and Vancouver Way through three new connected roundabouts. The westernmost roundabout would connect the new local street extension to I-5 southbound. The middle roundabout would connect the I-5 northbound off-ramp to the local street extension. The easternmost roundabout would connect the new local street extension to an arterial bridge crossing North Portland Harbor to Hayden Island. This roundabout would also connect the local street extension to Marine Drive and Vancouver Way.

To access Hayden Island using the arterial bridge from the east on Martin Luther King Jr. Boulevard, motorists would exit Martin Luther King Jr. Boulevard at the existing off-ramp to Vancouver Way just west of the Walker Street overpass. Then motorists would travel west on Vancouver Way, through the intersection with Marine Drive and straight through the roundabout to the arterial bridge.

From Hayden Island, motorists traveling south to Portland via Martin Luther King Jr. Boulevard would turn onto the arterial bridge southbound and travel straight through the roundabout onto Vancouver Way. At the intersection of Vancouver Way and Marine Drive, motorists would turn right onto Union Court and follow the existing road southeast to the existing on-ramp onto Martin Luther King Jr. Boulevard.

The conceptual floodwall alignment from the proposed USACE PMLS project is located on the north side of Marine Drive, near two industrial properties, with three proposed closure structures[6] for property access. The Modified LPA would realign Marine Drive to the south and provide access to the two industrial properties via the new local road extension from Expo Road. Therefore, the change in access for the two industrial properties could require small modifications to the floodwall alignment (a potential shift of 5 to 10 feet to the south) and closure structure locations.

Marine Drive and the two southbound on-ramps would travel over the Cross Levee approximately 10 to 20 feet above the proposed elevation of the improved levee, and they would be supported by fill and retaining walls near an existing low spot in the Cross Levee.

The I-5 southbound on-ramp from Marine Drive would continue on a new bridge structure. Although the bridge's foundation locations have not been determined yet, they would be constructed through the western slope of the Cross Levee (between the existing I-5 mainline and the existing light-rail).

NORTH PORTLAND HARBOR BRIDGES

To the north of the Marine Drive interchange is the Hayden Island interchange area, which is shown in Figure 1-8. I-5 crosses over the North Portland Harbor when traveling between these two interchanges. The Modified LPA proposes to replace the existing I-5 bridge spanning North Portland Harbor to improve seismic resiliency.

Six new parallel bridges would be built across the waterway under the Modified LPA: one on the east side of the existing I-5 North Portland Harbor bridge and five on the west side or overlapping the location of the existing bridge (which would be removed). From west to east, these bridges would carry:

- The LRT tracks.
- The southbound I-5 off-ramp to Marine Drive.
- The southbound I-5 mainline.
- The northbound I-5 mainline.
- The northbound I-5 on-ramp from Marine Drive.
- An arterial bridge between the Portland mainland and Hayden Island for local traffic; this bridge would also include a shared-use path for pedestrians and bicyclists.

[6] Levee closure structures are put in place at openings along the embankment/floodwall to provide flood protection during high water conditions.

Each of the six replacement North Portland Harbor bridges would be supported on foundations constructed of 10-foot-diameter drilled shafts. Concrete columns would rise from the drilled shafts and connect to the superstructures of the bridges. All new structures would have at least as much vertical navigation clearance over North Portland Harbor as the existing North Portland Harbor bridge.

Compared to the existing bridge, the two new I-5 mainline bridges would have a similar vertical clearance of approximately 7 feet above the proposed height of the improved levees (elevation 38 feet NAVD 88). The two ramp bridges and the arterial bridge would have approximately 15 feet of vertical clearance above the proposed height of the levees. The foundation locations for the five roadway bridges have not been determined at this stage of design, but some foundations could be constructed through landward or riverward levee slopes.

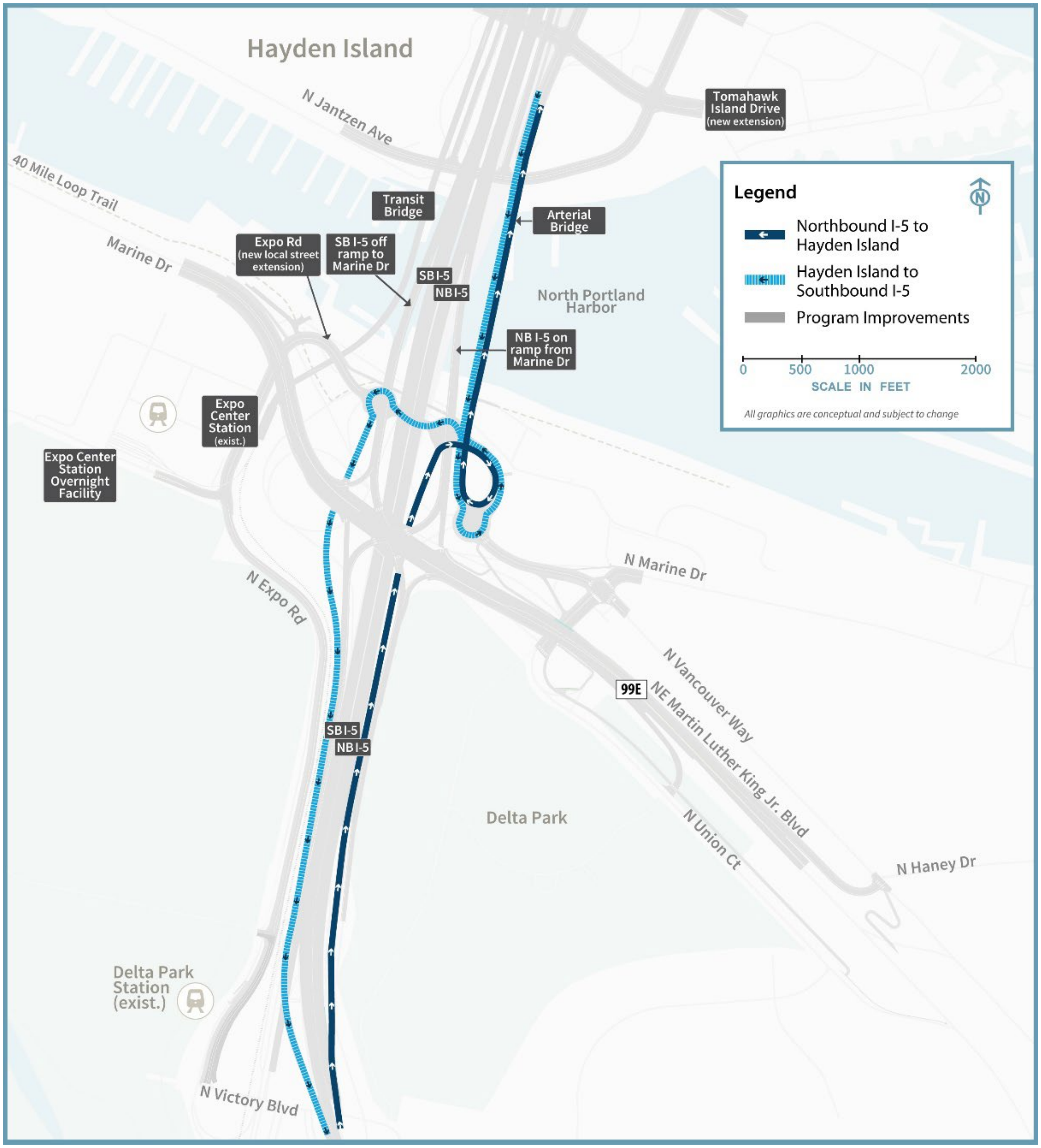
HAYDEN ISLAND INTERCHANGE AREA

All traffic movements for the Hayden Island interchange would be reconfigured. See Figure 1-8 for a layout and construction footprint of the Hayden Island interchange. A half-diamond interchange would be built on Hayden Island with a northbound I-5 on-ramp from Jantzen Drive and a southbound I-5 off-ramp to Jantzen Drive. This would lengthen the ramps and improve merging/diverging speeds compared to the existing substandard ramps that require acceleration and deceleration in a short distance. The I-5 mainline would be partially elevated and partially located on fill across the island.

There would not be a southbound I-5 on-ramp or northbound I-5 off-ramp on Hayden Island. Connections to Hayden Island for those movements would be via the local access (i.e., arterial) bridge connecting North Portland to Hayden Island (Figure 1-10). Vehicles traveling northbound on I-5 wanting to access Hayden Island would exit with traffic going to the Marine Drive interchange, cross under Martin Luther King Jr. Boulevard to the new roundabout at the Expo Road local street extension, travel east through this roundabout to the easternmost roundabout, and use the arterial bridge to cross North Portland Harbor. Vehicles on Hayden Island looking to enter I-5 southbound would use the arterial bridge to cross North Portland Harbor, cross under I-5 using the new Expo Road local street extension to the westernmost roundabout, cross under Marine Drive, merge with the Marine Drive southbound on-ramp, and merge with I-5 southbound south of Victory Boulevard.

Improvements to Jantzen Avenue may include additional left-turn and right-turn lanes at the interchange ramp terminals and active transportation facilities. Improvements to Hayden Island Drive would include new connections to the new arterial bridge over North Portland Harbor. The existing I-5 northbound and southbound access points from Hayden Island Drive would also be removed. A new extension of Tomahawk Island Drive would travel east-west through the middle of Hayden Island and under the I-5 interchange, thus improving connectivity across I-5 on the island.

Figure 1-10. Vehicle Circulation between Hayden Island and the Portland Mainland



NB = northbound; SB = southbound

1.1.2.2 Transit

A new light-rail alignment for northbound and southbound trains would be constructed within Subarea A (see Figure 1-8) to extend from the existing Expo Center MAX Station over North Portland Harbor to a new station at Hayden Island. An overnight LRV facility would be constructed on the southeast corner of the Expo Center property (see Figure 1-8) to provide storage for trains during hours when MAX is not in service. This facility is described in Section 1.1.6, Transit Support Facilities. The existing Expo Center MAX Station would be modified to remove the westernmost track and platform. Other platform modifications, including track realignment and regrading the station, are anticipated to transition to the extension alignment. This may require reconstruction of the operator break facility, signal/communication buildings, and traction power substations. Immediately north of the Expo Center MAX Station, the alignment would curve east toward I-5, pass beneath Marine Drive, cross the proposed Expo Road local street extension and the 40-Mile Loop Trail at grade, then rise over the existing levee onto a light-rail bridge to cross North Portland Harbor. On Hayden Island, proposed transit components include northbound and southbound LRT tracks over Hayden Island; the tracks would be elevated at approximately the height of the new I-5 mainline. An elevated LRT station would also be built on the island immediately west of I-5. The light-rail alignment would extend north on Hayden Island along the western edge of I-5 before transitioning onto the lower level of the new double-deck western bridge over the Columbia River (see Figure 1-8). For the single-level configurations, the light-rail alignment would extend to the outer edge of the western bridge over the Columbia River.

After crossing the new local road extension from Expo Road, the new light-rail track would cross over the main levee (see Figure 1-9). The light-rail profile is anticipated to be approximately 3 feet above the improved levees at the existing floodwall (and improved floodwall), and the tracks would be constructed on fill supported by retaining walls above the floodwall. North of the floodwall, the light-rail tracks would continue onto the new light-rail bridge over North Portland Harbor (as described above).

The Modified LPA's light-rail extension would be close to or would cross the north end of the Cross Levee. The IBR Program would realign the Cross Levee to the east of the light-rail alignment to avoid the need for a closure structure on the light-rail alignment. This realigned Cross Levee would cross the new local road extension. A closure structure may be required because the current proposed roadway is a few feet lower than the proposed elevation of the improved levee.

1.1.2.3 Active Transportation

In the Victory Boulevard interchange area (see Figure 1-8), active transportation facilities would be provided along Expo Road between Victory Boulevard and the Expo Center; this would provide a direct connection between the Victory Boulevard and Marine Drive interchange areas, as well as links to the Delta Park and Expo Center MAX Stations.

New shared-use path connections throughout the Marine Drive interchange area would provide access between the Bridgeton neighborhood (on the east side of I-5), Hayden Island, and the Expo Center MAX Station. There would also be connections to the existing portions of the 40-Mile Loop Trail, which runs north of Marine Drive under I-5 through the interchange area. The path would continue along the extension of Expo Road under the interchange to the intersection of Marine Drive and Vancouver Way, where it would connect under Martin Luther King Jr. Boulevard to Delta Park.

East of the Marine Drive interchange, new shared-use paths on Martin Luther King Jr. Boulevard and on the parallel street, Union Court, would connect travelers to Marine Drive and across the arterial bridge to Hayden Island. The shared-use facilities on Martin Luther King Jr. Boulevard would provide westbound and eastbound cyclists and pedestrians with off-street crossings of the interchange and would also provide connections to both the Expo Center MAX Station and the 40-Mile Loop Trail to the west.

The new arterial bridge over North Portland Harbor would include a shared-use path for pedestrians and bicyclists (see Figure 1-8). On Hayden Island, pedestrian and bicycle facilities would be provided on Jantzen Avenue, Hayden Island Drive, and Tomahawk Island Drive. The shared-use path on the arterial bridge would continue along the arterial bridge to the south side of Tomahawk Island Drive. A parallel, elevated path from the arterial bridge would continue adjacent to I-5 across Hayden Island and cross above Tomahawk Island Drive and Hayden Island Drive to connect to the lower level of the new double-deck eastern bridge or the outer edge of the new single-level eastern bridge over the Columbia River. A ramp down to the north side of Hayden Island Drive would be provided from the elevated path.

1.1.3 Columbia River Bridges (Subarea B)

This section discusses the geographic Subarea B shown in Figure 1-3. See Figure 1-11 for highway and interchange improvements in Subarea B. Refer to Figure 1-3 for an overview of the geographic subareas.

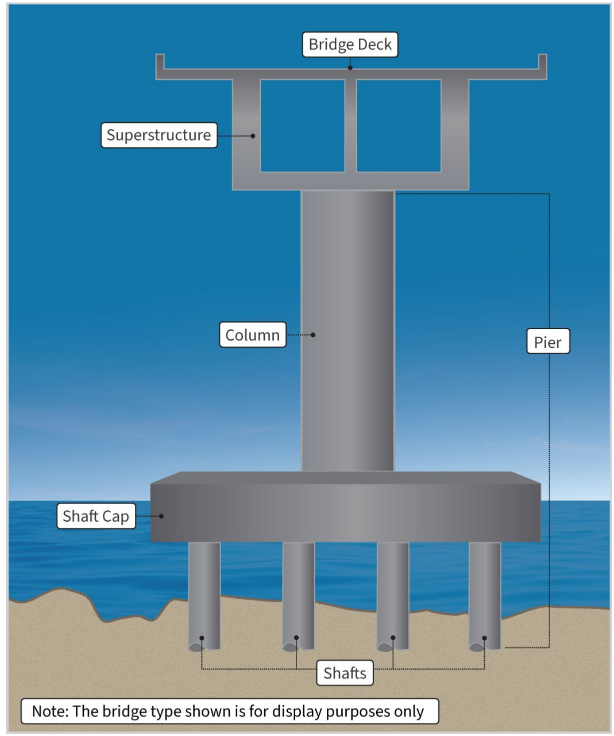
1.1.3.1 Highways, Interchanges, and Local Roadways

The two existing parallel I-5 bridges that cross the Columbia River would be replaced by two new parallel bridges, located west of the existing bridges (see Figure 1-11). The new eastern bridge would accommodate northbound highway traffic and a shared-use path. The new western bridge would carry southbound traffic and two-way light-rail tracks. Whereas the existing bridges each have three lanes with no shoulders, each of the two new bridges would be wide enough to accommodate three through lanes, one or two auxiliary lanes, and shoulders on both sides of the highway. Lanes and shoulders would be built to full design standards.

Figure 1-11. Columbia River Bridges (Subarea B)

As with the existing bridge (Figure 1-13), the new Columbia River bridges would provide three navigation channels: a primary navigation channel and two barge channels (see Figure 1-14). The current location of the primary navigation channel is near the Vancouver shoreline where the existing lift spans are located. Under the Modified LPA, the primary navigation channel would be shifted south approximately 500 feet (measured by channel centerlines), and the existing center barge channel would shift north and become the north barge channel. The new primary navigation channel would be 400 feet wide (this width includes a 300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side of the authorized channel) and the two barge channels would also each be 400 feet wide.

Figure 1-12. Bridge Foundation Concept



The existing Interstate Bridge has nine in-water pier sets,[7] whereas the new Columbia River bridges (any bridge configuration) would be built on six in-water pier sets, plus multiple piers on land (pier locations are shown on Figure 1-14). Each in-water pier set would be supported by a foundation of drilled shafts; each group of shafts would be tied together with a concrete shaft cap. Columns or pier walls would rise from the shaft caps and connect to the superstructures of the bridges (see Figure 1-12).

BRIDGE CONFIGURATIONS

Three bridge configurations are being considered: (1) double-deck fixed-span (with one bridge type), (2) a single-level fixed-span (with three potential bridge types), and (3) a single-level movable-span (with one bridge type). Both the double-deck and single-level fixed-span configurations would provide 116 feet of vertical navigation clearance at their respective highest spans; the same as the CRC LPA. The CRC LPA included a double-deck fixed-span bridge configuration. The single-level fixed-span configuration was developed and is being considered as part of the IBR Program in response to physical and contextual changes (i.e., design and operational considerations) since 2013 that necessitated examination of a refinement in the double-deck bridge configuration (e.g., ingress and egress of transit from the lower level of the double-deck fixed-span configuration on the north end of the southbound bridge).

[7] A pier set consists of the pier supporting the northbound bridge and the pier supporting the southbound bridge at a given location.

Figure 1-13. Existing Navigation Clearances of the Interstate Bridge

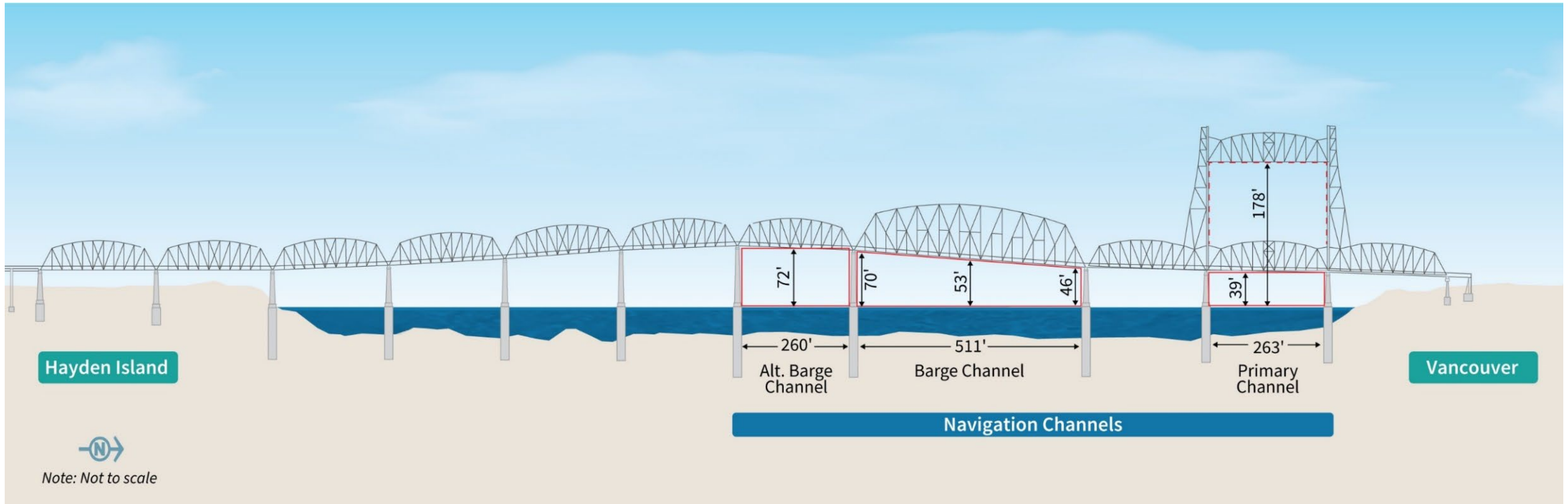
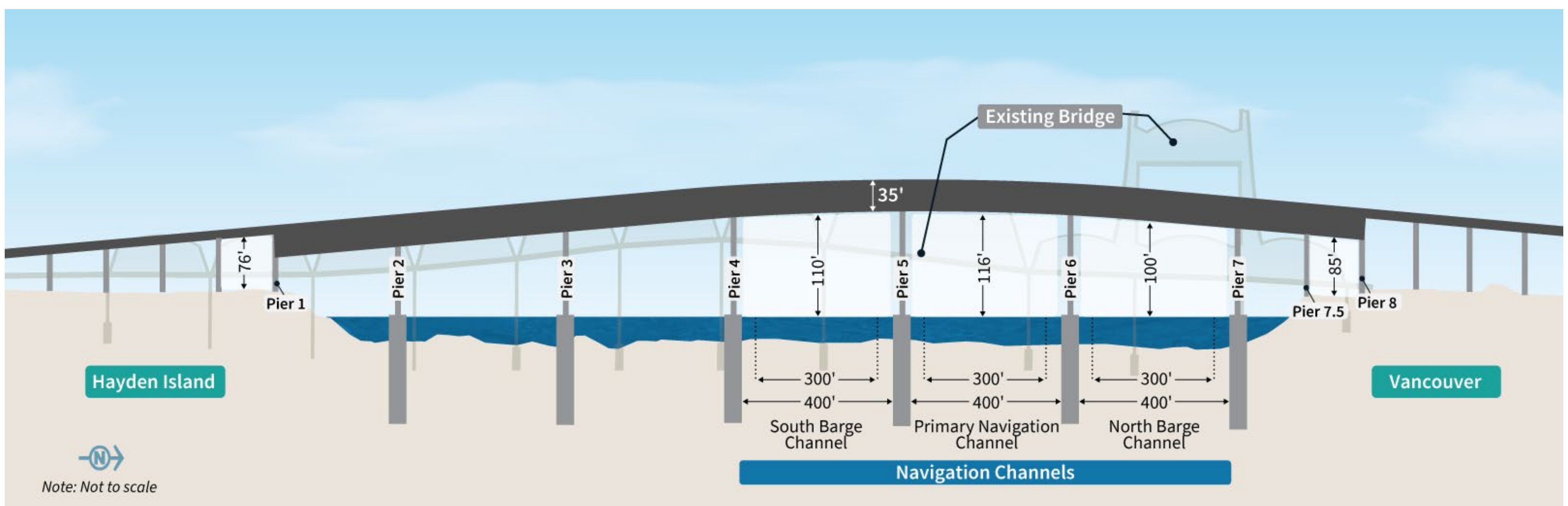


Figure 1-14. Profile and Navigation Clearances of the Proposed Modified LPA Columbia River Bridges with a Double-Deck Fixed-Span Configuration



Note: The location and widths of the proposed navigation channels would be same for all bridge configuration and bridge type options. The three navigation channels would each be 400 feet wide (this width includes a 300-foot congressionally or USACE-authorized channel (shown in dotted lines) plus a 50-foot channel maintenance buffer on each side of the authorized channel). The vertical navigation clearance would vary.

Consideration of the single-level movable-span configuration as part the IBR Program was necessitated by the U.S. Coast Guard's (USCG) review of the Program's navigation impacts on the Columbia River and issuance of a Preliminary Navigation Clearance Determination (PNCD) (USCG 2022). The USCG PNCD set the preliminary vertical navigation clearance recommended for the issuance of a bridge permit at 178 feet; this is the current vertical navigation clearance of the Interstate Bridge.

The IBR Program is carrying forward the three bridge configurations to address changed conditions, including changes in the USCG bridge permitting process, in order to ensure a permittable bridge configuration is within the range of options considered. The IBR Program continues to refine the details supporting navigation impacts and is coordinating closely with the USCG to determine how a fixed-span bridge may be permittable. Although the fixed-span configurations do not comply with the current USCG PNCD, they do meet the Purpose and Need and provide potential improvements to traffic (passenger vehicle and freight), transit, and active transportation operations.

Each of the bridge configurations assumes one auxiliary lane; two auxiliary lanes could be applied to any of the bridge configurations. All typical sections for the one auxiliary lane option would provide 14-foot shoulders to maintain traffic during construction of the Modified LPA and future maintenance.

Double-Deck Fixed-Span Configuration

The double-deck fixed-span configuration would be two side-by-side, double-deck, fixed-span steel truss bridges. Figure 1-15 is an example of this configuration (this image is subject to change and is shown as a representative concept; it does not depict the final design). The double-deck fixed-span configuration would provide 116 feet of vertical navigation clearance for river traffic using the primary navigation channel and 400 feet of horizontal navigation clearance at the primary navigation channel, as well as barge channels. This bridge height would not impede takeoffs and landings by aircraft using Pearson Field or Portland International Airport.

The eastern bridge would accommodate northbound highway traffic on the upper level and the shared-use path and utilities on the lower level. The western bridge would carry southbound traffic on the upper level and two-way light-rail tracks on the lower level. Each bridge deck would be 79 feet wide, with a total out-to-out width of 173 feet.[8]

Figure 1-16 is a cross section of the two parallel double-deck bridges. Like all bridge configurations, the double-deck fixed-span configuration would have six in-water pier sets. Each pier set would require 12 in-water drilled shafts, for a total of 72 in-water drilled shafts. Each individual shaft cap would be approximately 50 feet by 85 feet. This bridge configuration would have a 3.8% maximum grade on the Oregon side of the bridge and a 4% maximum grade on the Washington side.

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[8] "Out-to-out width" is the measurement between the outside edges of the bridge across its width at the widest point.

Figure 1-15. Conceptual Drawing of a Double-Deck Fixed-Span Configuration

Note: Visualization is looking southwest from Vancouver.

Single-Level Fixed-Span Configuration

The single-level fixed-span configuration would have two side-by-side, single-level, fixed-span steel or concrete bridges. This report considers three single-level fixed-span bridge type options: a girder bridge, an extradosed bridge, and a finback bridge. The description in this section applies to all three bridge types (unless otherwise indicated). Conceptual examples of each of these options are shown on Figure 1-17. These images are subject to change and do not represent final design.

This configuration would provide 116 feet of vertical navigation clearance for river traffic using the primary navigation channel and 400 feet of horizontal navigation clearance at the primary navigation channel, as well as barge channels. This bridge height would not impede takeoffs and landings by aircraft using Pearson Field or Portland International Airport.

The eastern bridge would accommodate northbound highway traffic and the shared-use path; the bridge deck would be 104 feet wide. The western bridge would carry southbound traffic and two-way light-rail tracks; the bridge deck would be 113 feet wide. The I-5 highway, light-rail tracks, and the shared-use path would be on the same level across the two bridges, instead of being divided between two levels with the double-deck configuration. The total out-to-out width of the single-level fixed-span configuration (extradosed or finback options) would be 272 feet at its widest point, approximately 99 feet wider than the double-deck configuration. The total out-to-out width of the single-level fixed-span configuration (girder option) would be 232 feet at its widest point. Figure 1-18 shows a typical cross section of the single-level configuration. This cross section is a representative example of an extradosed or finback bridge as shown by the 10-foot-wide superstructure above the bridge deck; the girder bridge would not have the 10-foot-wide bridge columns shown on Figure 1-18.

There would be six in-water pier sets with 16 in-water drilled shafts on each combined shaft cap, for a total of 96 in-water drilled shafts. The combined shaft caps for each pier set would be 50 feet by 230 feet.

This bridge configuration would have a 3% maximum grade on both the Oregon and Washington sides of the bridge.

Figure 1-16. Cross Section of the Double-Deck Fixed-Span Configuration

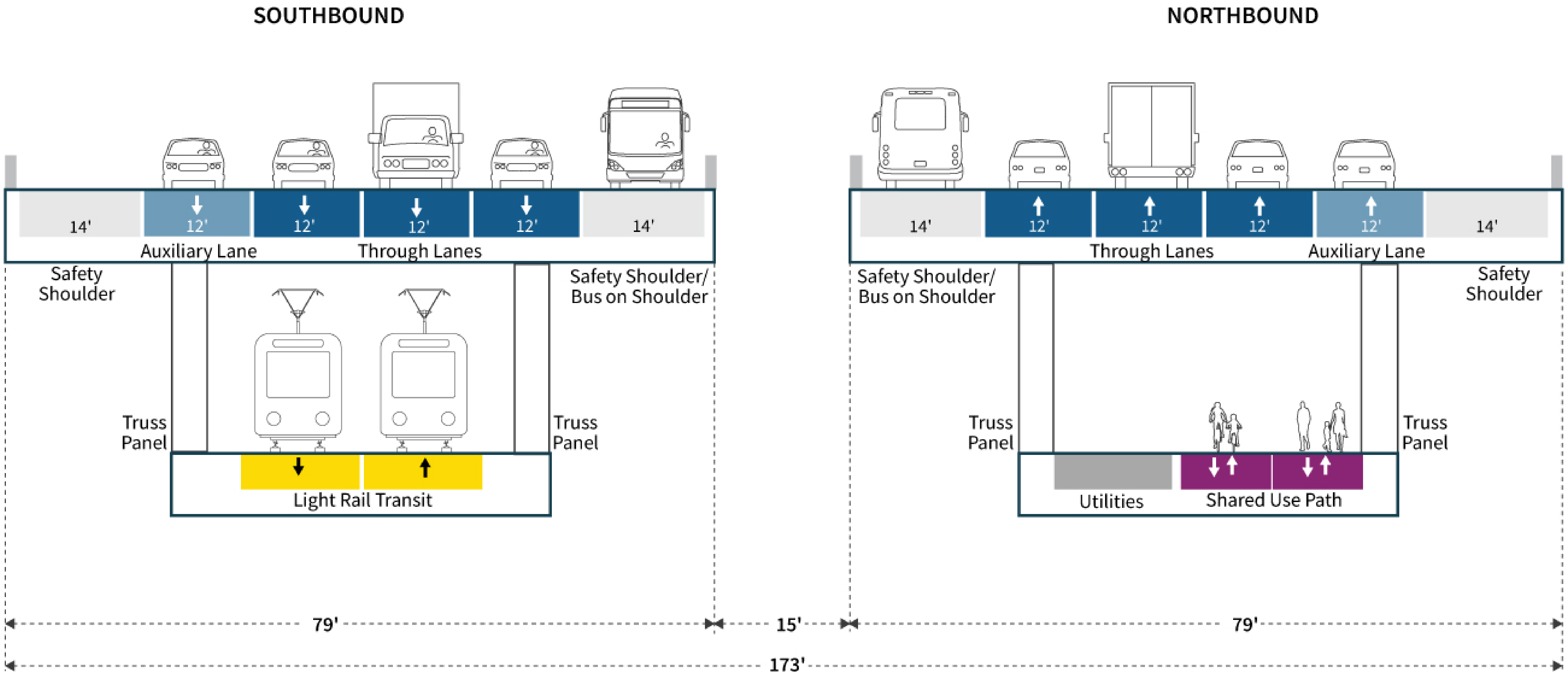
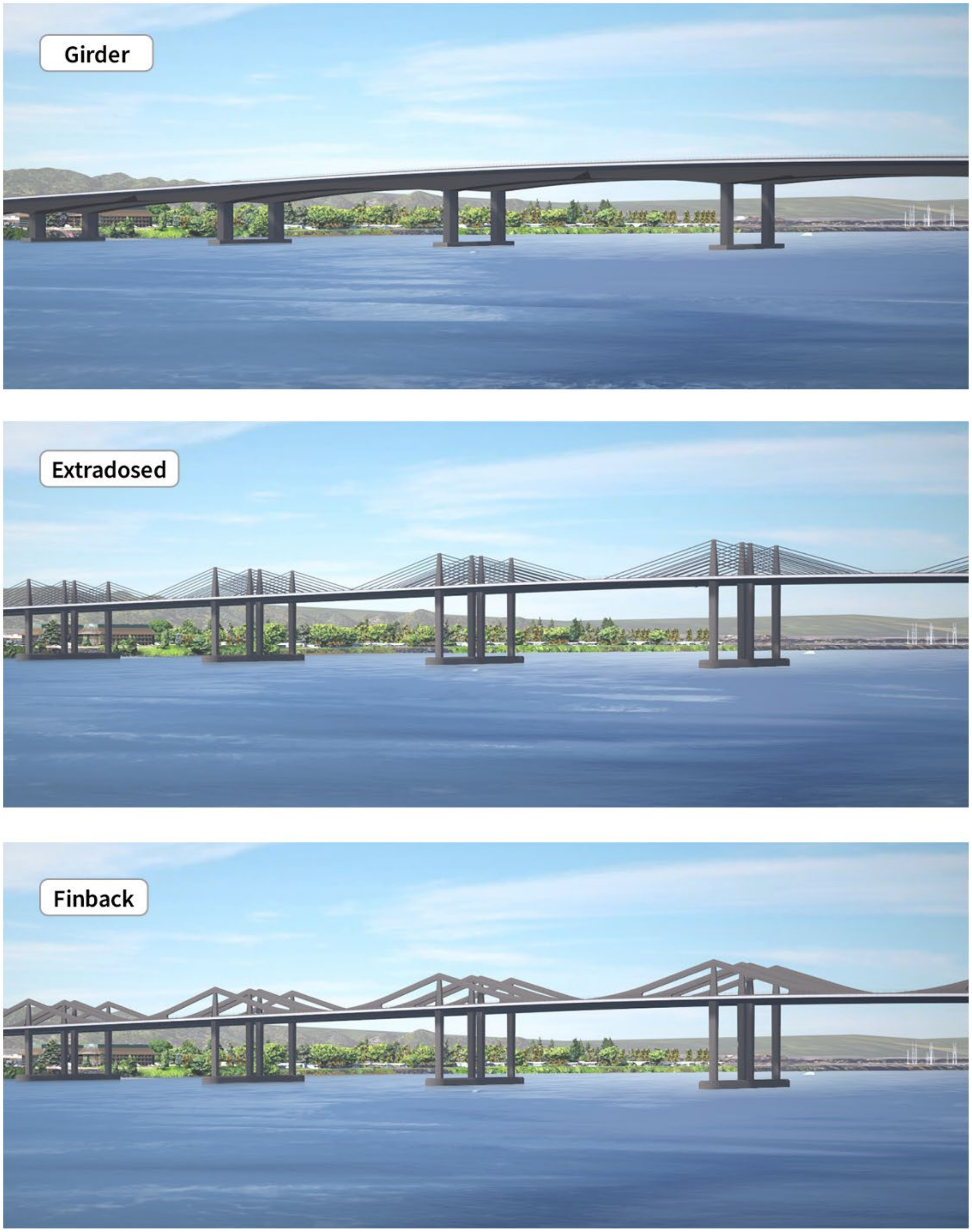
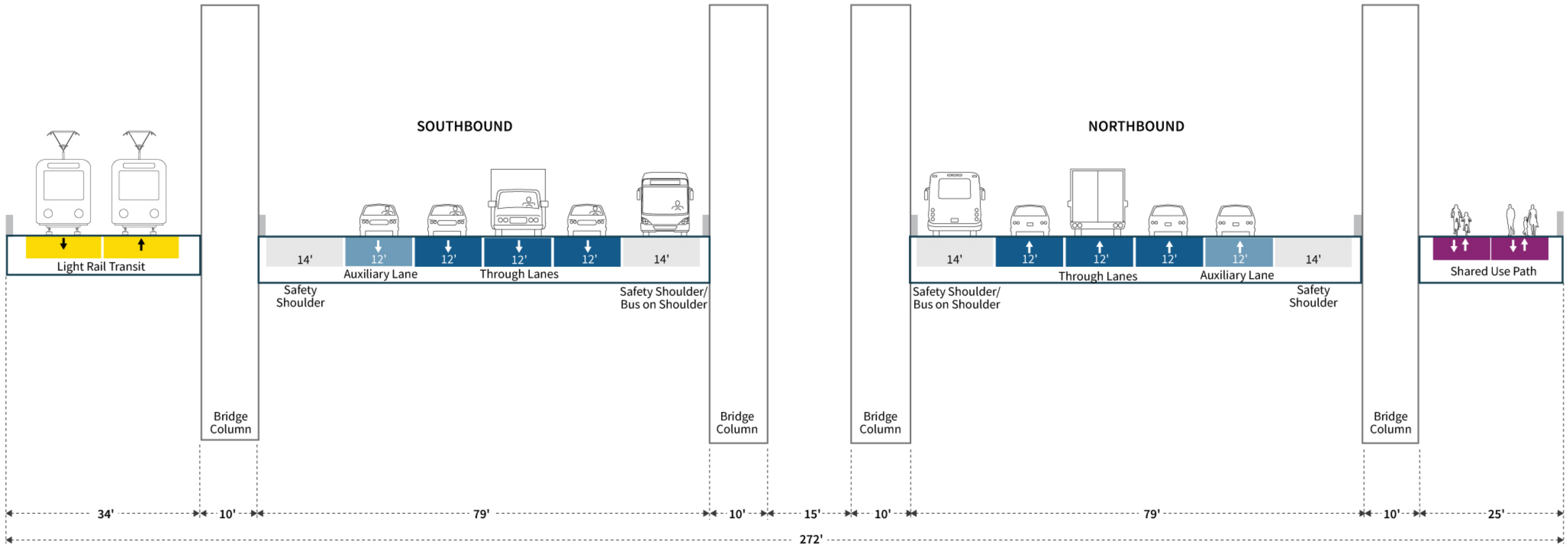


Figure 1-17. Conceptual Drawings of Single-Level Fixed-Span Bridge Types



Note: Visualizations are for illustrative purposes only. They do not reflect property impacts or represent final design. Visualization is looking southwest from Vancouver.

Figure 1-18. Cross Section of the Single-Level Fixed-Span Configuration (Extradosed or Finback Bridge Types)



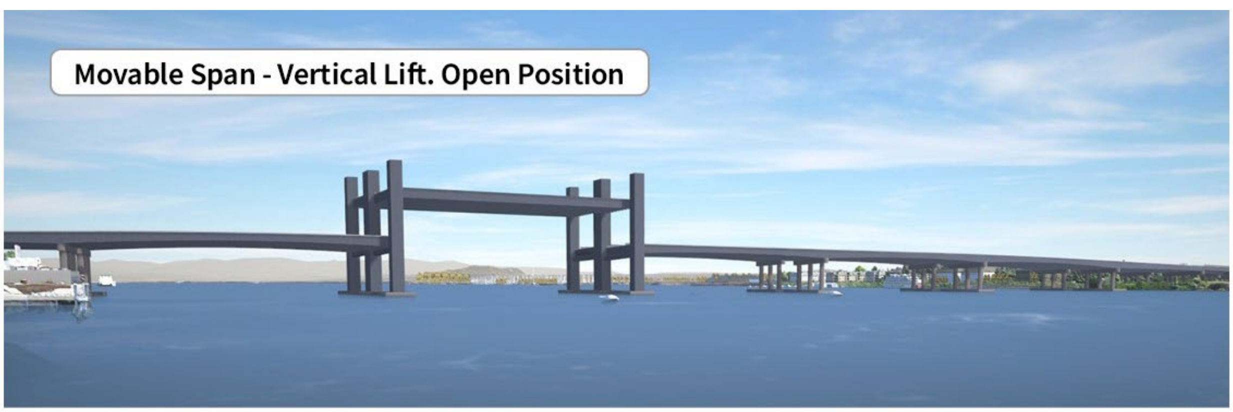
Note: The cross section for a girder type bridge would be the same except that it would not have the four 10-foot bridge columns making the total out-to-out width 232 feet.

Single-Level Movable-Span Configuration

The single-level movable-span configuration would have two side-by-side, single-level steel girder bridges with movable spans between Piers 5 and 6. For the purpose of this report, the IBR Program assessed a vertical lift span movable-span configuration with counterweights based on the analysis in the *River Crossing Bridge Clearance Assessment Report – Movable-Span Options,* included as part of Attachment C in Appendix D, Design Options Development, Screening, and Evaluation Technical Report. A conceptual example of a vertical lift-span bridge is shown in Figure 1-19. These images are subject to change and do not represent final design.

A movable span must be located on a straight and flat bridge section (i.e., without curvature and with minimal slope). To comply with these requirements, and for the bridge to maintain the highway, transit, and active transportation connections on Hayden Island and in Vancouver while minimizing property acquisitions and displacements, the movable span is proposed to be located 500 feet south of the existing lift span, between Piers 5 and 6. To accommodate this location of the movable span, the IBR Program is coordinating with USACE to obtain authorization to change the location of the primary navigation channel, which currently aligns with the Interstate Bridge lift spans near the Washington shoreline.

Figure 1-19. Conceptual Drawings of Single-Level Movable-Span Configurations in the Closed and Open Positions



Note: Visualizations are for illustrative purposes only. They do not reflect property impacts or represent final design. Visualization is looking southeast (upstream) from Vancouver.

The single-level movable-span configuration would provide 92 feet of vertical navigation clearance over the proposed relocated primary navigation channel when the movable spans are in the closed position, with 99 feet of vertical navigation clearance available over the north barge channel. The 92-foot vertical clearance is based on achieving a straight, movable span and maintaining an acceptable grade for transit operations. In addition, it satisfies the requirement of a minimum of 72 feet of vertical navigation clearance (the existing Interstate Bridge's maximum clearance over the alternate (southernmost) barge channel when the existing lift span is in the closed position).

In the open position, the movable span would provide 178 feet of vertical navigation clearance over the proposed relocated primary navigation channel.

Similar to the fixed-span configurations, the movable span would provide 400 feet of horizontal navigation clearance for the primary navigation channel and for each of the two barge channels.

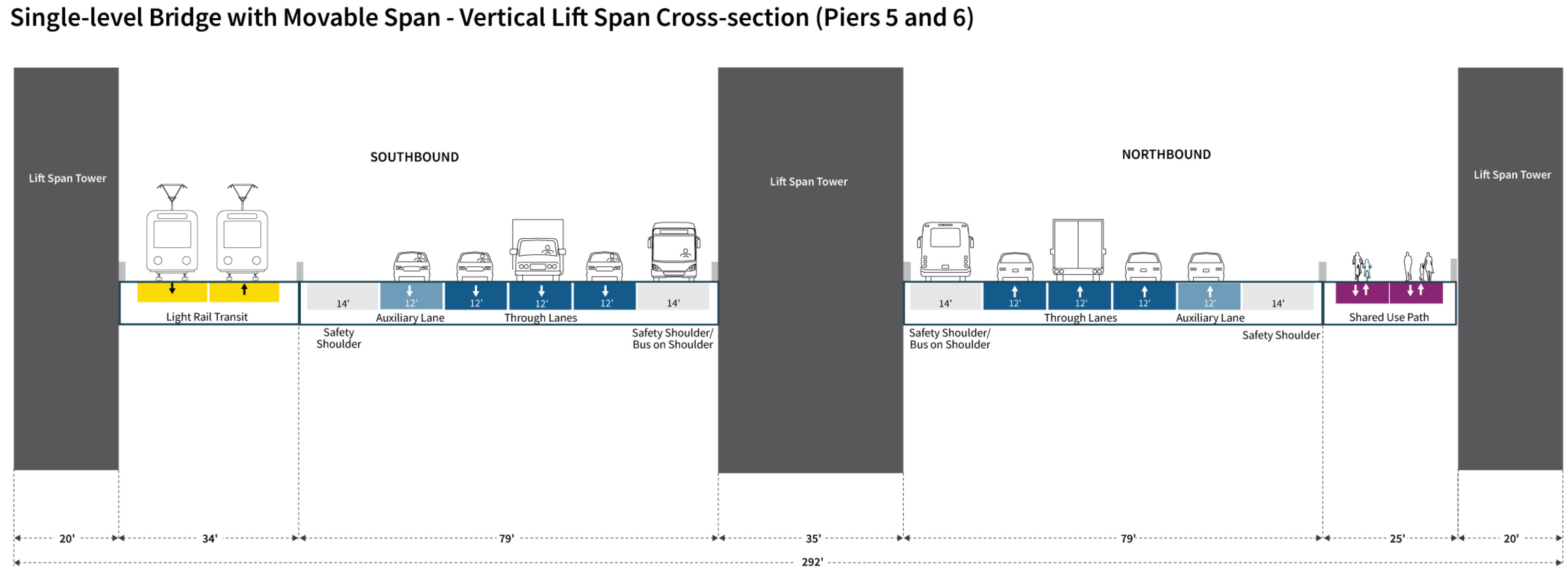
The vertical lift-span towers would be approximately 243 feet high; this is shorter than the existing lift-span towers, which are 247 feet high. This height of the vertical lift-span towers would not impede takeoffs and landings by aircraft using Portland International Airport. At Pearson Field, the Federal Aviation Administration issues obstacle departure procedures to avoid the existing Interstate Bridge lift towers; the single-level movable-span configuration would retain the same procedures.

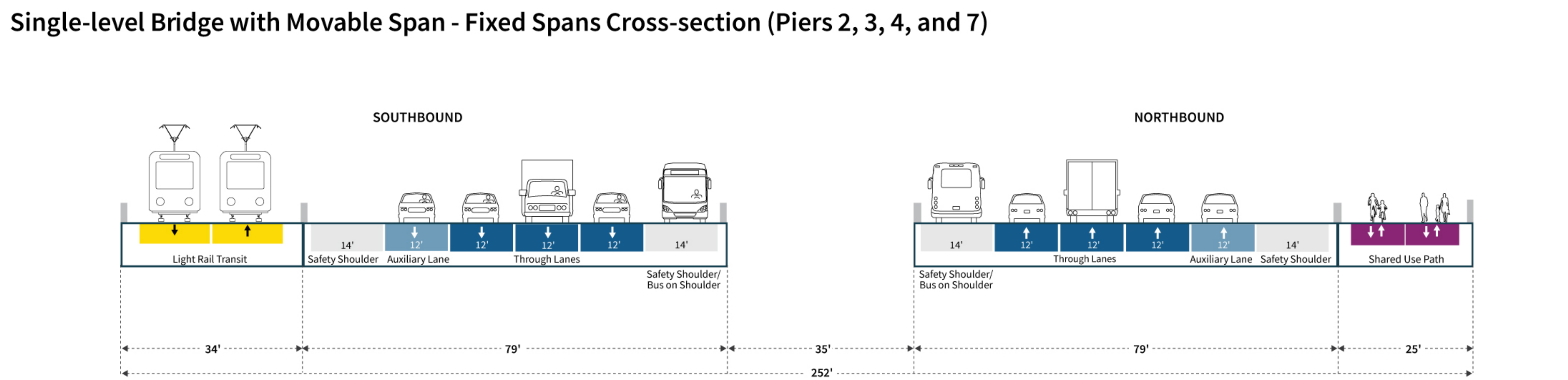
Similar to the single-level fixed-span configuration, the eastern bridge would accommodate northbound highway traffic and the shared-use path, and the western bridge would carry southbound traffic and two-way light-rail tracks. The I-5 highway, light-rail tracks, and shared-use path would be on the same level across the bridges instead of on two levels as with the double-deck configuration. Cross sections of the single-level movable-span configuration are shown in Figure 1-20; the top cross section depicts the vertical lift spans (Piers 5 and 6), and the bottom cross section depicts the fixed spans (Piers 2, 3, 4, and 7). The movable and fixed cross sections are slightly different because the movable span requires lift towers, which are not required for the other fixed spans of the bridges.

There would be six in-water pier sets and two piers on land per bridge. The vertical lift span would have 22 in-water drilled shafts each for Piers 5 and 6; the shaft caps for these piers would be 50 feet by 312 feet to accommodate the vertical lift spans. Piers 2, 3, 4, and 7 would have 16 in-water drilled shafts each; the shaft caps for these piers would be the same as for the fixed-span options (50 feet by 230 feet). The vertical lift-span configuration would have a total of 108 in-water drilled shafts.

This single-level movable-span configuration would have a 3% maximum grade on the Oregon side of the bridge and a 1.5% maximum grade on the Washington side.

Figure 1-20. Cross Section of the Single-Level Movable-Span Bridge Type





Summary of Bridge Configurations

This section summarizes and compares each of the bridge configurations. Table 1-2 lists the key considerations for each configuration. Figure 1-21 compares each configuration's footprint. The footprints of each configuration would differ in only three locations: over the Columbia River and at the bridge landings on Hayden Island and Vancouver. The rest of the I-5 corridor would have the same footprint. Over the Columbia River, the footprint of the double-deck fixed-span configuration would be 173 feet wide. Comparatively, the finback or extradosed bridge types of the single-level fixed-span configuration would be 272 feet wide (approximately 99 feet wider), and the single-level fixed-span configuration with a girder bridge type would be 232 feet wide (approximately 59 feet wider). The single-level movable-span configuration would be 252 feet wide (approximately 79 feet wider than the double-deck fixed-span configuration), except at Piers 5 and 6, where larger bridge foundations would require an additional 40 feet of width to support the movable span. The single-level configurations would have a wider footprint at the bridge landings on Hayden Island and Vancouver because transit and active transportation would be located adjacent to the highway, rather than below the highway in the double-deck option.

Figure 1-22 compares the basic profile of each configuration. The lower deck of the double-deck fixed-span and the single-level fixed-span configuration would have similar profiles. The single-level movable-span configuration would have a lower profile than the fixed-span configurations when the span is in the closed position.

Figure 1-21. Bridge Configuration Footprint Comparison

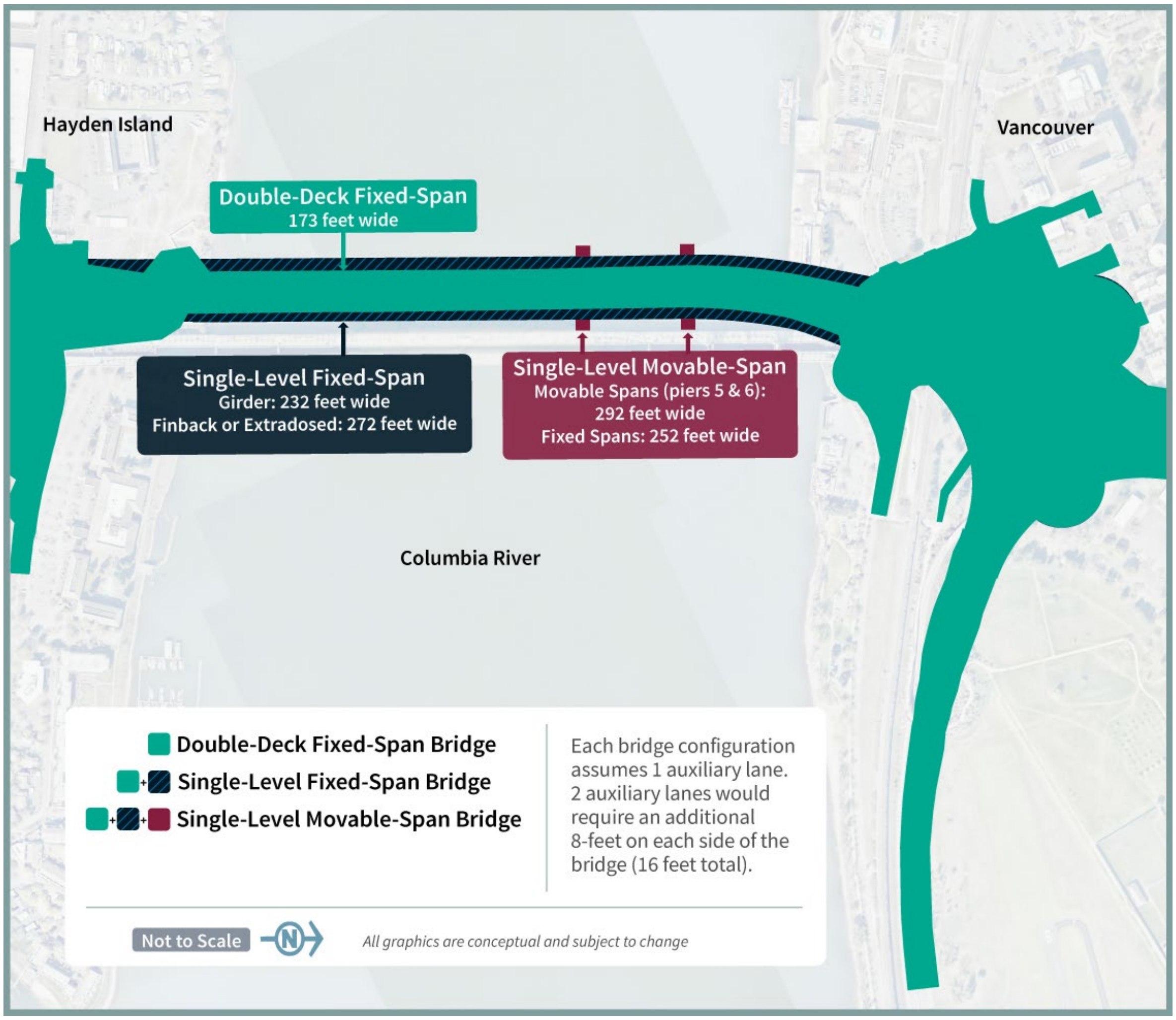
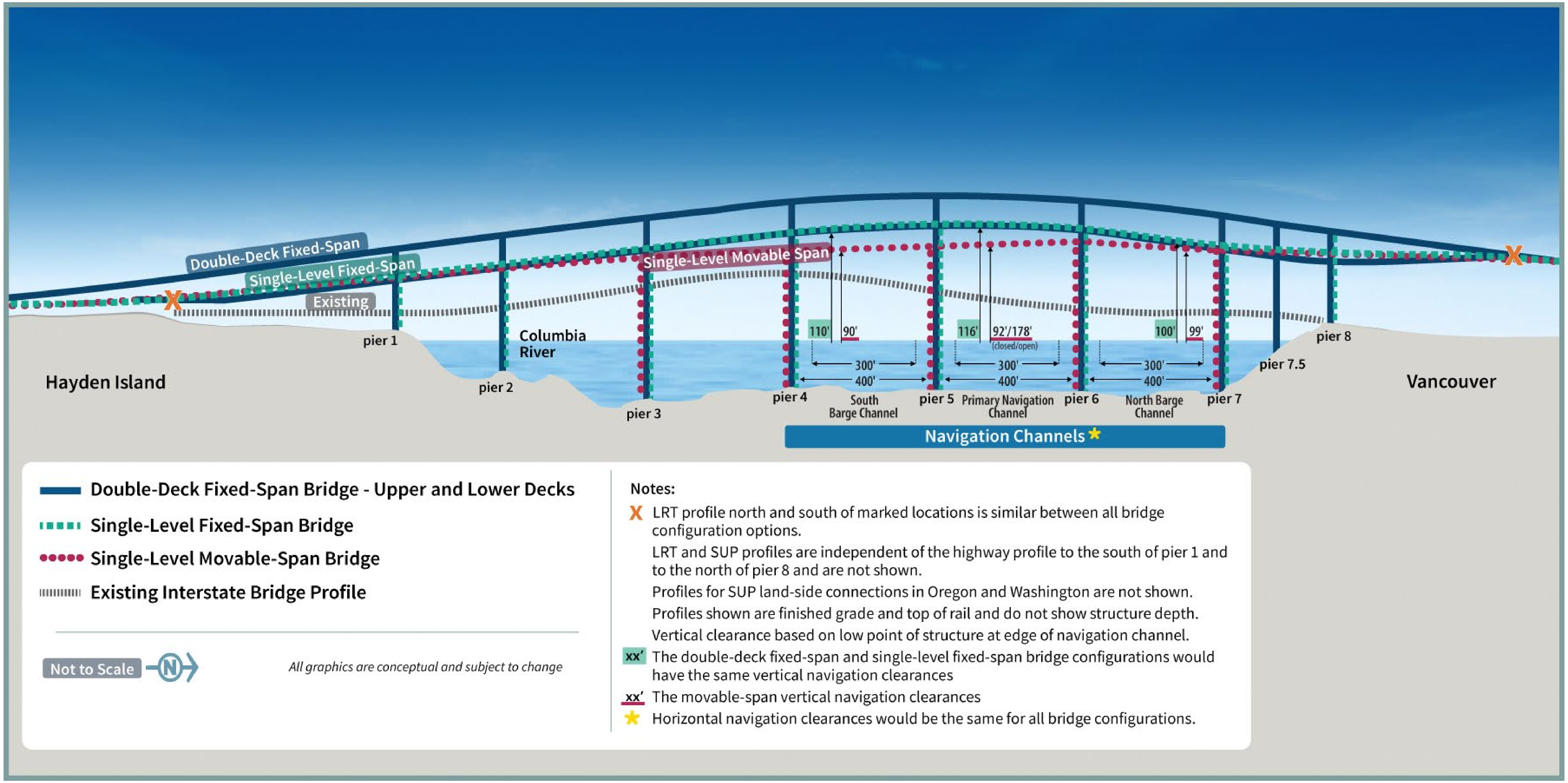


Figure 1-22. Bridge Configuration Profile Comparison



LRT = light-rail transit; SUP = shared-use path

Table 1-2. Summary of Bridge Configurations

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Bridge type	Steel through-truss spans.	Double-deck steel truss.	Single-level, concrete or steel girders, extradosed or finback.	Single-level, steel girders with vertical lift span.
Number of bridges	Two	Two	Two	Two
Movable-span type	Vertical lift span with counterweights.	N/A	N/A	Vertical lift span with counterweights.
Movable-span location	Adjacent to Vancouver shoreline.	N/A	N/A	Between Piers 5 and 6 (approximately 500 feet south of the existing lift span).
Lift opening restrictions	Weekday peak AM and PM highway travel periods. [b]	N/A	N/A	Additional restrictions to daytime bridge openings; requires future federal rulemaking process and authorization by USCG (beyond the assumed No-Build Alternative bridge restrictions for peak AM and PM highway travel periods).[b] Typical opening durations are assumed to be 9 to 18 minutes [c] for the purposes of impact analysis but would ultimately depend on various operational considerations related to vessel traffic and river and weather conditions. Additional time would also be required to stop traffic prior to opening and restart traffic after the bridge closes.

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Out-to-out width [d]	138 feet total width.	173 feet total width.	Girder: 232 feet total width. Extradosed/Finback: 272 feet total width.	• 292 feet at the movable span. • 252 feet at the fixed spans.
Deck widths	52 feet (SB) 52 feet (NB)	79 feet (SB) 79 feet (NB)	Girder: • 113 feet (SB) • 104 feet (NB) Extradosed/Finback: • 133 feet (SB) • 124 feet (NB)	113 feet SB fixed span. 104 feet NB fixed span.
Vertical navigation clearance	Primary navigation channel: • 39 feet when closed. • 178 feet when open. Barge channel: • 46 feet to 70 feet. Alternate barge channel: • 72 feet (maximum clearance without opening).	Primary navigation channel: • 116 feet maximum. North barge channel: • 100 feet maximum. South barge channel: • 110 feet maximum.	Primary navigation channel: • 116 feet maximum. North barge channel: • 100 feet maximum. South barge channel: • 110 feet maximum.	Primary navigation channel: • Closed position: 92 feet. • Open position: 178 feet. North barge channel: • 99 feet maximum. South barge channel: • 90 feet maximum.
Horizontal navigation clearance	263 feet for primary navigation channel. 511 feet for barge channel. 260 feet for alternate barge channel.	400 feet for all navigation channels (300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side).	400 feet for all navigation channels (300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side).	400 feet for all navigation channels (300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side).

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Maximum elevation of bridge component (NAVD 88)[e]	247 feet at top of lift tower.	166 feet.	Girder: 137 feet. Extradosed/Finback: 179 feet at top of pylons.	243 feet at top of lift tower.
Movable span length (from center of pier to center of pier)	278 feet.	N/A	N/A	450 feet.
Number of in-water pier sets	Nine	Six	Six	Six
Number of in-water drilled shafts	N/A	72	96	108
Shaft cap sizes	N/A	50 feet by 85 feet.	50 feet by 230 feet.	Piers 2, 3, 4, and 7: 50 feet by 230 feet. Piers 5 and 6: 50 feet by 312 feet (one combined footing at each location to house tower/equipment for the lift span).
Maximum grade	5%	4% on the Washington side. 3.8% on the Oregon side.	3% on the Washington side. 3% on the Oregon side.	1.5% on the Washington side. 3% on the Oregon side.
Light-rail transit location	N/A	Below highway on SB bridge.	West of highway on SB bridge.	West of highway on SB bridge.
Express bus	Shared roadway lanes.	Inside shoulder of NB and SB (upper) bridges.	Inside shoulder of NB and SB bridges.	Inside shoulder of NB and SB bridges.

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Shared-use path location	Sidewalk adjacent to roadway in both directions.	Below highway on NB bridge.	East of highway on NB bridge.	East of highway on NB bridge.

as When different bridge types are not mentioned, data applies to all bridge types under the specified bridge configuration.

b The No-Build Alternative assumes existing conditions that restrict bridge openings during weekday peak periods (Monday through Friday 6:30 a.m. to 9 a.m.; 2:30 p.m. to 6 p.m., excluding federal holidays). This analysis estimates the potential frequency for bridge openings for vessels requiring more than 99 feet of clearance.

c For the purposes of the transportation analysis (see the Transportation Technical Report), the movable-span opening time is assumed to be an average of 12 minutes.

d "Out-to-out width" is the measurement between the outside edges of the bridge across its width at the widest point.

e NAVD 88 (North American Vertical Datum of 1988) is a vertical control datum (reference point) used by federal agencies for surveying.

NB = northbound; SB = southbound; USCG = U.S. Coast Guard

1.1.4 Downtown Vancouver (Subarea C)

This section discusses the geographic Subarea C shown in Figure 1-3. See Figure 1-23 for all highway and interchange improvements in Subarea C. Refer to Figure 1-3 for an overview of the geographic subareas.

1.1.4.1 Highways, Interchanges, and Local Roadways

North of the Columbia River bridges in downtown Vancouver, improvements are proposed to the SR 14 interchange (Figure 1-23).

SR 14 INTERCHANGE

The new Columbia River bridges would touch down just north of the SR 14 interchange (Figure 1-23). The function of the SR 14 interchange would remain essentially the same as it is now, although the interchange would be elevated. Direct connections between I-5 and SR 14 would be rebuilt. Access to and from downtown Vancouver would be provided as it is today, but the connection points would be relocated. Downtown Vancouver I-5 access to and from the south would be at C Street as it is today, while downtown connections to and from SR 14 would be from Columbia Street at 3rd Street.

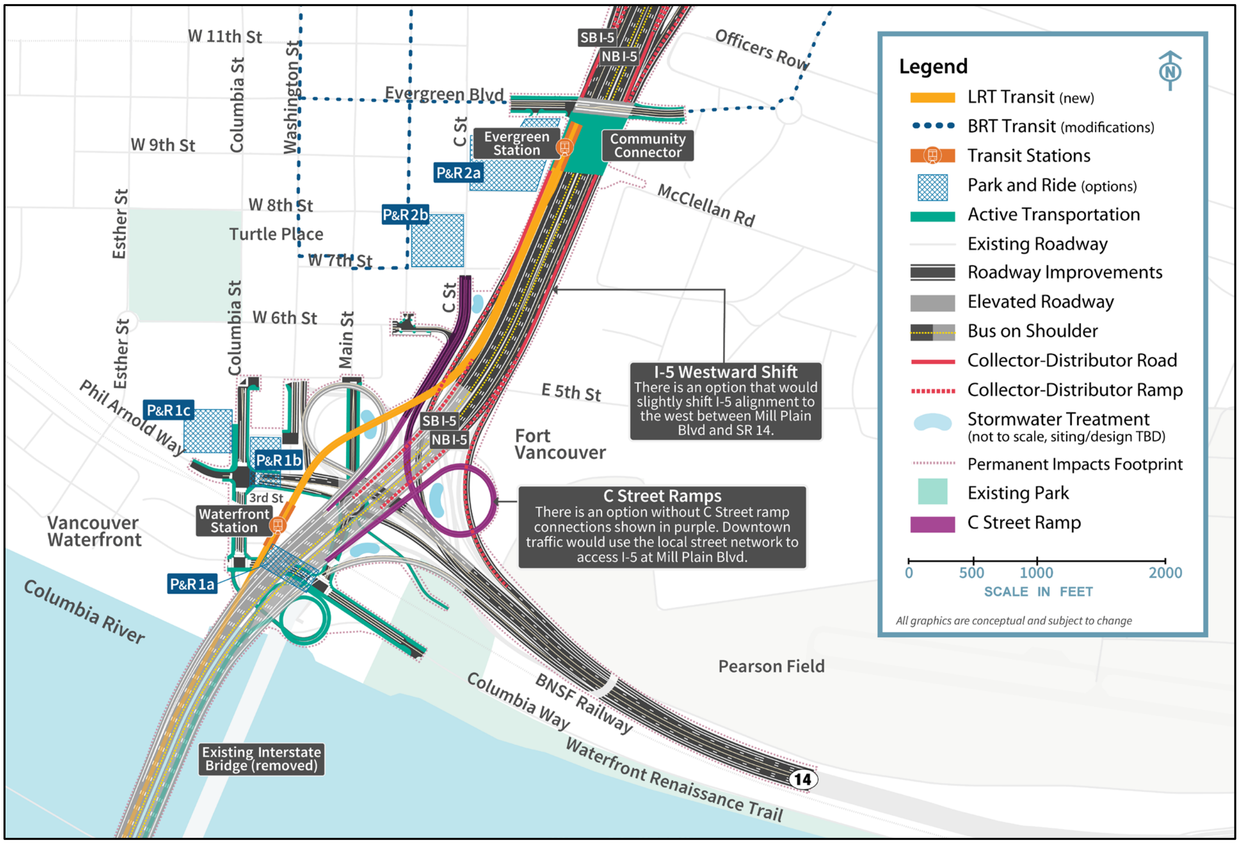
Main Street would be extended between 5th Street and Columbia Way. Vehicles traveling from downtown Vancouver to access SR 14 eastbound would use the new extension of Main Street to the roundabout underneath I-5. If coming from the west or south (waterfront) in downtown Vancouver, vehicles would use the Phil Arnold Way/3rd Street extension to the roundabout, then continue to SR 14 eastbound. The existing Columbia Way roadway under I-5 would be realigned to the north of its existing location and would intersect both the new Main Street extension and Columbia Street with T intersections.

In addition, the existing overcrossing of I-5 at Evergreen Boulevard would be reconstructed.

Design Option Without C Street Ramps

Under this design option, downtown Vancouver I-5 access to and from the south would be through the Mill Plain interchange rather than C Street. There would be no eastside loop ramp from I-5 northbound to C Street and no directional ramp on the west side of I-5 from C Street to I-5 southbound. The existing eastside loop ramp would be removed. This design option has been included because of changes in local planning that necessitate consideration of design options that reduce the footprint and associated direct and temporary environmental impacts in Vancouver.

Figure 1-23. Downtown Vancouver (Subarea C)



BRT = bus rapid transit; LRT = light-rail transit; NB = northbound; P&R = park and ride; SB = southbound

Design Option to Shift I-5 Westward

This design option would shift the I-5 mainline and ramps approximately 40 feet to the west between SR 14 and Mill Plain Boulevard. The westward I-5 alignment shift could also be paired with the design option without C Street ramps. The inclusion of this design option is due to changes in local planning, which necessitate consideration of design options that that shifts the footprint and associated direct and temporary environmental impacts in Vancouver.

1.1.4.2 Transit

LIGHT-RAIL ALIGNMENT AND STATIONS

Under the Modified LPA, the light-rail tracks would exit the highway bridge and be on their own bridge along the west side of the I-5 mainline after crossing the Columbia River (see Figure 1-23). The light-rail bridge would cross approximately 35 feet over the BNSF Railway tracks. An elevated light-rail station near the Vancouver waterfront (Waterfront Station) would be situated near the overcrossing of the BNSF tracks between Columbia Way and 3rd Street. Access to the elevated station would be primarily by elevator as the station is situated approximately 75 feet above existing ground level. A stairwell(s) would be provided for emergency egress. The number of elevators and stairwells provided would be based on the ultimate platform configuration, station location relative to the BNSF trackway, projected ridership, and fire and life safety requirements. Passenger drop-off facilities would be located at ground level and would be coordinated with the C-TRAN bus service at this location. The elevated light-rail tracks would continue north, cross over the westbound SR 14 on-ramp and the C Street/6th Street on-ramp to southbound I-5, and then straddle the southbound I-5 C-D roadway. Transit components in the downtown Vancouver area are similar between the two SR 14 interchange area design options discussed above.

North of the Waterfront Station, the light-rail tracks would continue to the Evergreen Station, which would be the terminus of the light-rail extension (see Figure 1-23). The light-rail tracks from downtown Vancouver to the terminus would be entirely on an elevated structure supported by single columns, where feasible, or by columns on either side of the roadway where needed. The light-rail tracks would be a minimum of 27 feet above the I-5 roadway surface. The Evergreen Station would be located at the same elevation as Evergreen Boulevard, on the proposed Community Connector, and it would provide connections to C-TRAN's existing BRT system. Passenger drop-off facilities would be near the station and would be coordinated with the C-TRAN bus service at this location.

PARK AND RIDES

Up to two park and rides could be built in Vancouver along the light-rail alignment: one near the Waterfront Station and one near the Evergreen Station. Additional information regarding the park and rides can be found in the Transportation Technical Report.

> Park and rides can expand the catchment area of public transit systems, making transit more accessible to people who live farther away from fixed-route transit service, and attracting new riders who might not have considered using public transit otherwise.

Waterfront Station Park-and-Ride Options

There are three site options for the park and ride near the Waterfront Station (see Figure 1-23). Each would accommodate up to 570 parking spaces.

1. Columbia Way (below I-5). This park-and-ride site would be a multilevel aboveground structure located below the new Columbia River bridges, immediately north of a realigned Columbia Way.
2. Columbia Street/SR 14. This park-and-ride site would be a multilevel aboveground structure located along the east side of Columbia Street. It could span across (or over) the SR 14 westbound off-ramp to provide parking on the north and south sides of the off-ramp.
3. Columbia Street/Phil Arnold Way (Waterfront Gateway Site). This park-and-ride site would be located along the west side of Columbia Street immediately north of Phil Arnold Way. This park and ride would be developed in coordination with the City of Vancouver's Waterfront Gateway program and could be a joint-use parking facility not constructed exclusively for park-and-ride users.

Evergreen Station Park-and-Ride Options

There are two site options for the park and ride near the Evergreen Station (see Figure 1-23).

1. Library Square. This park-and-ride site would be located along the east side of C Street and south of Evergreen Boulevard. It would accommodate up to 700 parking spaces in a multilevel belowground structure according to a future agreement on City-owned property associated with Library Square. Current design concepts suggest the park and ride most likely would be a joint-use parking facility for park-and-ride users and patrons of other uses on the ground or upper levels as negotiated as part of future decisions.
2. Columbia Credit Union. This park-and-ride site is an existing multistory garage that is located below the Columbia Credit Union office tower along the west side of C Street between 7th Street and 8th Street. The existing parking structure currently serves the office tower above it and the Regal City Center across the street. This would be a joint-use parking facility, not for the exclusive use of park-and-ride users, that could serve as additional or overflow parking if the 700 required parking spaces cannot be accommodated elsewhere.

1.1.4.3 Active Transportation

Within the downtown Vancouver area, the shared-use path on the northbound (or eastern) bridge would exit the bridge at the SR 14 interchange, loop down on the east side of I-5 via a vertical spiral path, and then cross back below I-5 to the west side of I-5 to connect to the Waterfront Renaissance Trail on Columbia Street and into Columbia Way (see Figure 1-23). Access would be provided across state right of way beneath the new bridges to provide a connection between the recreational areas along the City's Columbia River waterfront east of the bridges and existing and future waterfront uses west of the bridges.

Active transportation components in the downtown Vancouver area would be similar without the C Street ramps and with the I-5 westward shift.

At Evergreen Boulevard, a community connector is proposed to be built over I-5 just south of Evergreen Boulevard and east of the Evergreen Station (see Figure 1-23). The structure is proposed to include off-street pathways for active transportation modes including pedestrians, bicyclists, and other micro-mobility modes, and public space and amenities to support the active transportation facilities. The primary intent of the Community Connector is to improve connections between downtown Vancouver on the west side of I-5 and the Vancouver National Historic Reserve on the east side.

1.1.5 Upper Vancouver (Subarea D)

This section discusses the geographic Subarea D shown in Figure 1-3. See Figure 1-24 for all highway and interchange improvements in Subarea D. Refer to Figure 1-3 for an overview of the geographic subareas.

1.1.5.1 Highways, Interchanges, and Local Roadways

Within the upper Vancouver area, the IBR Program proposes improvements to three interchanges—Mill Plain, Fourth Plain, and SR 500—as described below.

MILL PLAIN BOULEVARD INTERCHANGE

The Mill Plain Boulevard interchange is north of the SR 14 interchange (see Figure 1-24). This interchange would be reconstructed as a tight-diamond configuration but would otherwise remain similar in function to the existing interchange. The ramp terminal intersections would be sized to accommodate high, wide heavy freight vehicles that travel between the Port of Vancouver and I-5. The off-ramp from I-5 northbound to Mill Plain Boulevard would diverge from the C-D road that would continue north, crossing over Mill Plain Boulevard, to provide access to Fourth Plain Boulevard via a C-D roadway. The off-ramp to Fourth Plain Boulevard would be reconstructed and would cross over Mill Plain Boulevard east of I-5, similar to the way it functions today.

FOURTH PLAIN BOULEVARD INTERCHANGE

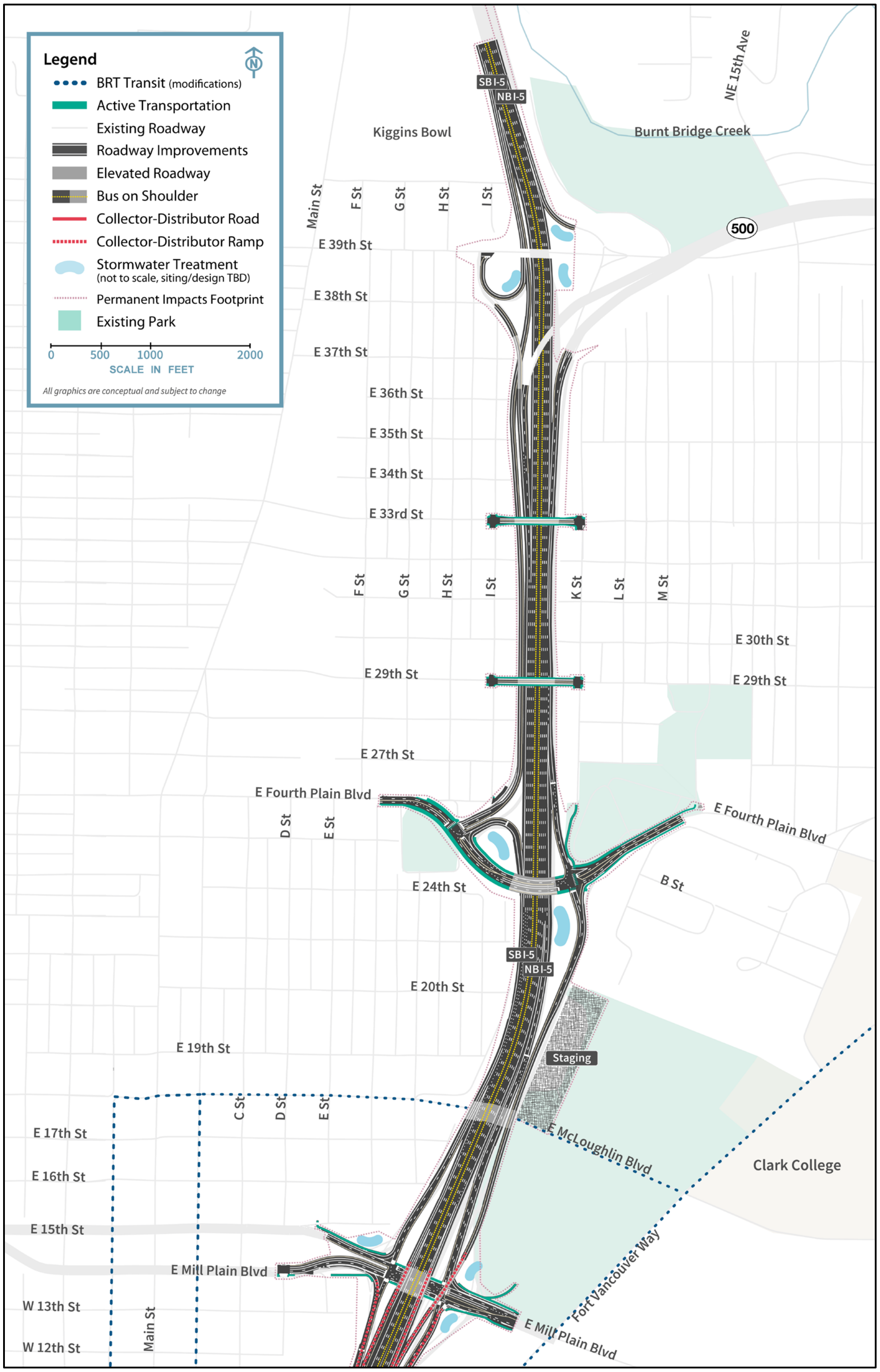
At the Fourth Plain Boulevard interchange (Figure 1-24), improvements would include reconstruction of the overpass of I-5 and the ramp terminal intersections. Northbound I-5 traffic exiting to Fourth Plain Boulevard would first exit to the northbound C-D roadway which provides off-ramp access to Fourth Plain Boulevard and Mill Plain Boulevard. The westbound SR 14 to northbound I-5 on-ramp also joins the northbound C-D roadway before continuing north past the Fourth Plain Boulevard and Mill Plain Boulevard off-ramps as an auxiliary lane. The southbound I-5 off-ramp to Fourth Plain Boulevard would be braided below the 39th Street on-ramp to southbound I-5. This change would eliminate the existing nonstandard weave between the SR 500 interchange and the off-ramp to Fourth Plain Boulevard. It would also eliminate the existing westbound SR 500 to Fourth Plain Boulevard off-ramp connection. The existing overcrossing of I-5 at 29th Street would be reconstructed to accommodate a widened I-5, provide adequate vertical clearance over I-5, and provide pedestrian and bicycle facilities.

SR 500 INTERCHANGE

The northern terminus of the I-5 improvements would be in the SR 500 interchange area (Figure 1-24). The improvements would primarily be to connect the Modified LPA to existing ramps. The off-ramp from I-5 southbound to 39th Street would be reconstructed to establish the beginning of the braided ramp to Fourth Plain Boulevard and restore the loop ramp to 39th Street. Ramps from existing I-5 northbound to SR 500 eastbound and from 39th Street to I-5 northbound would be partially reconstructed. The existing bridges for 39th Street over I-5 and SR 500 westbound to I-5 southbound would be retained. The 39th Street to I-5 southbound on-ramp would be reconstructed and braided over (i.e., grade separated or pass over) the new I-5 southbound off-ramp to Fourth Plain Boulevard.

The existing overcrossing of I-5 at 33rd Street would also be reconstructed to accommodate a widened I-5, provide adequate vertical clearance over I-5, and provide pedestrian and bicycle facilities.

Figure 1-24. Upper Vancouver (Subarea D)



BRT = bus rapid transit; TBD = to be determined

1.1.5.2 Transit

There would be no LRT facilities in upper Vancouver. Proposed operational changes to bus service, including I-5 bus-on-shoulder service, are described in Section 1.1.7, Transit Operating Characteristics.

1.1.5.3 Active Transportation

Several active transportation improvements would be made in Subarea D consistent with City of Vancouver plans and policies. At the Fourth Plain Boulevard interchange, there would be improvements to provide better bicycle and pedestrian mobility and accessibility; these include bicycle lanes, neighborhood connections, and a connection to the City of Vancouver's planned two-way cycle track on Fourth Plain Boulevard. The reconstructed overcrossings of I-5 at 29th Street and 33rd Street would provide pedestrian and bicycle facilities on those cross streets. No new active transportation facilities are proposed in the SR 500 interchange area. Active transportation improvements at the Mill Plain Boulevard interchange include buffered bicycle lanes and sidewalks, pavement markings, lighting, and signing.

1.1.6 Transit Support Facilities

1.1.6.1 Ruby Junction Maintenance Facility Expansion

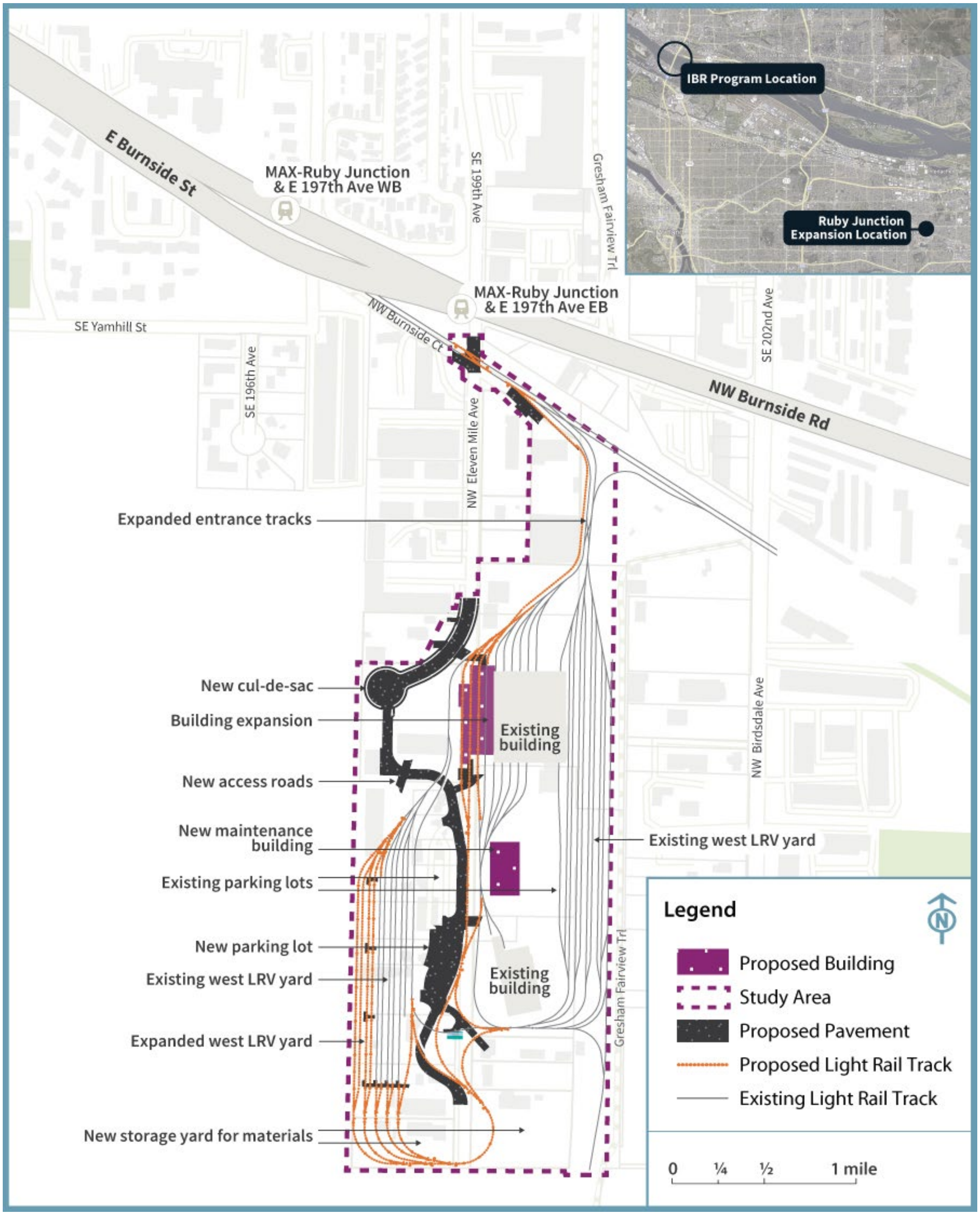
The TriMet Ruby Junction Maintenance Facility in Gresham, Oregon, would be expanded to accommodate the additional LRVs associated with the Modified LPA's LRT service (the Ruby Junction location relative to the study area is shown in Figure 1-25). Improvements would include additional storage for LRVs and maintenance materials and supplies, expanded LRV maintenance bays, expanded parking and employee support areas for additional personnel, and a third track at the northern entrance to Ruby Junction. Figure 1-25 shows the proposed footprint of the expansion.

The existing main building would be expanded west to provide additional maintenance bays. To make space for the building expansion, Eleven Mile Avenue would be vacated and would terminate in a new cul-de-sac west of the main building. New access roads would be constructed to maintain access to TriMet buildings south of the cul-de-sac.

The existing LRV storage yard, west of Eleven Mile Avenue, would be expanded to the west to accommodate additional storage tracks and a runaround track (a track constructed to bypass congestion in the maintenance yard). This expansion would require partial demolition of an existing TriMet building (just north of the LRV storage) and would require relocating the material storage yard to the properties just south of the south building.

All tracks in the west LRV storage yard would also be extended southward to connect to the proposed runaround track. The runaround track would connect to existing tracks near the existing south building. The connections to the runaround track would require partial demolition of an existing TriMet building plus full demolition of one existing building and partial demolition of another existing building on the private property west of the south end of Eleven Mile Avenue. The function of the existing TriMet building would either be transferred to existing modified buildings or to new replacement buildings on site.

Figure 1-25. Ruby Junction Maintenance Facility Study Area



EB = eastbound; LRV = light-rail vehicle; WB = westbound

The existing parking lot west of Eleven Mile Avenue would be expanded toward the south to provide more parking for TriMet personnel.

A third track would be needed at the north entrance to Ruby Junction to accommodate increased train volumes without decreasing service. The additional track would also reduce operational impacts during construction and maintenance outages for the yard. Constructing the third track would require reconstruction of Burnside Court east of Eleven Mile Avenue. An additional crossover would also be needed on the mainline track where it crosses Eleven Mile Avenue; it would require reconstruction of the existing track crossings for vehicles, bicycles, and pedestrians.

1.1.6.2 Expo Center Overnight LRV Facility

An overnight facility for LRVs would be constructed on the southeast corner of the Expo Center property (as shown on Figure 1-8) to reduce deadheading between Ruby Junction and the northern terminus of the MAX Yellow Line extension. Deadheading occurs when LRVs travel without passengers to make the vehicles ready for service. The facility would provide a yard access track, storage tracks for approximately 10 LRVs, one building for light LRV maintenance, an operator break building, a parking lot for operators, and space for security personnel. This facility would necessitate relocation and reconstruction of the Expo Road entrance to the Expo Center (including the parking lot gates and booths). However, it would not affect existing Expo Center buildings.

The overnight facility would connect to the mainline tracks by crossing Expo Road just south of the existing Expo Center MAX Station. The connection tracks would require relocation of one or two existing LRT facilities, including a traction power substation building and potentially the existing communication building, which are both just south of the Expo Center MAX Station. Existing artwork at the station may require relocation.

1.1.6.3 Additional Bus Bays at the C-TRAN Operations and Maintenance Facility

Three bus bays would be added to the C-TRAN operations and maintenance facility. These new bus bays would provide maintenance capacity for the additional express bus service on I-5 (see Section 1.1.7, Transit Operating Characteristics). Modifications to the facility would accommodate new vehicles as well as maintenance equipment.

1.1.7 Transit Operating Characteristics

1.1.7.1 LRT Operations

Nineteen new LRVs would be purchased to operate the extension of the MAX Yellow Line. These vehicles would be similar to those currently used for the TriMet MAX system. With the Modified LPA, LRT service in the new and existing portions of the Yellow Line in 2045 would operate with 6.7-minute average headways (defined as gaps between arriving transit vehicles) during the 2-hour morning peak period. Mid-day and evening headways would be 15 minutes, and late-night headways would be 30 minutes. Service would operate between the hours of approximately 5 a.m. (first southbound train leaving Evergreen Station) and 1 a.m. (last northbound train arriving at the station), which is consistent with current service on the Yellow Line. LRVs would be deadheaded at Evergreen Station before beginning service each day. A third track at this northern terminus would accommodate layovers.

1.1.7.2 Express Bus Service and Bus on Shoulder

C-TRAN provides bus service that connects to LRT and augments travel between Washington and Oregon with express bus service to key employment centers in Oregon. Beginning in 2022, the main express route providing service in the IBR corridor, Route 105, had two service variations. One pattern provides service between Salmon Creek and downtown Portland with a single intermediate stop at the 99th Street Transit Center, and one provides service between Salmon Creek and downtown Portland with two intermediate stops: 99th Street Transit Center and downtown Vancouver. This route currently provides weekday service with 20-minute peak and 60-minute off-peak headways.

Once the Modified LPA is constructed, C-TRAN Route 105 would be revised to provide direct service from the Salmon Creek Park and Ride and 99th Street Transit Center to downtown Portland, operating at 5-minute peak headways with no service in the off-peak. The C-TRAN Route 105 intermediate stop service through downtown Vancouver would be replaced with C-TRAN Route 101, which would provide direct service from downtown Vancouver to downtown Portland at 10-minute peak and 30-minute off-peak headways.

Two other existing C-TRAN express bus service routes would remain unchanged after completion of the Modified LPA. C-TRAN Route 190 would continue to provide service from the Andresen Park and Ride in Vancouver to Marquam Hill in Portland. This route would continue to operate on SR 500 and I-5 within the study area. Route headways would be 10 minutes in the peak periods with no off-peak service. C-TRAN Route 164 would continue to provide service from the Fisher's Landing Transit Center to downtown Portland. This route would continue to operate within the study area only in the northbound direction during PM service to use the I-5 northbound high-occupancy vehicle lane in Oregon before exiting to eastbound SR 14 in Washington. Route headways would be 10 minutes in the peak and 30 minutes in the off-peak.

C-TRAN express bus Routes 105 and 190 are currently permitted to use the existing southbound inside shoulder of I-5 from 99th Street to the Interstate Bridge in Vancouver. However, the existing shoulders are too narrow for bus-on-shoulder use in the rest of the I-5 corridor in the study area. The Modified LPA would include inside shoulders on I-5 that would be wide enough (14 feet on the Columbia River bridges and 11.5 to 12 feet elsewhere on I-5) to allow northbound and southbound buses to operate on the shoulder, except where I-5 would have to taper to match existing inside shoulder widths at the north and south ends of the corridor. Figure 1-8, Figure 1-16, Figure 1-23, and Figure 1-24 show the potential bus-on-shoulder use over the Columbia River bridges. Bus on shoulder could operate on any of the Modified LPA bridge configurations and bridge types. Additional approvals (including a continuing control agreement), in coordination with ODOT, may be needed for buses to operate on the shoulder on the Oregon portion of I-5.

After completion of the Modified LPA, two C-TRAN express bus routes operating on I-5 through the study area would be able to use bus-on-shoulder operations to bypass congestion in the general-purpose lanes. C-TRAN Route 105 would operate on the shoulder for the full length of the study area. C-TRAN Route 190 would operate on the shoulder for the full length of the corridor except for the distance required to merge into and out of the shoulder as the route exits from and to SR 500. These two express bus routes (105 and 190) would have a combined frequency of every 3 minutes during the 2045 AM and PM peak periods. To support the increased frequency of express bus service, eight electric double-decker or articulated buses would be purchased.

If the C Street ramps were removed from the SR 14 interchange, C-TRAN Route 101 could also use bus-on-shoulder operations south of Mill Plain Boulevard; however, if the C Street ramps remained in place, Route 101 could still use bus-on-shoulder operations south of the SR 14 interchange but would need to begin merging over to the C Street exit earlier than if the C Street ramps were removed. Route 101 would operate at 10-minute peak and 30-minute off-peak headways. C-TRAN Route 164 would not be anticipated to use bus-on-shoulder operations because of the need to exit to SR 14 from northbound I-5.

1.1.7.3 Local Bus Route Changes

The TriMet Line 6 bus route would be changed to terminate at the Expo Center MAX Station, requiring passengers to transfer to the new LRT connection to access Hayden Island. TriMet Line 6 is anticipated to travel from Martin Luther King Jr. Boulevard through the newly configured area providing local connections to Marine Drive. It would continue west to the Expo Center MAX Station. Table 1-3 shows existing service and anticipated future changes to TriMet Line 6.

As part of the Modified LPA, several local C-TRAN bus routes would be changed to better complement the new light-rail extension. Most of these changes would reroute existing bus lines to provide a transfer opportunity near the new Evergreen Station. Table 1-3 shows existing service and anticipated future changes to C-TRAN bus routes. In addition to the changes noted in Table 1-3, other local bus route modifications would move service from Broadway to C Street. The changes shown may be somewhat different if the C Street ramps are removed.

Table 1-3. Proposed TriMet and C-TRAN Bus Route Changes

Bus Route	Existing Route	Changes with Modified LPA
TriMet Line 6	Connects Goose Hollow, Portland City Center, N/NE Portland, Jantzen Beach and Hayden Island. Within the study area, service currently runs between Delta Park MAX Station and Hayden Island via I-5.	Route would be revised to terminate at the Expo Center MAX Station. Route is anticipated to travel from Martin Luther King Jr. Boulevard through the newly configured Marine Drive area, then continue west to connect via facilities on the west side of I-5 with the Expo Center MAX Station.

Bus Route	Existing Route	Changes with Modified LPA
C-TRAN Fourth Plain and Mill Plain bus rapid transit (The Vine)	Runs between downtown Vancouver and the Vancouver Mall Transit Center via Fourth Plain Boulevard, with a second line along Mill Plain Boulevard. In the study area, service currently runs along Washington and Broadway Streets through downtown Vancouver.	Route would be revised to begin/end near the Evergreen Station in downtown Vancouver and provide service along Evergreen Boulevard to Fort Vancouver Way, where it would travel to or from Mill Plain Boulevard or Fourth Plain Boulevard depending on clockwise/counterclockwise operations. The Fourth Plain Boulevard route would continue to serve existing Vine stations beyond Evergreen Boulevard.
C-TRAN #2 Lincoln	Connects the 99th Street Transit Center to downtown Vancouver via Lincoln and Kaufman Avenues. Within the study area, service currently runs along Washington and Broadway Streets between 7th and 15th Streets in downtown Vancouver.	Route would be modified to begin/end near C Street and 9th Street in downtown Vancouver.
C-TRAN #25 St. Johns	Connects the 99th Street Transit Center to downtown Vancouver via St. Johns Boulevard and Fort Vancouver Way. Within the study area, service currently runs along Evergreen Boulevard, Jefferson Street/Kaufman Avenue, 15th Street, and Franklin Street in downtown Vancouver.	Route would be modified to begin/end near C Street and 9th Street in downtown Vancouver.
C-TRAN #30 Burton	Connects the Fisher's Landing Transit Center with downtown Vancouver via 164th/162nd Avenues and 18th, 25th, 28th, and 39th Streets. Within the study area, service currently runs along McLoughlin Boulevard and on Washington and Broadway Streets between 8th and 15th Streets.	Route would be modified to begin/end near C Street and 9th Street in downtown Vancouver.
C-TRAN #60 Delta Park Regional	Connects the Delta Park MAX station in Portland with downtown Vancouver via I-5. Within the study area, service currently runs along I-5, Mill Plain Boulevard, and Broadway Street.	Route would be discontinued.

1.1.8 Tolling

Tolling cars and trucks that would use the new Columbia River bridges is proposed as a method to help fund the bridge construction and future maintenance, as well as to encourage alternative mode choices for trips across the Columbia River. Federal and state laws set the authority to toll the I-5 crossing. The IBR Program plans to toll the I-5 river bridge under the federal tolling authorization program codified in 23 U.S. Code Section 129 (Section 129). Section 129 allows public agencies to impose new tolls on federal-aid interstate highways for the reconstruction or replacement of toll-free bridges or tunnels. In 2023, the Washington State Legislature authorized tolling on the Interstate Bridge, with toll rates and policies to be set by the Washington State Transportation Commission (WSTC). In Oregon, the legislature authorized tolling giving the Oregon Transportation Commission the authority to toll I-5, including the ability to set the toll rates and policies. Subsequently, the Oregon Transportation Commission (OTC) is anticipated to review and approve the I-5 tollway project application that would designate the Interstate Bridge as a “tollway project” in 2024. At the beginning of 2024, the OTC and the WSTC entered into a bi-state tolling agreement to establish a cooperative process for setting toll rates and policies. This included the formation of the I-5 Bi-State Tolling Subcommittee consisting of two commissioners each from the OTC and WSTC and tasked with developing toll rate and policy recommendations for joint consideration and adoption by each state’s commission. Additionally, the two states plan to enter into a separate agreement guiding the sharing and uses of toll revenues, including the order of uses (flow of funds) for bridge construction, debt service, and other required expenditures. WSDOT and ODOT also plan to enter into one or more agreements addressing implementation logistics, toll collection, and operations and maintenance for tolling the bi-state facility.

The Modified LPA includes a proposal to apply variable tolls on vehicles using the Columbia River bridges with the toll collected electronically in both directions. Tolls would vary by time of day with higher rates during peak travel periods and lower rates during off-peak periods. The IBR Program has evaluated multiple toll scenarios generally following two different variable toll schedules for the tolling assessment. For purposes of this NEPA analysis, the lower toll schedule was analyzed with tolls assumed to range between $1.50 and $3.15 (in 2026 dollars as representative of when tolling would begin) for passenger vehicles with a registered toll payment account. Medium and heavy trucks would be charged a higher toll than passenger vehicles and light trucks. Passenger vehicles and light trucks without a registered toll payment account would pay an additional $2.00 per trip to cover the cost of identifying the vehicle owner from the license plate and invoicing the toll by mail.

The analysis assumes that tolling would commence on the existing Interstate Bridge—referred to as pre-completion tolling—starting April 1, 2026. The actual date pre-completion tolling begins would depend on when construction would begin. The traffic and tolling operations on the new Columbia River bridges were assumed to commence by July 1, 2033. The actual date that traffic and tolling operations on the new bridges begin would depend on the actual construction completion date. During the construction period, the two commissions may consider toll-free travel overnight on the existing Interstate Bridge, as was analyzed in the Level 2 Toll Traffic and Revenue Study, for the hours between 11 p.m. and 5 a.m. This toll-free period could help avoid situations where users would be charged during lane or partial bridge closures where construction delays may apply. Once the new I-5 Columbia River bridges open, twenty-four-hour tolling would begin.

Tolls would be collected using an all-electronic toll collection system using transponder tag readers and license plate cameras mounted to structures over the roadway. Toll collection booths would not be required. Instead, motorists could obtain a transponder tag and set up a payment account that would automatically bill the account holder associated with the transponder each time the vehicle crossed the bridge. Customers without transponders, including out-of-area vehicles, would be tolled by a license plate recognition system that would bill the address of the owner registered to that vehicle's license plate. The toll system would be designed to be nationally interoperable. Transponders for tolling systems elsewhere in the country could be used to collect tolls on I-5, and drivers with an account and transponder tag associated with the Interstate Bridge could use them to pay tolls in other states for which reciprocity agreements had been developed. There would be new signage, including gantries, to inform drivers of the bridge toll. These signs would be on local roads, I-5 on-ramps, and on I-5, including locations north and south of the bridges where drivers make route decisions (e.g., I-5/I-205 junction and I-5/I-84 junction).

1.1.9 Transportation System- and Demand-Management Measures

Many well-coordinated transportation demand-management and system-management programs are already in place in the Portland-Vancouver metropolitan region. In most cases, the impetus for the programs comes from state regulations: Oregon's Employee Commute Options rule and Washington's Commute Trip Reduction law (described in the sidebar).

The physical and operational elements of the Modified LPA provide the greatest transportation demand-management opportunities by promoting other modes to fulfill more of the travel needs in the corridor. These include:

- Major new light-rail line in exclusive right of way, as well as express bus routes and bus routes that connect to new light-rail stations.
- I-5 inside shoulders that accommodate express buses.
- Modern bicycle and pedestrian facilities that accommodate more bicyclists and pedestrians and improve connectivity, safety, and travel time.
- Park-and-ride facilities.
- A variable toll on the new Columbia River bridges.

In addition to these fundamental elements of the Modified LPA, facilities and equipment would be implemented that could help existing or expanded transportation system management measures maximize the capacity and efficiency of the system. These include:

- Replacement or expanded variable message signs in the study area. These signs alert drivers to incidents and events, allowing them to seek alternate routes or plan to limit travel during periods of congestion.

State Laws to Reduce Commute Trips

Oregon and Washington have both adopted regulations intended to reduce the number of people commuting in single-occupancy vehicles (SOVs). Oregon's Employee Commute Options Program, created under Oregon Administrative Rule 340-242-0010, requires employers with over 100 employees in the greater Portland area to provide commute options that encourage employees to reduce auto trips to the work site. Washington's 1991 Commute Trip Reduction (CTR) Law, updated as the 2006 CTR Efficiency Act (Revised Code of Washington §70.94.521) addresses traffic congestion, air pollution, and petroleum fuel consumption. The law requires counties and cities with the greatest traffic congestion and air pollution to implement plans to reduce SOV demand. An additional provision mandates "major employers" and "employers at major worksites" to implement programs to reduce SOV use.

- Replacement or expanded traveler information systems with additional traffic monitoring equipment and cameras.
- Expanded incident response capabilities, which help traffic congestion to clear more quickly following accidents, spills, or other incidents.
- Queue jumps or bypass lanes for transit vehicles where multilane approaches are provided at ramp signals for on-ramps. Locations for these features will be determined during the detailed design phase.
- Active traffic management including strategies such as ramp metering, dynamic speed limits, and transit signal priority. These strategies are intended to manage congestion by controlling traffic flow or allowing transit vehicles to enter traffic before single-occupant vehicles.

1.2 Modified LPA Construction

The following information on the construction activities and sequence follows the information prepared for the CRC LPA. Construction durations have been updated for the Modified LPA. Because the main elements of the IBR Modified LPA are similar to those in the CRC LPA (i.e., multimodal river crossings and interchange improvements), this information provides a reasonable assumption of the construction activities that would be required.

The construction of bridges over the Columbia River sets the sequencing for other Program components. Accordingly, construction of the Columbia River bridges and immediately adjacent highway connections and improvement elements would be timed early to aid the construction of other components. Demolition of the existing Interstate Bridge would take place after the new Columbia River bridges were opened to traffic.

Electronic tolling infrastructure would be constructed and operational on the existing Interstate Bridge by the start of construction on the new Columbia River bridges. The toll rates and policies for tolling (including pre-completion tolling) would be determined after a more robust analysis and public process by the OTC and WSTC (refer to Section 1.1.8, Tolling).

1.2.1 Construction Components and Duration

Table 1-4 provides the estimated construction durations and additional information of Modified LPA components. The estimated durations are shown as ranges to reflect the potential for Program funding to be phased over time. In addition to funding, contractor schedules, regulatory restrictions on in-water work and river navigation considerations, permits and approvals, weather, materials, and equipment could all influence construction duration and overlap of construction of certain components. Certain work below the ordinary high-water mark of the Columbia River and North Portland Harbor would be restricted to minimize impacts to species listed under the Endangered Species Act and their designated critical habitat.

Throughout construction, active transportation facilities and three lanes in each direction on I-5 (accommodating personal vehicles, freight, and buses) would remain open during peak hours, except for short intermittent restrictions and/or closures. Advanced coordination and public notice would be given for restrictions, intermittent closures, and detours for highway, local roadway, transit, and active transportation users (refer to the Transportation Technical Report, for additional information). At least one navigation channel would remain open throughout construction. Advanced coordination and notice would be given for restrictions or intermittent closures to navigation channels as required.

Table 1-4. Construction Activities and Estimated Duration

Component	Estimated Duration	Notes
Columbia River bridges	4 to 7 years	• Construction is likely to begin with the main river bridges. • General sequence would include initial preparation and installation of foundation piles, shaft caps, pier columns, superstructure, and deck.
North Portland Harbor bridges	4 to 10 years	• Construction duration for North Portland Harbor bridges is estimated to be similar to the duration for Hayden Island interchange construction. The existing North Portland Harbor bridge would be demolished in phases to accommodate traffic during construction of the new bridges.
Hayden Island interchange	4 to 10 years	• Interchange construction duration would not necessarily entail continuous active construction. Hayden Island work could be broken into several contracts, which could spread work over a longer duration.
Marine Drive interchange	4 to 6 years	• Construction would need to be coordinated with construction of the North Portland Harbor bridges.
SR 14 interchange	4 to 6 years	• Interchange would be partially constructed before any traffic could be transferred to the new Columbia River bridges.
Demolition of the existing Interstate Bridge	1.5 to 2 years	• Demolition of the existing Interstate Bridge could begin only after traffic is rerouted to the new Columbia River bridges.
Three interchanges north of SR 14	3 to 4 years for all three	• Construction of these interchanges could be independent from each other and from construction of the Program components to the south. • More aggressive and costly staging could shorten this timeframe.

Component	Estimated Duration	Notes
Light-rail	4 to 6 years	• The light-rail crossing would be built with the Columbia River bridges. Light-rail construction includes all of the infrastructure associated with light-rail transit (e.g., overhead catenary system, tracks, stations, park and rides).
Total construction timeline	9 to 15 years	• Funding, as well as contractor schedules, regulatory restrictions on in-water work and river navigation considerations, permits and approvals, weather, materials, and equipment, could all influence construction duration.

1.2.2 Potential Staging Sites and Casting Yards

Equipment and materials would be staged in the study area throughout construction generally within existing or newly purchased right of way, on land vacated by existing transportation facilities (e.g., I-5 on Hayden Island), or on nearby vacant parcels. However, at least one large site would be required for construction offices, to stage the larger equipment such as cranes, and to store materials such as rebar and aggregate. Criteria for suitable sites include large, open areas for heavy machinery and material storage, waterfront access for barges (either a slip or a dock capable of handling heavy equipment and material) to convey material to the construction zone, and roadway or rail access for landside transportation of materials by truck or train.

Two potential major staging sites have been identified (see Figure 1-8 and Figure 1-23). One site is located on Hayden Island on the west side of I-5. A large portion of this parcel would be required for new right of way for the Modified LPA. The second site is in Vancouver between I-5 and Clark College. Other staging sites may be identified during the design process or by the contractor. Following construction of the Modified LPA, the staging sites could be converted for other uses.

In addition to on-land sites, some staging activities for construction of the new Columbia River and North Portland Harbor bridges would take place on the river itself. Temporary work structures, barges, barge-mounted cranes, derricks, and other construction vessels and equipment would be present on the river during most or all of the bridges' construction period. The IBR Program is working with USACE and USCG to obtain necessary clearances for these activities.

A casting or staging yard could also be required for construction of the overwater bridges if a precast concrete segmental bridge design is used. A casting yard would require access to the river for barges, a slip or a dock capable of handling heavy equipment and material, a large area suitable for a concrete batch plant and associated heavy machinery and equipment, and access to a highway or railway for delivery of materials. As with the staging sites, casting or staging yard sites may be identified as the design progresses or by the contractor and would be evaluated via a NEPA re-evaluation or supplemental NEPA document for potential environmental impacts at that time.

1.3 No-Build Alternative

The No-Build Alternative illustrates how transportation and environmental conditions would likely change by the year 2045 if the Modified LPA is not built. This alternative makes the same assumptions as the Modified LPA regarding population and employment growth through 2045, and it assumes that the same transportation and land use projects in the region would occur as planned.

Regional transportation projects included in the No-Build Alternative are those in the financially constrained 2018 *Regional Transportation Plan* (2018 RTP) adopted in December 2018 by the Metro Council (Metro 2018) and in March 2019 (RTC 2019) by the Southwest Washington Regional Transportation Council (RTC) Board of Directors is referred to as the 2018 RTP in this report. The 2018 RTP has a planning horizon year of 2040 and includes projects from state and local plans necessary to meet transportation needs over this time period; financially constrained means these projects have identified funding sources. The Transportation Technical Report lists the projects included in the financially constrained 2018 RTP.

The implementation of regional and local land use plans is also assumed as part of the No-Build Alternative. For the IBR Program analysis, population and employment assumptions used in the 2018 RTP were updated to 2045 in a manner consistent with regional comprehensive and land use planning. In addition to accounting for added growth, adjustments were made within Portland to reallocate the households and employment based on the most current update to Portland's comprehensive plan, which was not complete in time for inclusion in the 2018 RTP.

Other projects assumed as part of the No-Build Alternative include major development and infrastructure projects that are in the permitting stage or partway through phased development. These projects are discussed as reasonably foreseeable future actions in the IBR Cumulative Effects Technical Report. They include the Vancouver Waterfront project, Terminal 1 development, the Renaissance Boardwalk, the Waterfront Gateway Project, improvements to the levee system, several restoration and habitat projects, and the Portland Expo Center.

In addition to population and employment growth and the implementation of local and regional plans and projects, the No-Build Alternative assumes that the existing Interstate Bridge would continue to operate as it does today. As the bridge ages, needs for repair and maintenance would potentially increase, and the bridge would continue to be at risk of mechanical failure or damage from a seismic event.

2. METHODS

This section describes the methods used to evaluate energy and GHG emissions impacts from the Modified LPA, including guidance drawn from relevant laws and regulations.

2.1 Study Area

The study area for energy and GHG is shown in Figure 2-1. Energy and GHG impacts were evaluated for the regional roadway network and the proposed transit alignment and facilities based on the boundaries of Oregon Metro's (Metro's) regional travel demand model, which encompasses Multnomah, Clackamas, Washington, and Clark Counties.

To estimate the Modified LPA's effects on a smaller scale, the energy consumption and GHG emissions were also calculated using only the traffic segments in the traffic assignment area, also shown in Figure 2-1. The traffic assignment area is defined in the Transportation Technical Report as the area where the Modified LPA affects vehicle travel.

2.2 Relevant Laws and Regulations

The assessment of potential energy effects considered the Modified LPA's consistency with applicable federal, state, and local policies. Most federal, state, and local laws quantitatively regulate energy use or GHG emissions mainly in terms of conserving energy, providing the means to improve the efficiency of energy use, and striving toward long-term GHG emission reduction goals.

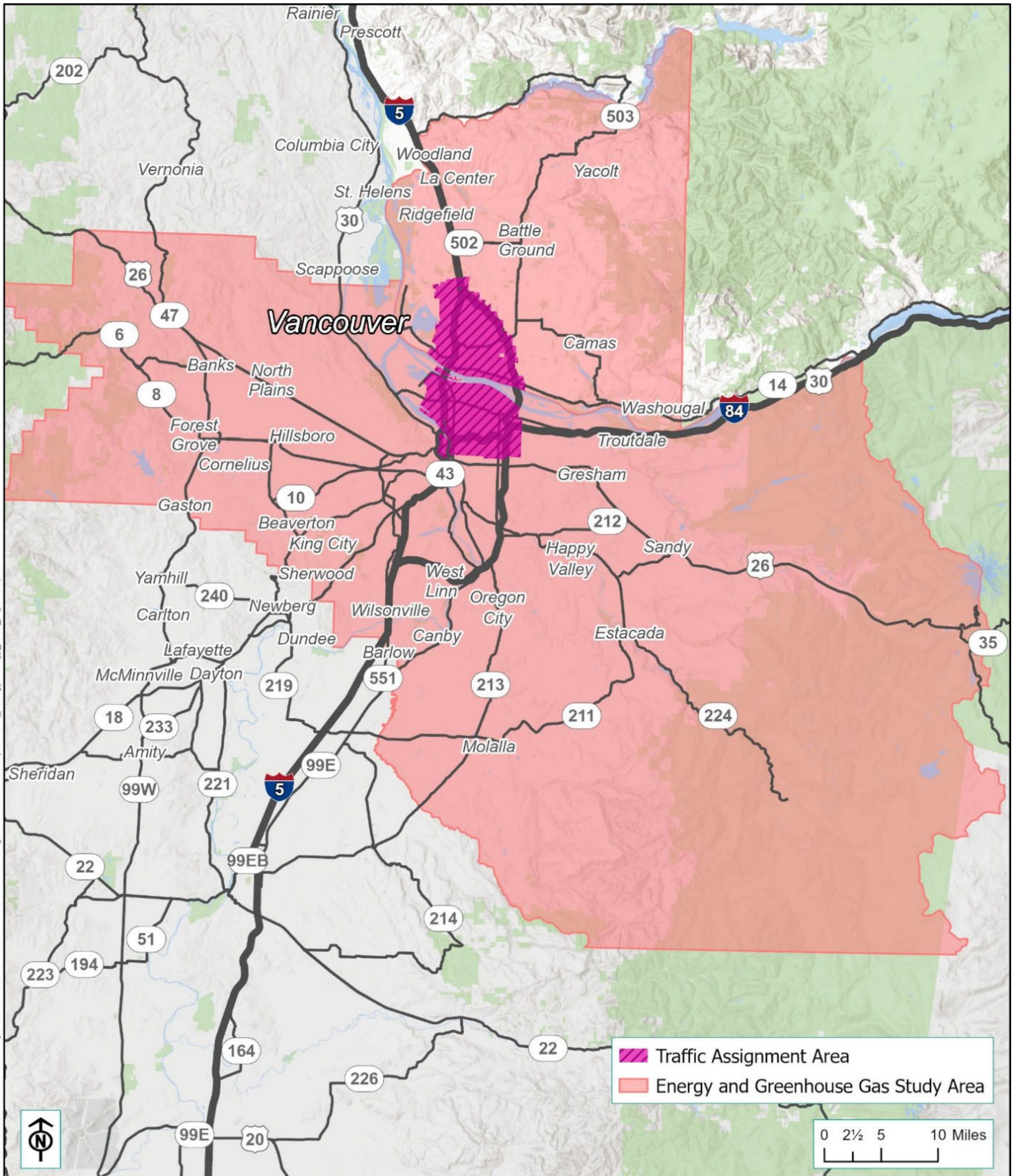
An estimate of the Modified LPA's energy consumption was used to determine its consistency with the following relevant laws, regulations, and policies. While there are no regulations that set limits on energy use or GHG emissions specifically, the Modified LPA should show that energy would be used wisely and that ways to reduce or minimize energy use have been considered.

2.2.1 Federal Laws, Regulations, and Policies

2.2.1.1 National Environmental Policy Act

NEPA (42 USC 4332) requires that federal agencies consider environmental effects before taking actions that could substantially affect the human environment. As interpreted by the Council on Environmental Quality, NEPA requires that the "environmental consequences" of a proposed project be considered in the decision-making process, including "energy requirements and conservation potential of various alternatives and mitigation measures" (Section 1502.15(e)).

Figure 2-1. Energy and Greenhouse Gas Study Area and Traffic Assignment Area



Date: 3/19/2024 Path: U:\Port\Projects\Clients\1585-WSP\274-1585-058 IBR Program\99Svcs\GIS\mapdocs\Ph_Energy\Energy_Tech_Figures.aprx

Source: ODOT, WSDOT, Mapbox, OpenStreetMap

On August 1, 2016, the Council on Environmental Quality released the Final Guidance for Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews. This guidance was most recently updated with interim guidance in 2023. The 2023 interim guidance provides federal agencies a common approach for assessing their proposed actions, while recognizing each agency's unique circumstances and authority. The guidance explains how agencies should apply NEPA principles and existing best practices, including how to apply those principles and best practices to quantify and contextualize GHG emissions associated with proposed actions.

2.2.1.2 Federal Highway Administration Technical Advisory T 6640.8A (1987)

Federal Highway Administration (FHWA) Technical Advisory T 6640.8A provides guidance on the preparation of environmental documents, including the analysis of energy effects. It states that an environmental impact statement "should discuss in general terms the construction and operational energy requirements and conservation potential of the various alternatives under consideration" (FHWA 1987).

2.2.1.3 Federal Fuel Economy Standards

The National Highway Traffic Safety Administration (NHTSA) Corporate Average Fuel Economy (CAFE) standards regulate how far vehicles must travel on a gallon of fuel. NHTSA sets CAFE standards for passenger cars and for light trucks (collectively, "light-duty vehicles") and separately sets fuel consumption standards for medium- and heavy-duty trucks and engines. CAFE standards were finalized in 2022, requiring an industry-wide fleet average of approximately 49 miles per gallon for passenger cars and light trucks in model year 2026, by increasing fuel efficiency by 8% annually for model years 2024 and 2025, and 10% annually for model year 2026 (NHTSA n.d.).

In 2020, the NHTSA and U.S. Environmental Protection Agency (EPA) issued the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, which sets fuel economy and carbon dioxide standards that increase 1.5% in stringency each year from model years 2021 through 2026. These standards will continue the U.S.'s progress toward energy independence and carbon dioxide reduction and will apply to light-duty vehicles.

2.2.2 State Laws, Regulations and Policies

2.2.2.1 Oregon Policies

OREGON STATEWIDE PLANNING GOALS – (OREGON ADMINISTRATIVE RULES [OAR] CHAPTER 660 DIVISION 15 [660-015])

In 1991, the Land Conservation and Development Commission adopted the Oregon Transportation Planning Rule (OAR 660-012-0000). This rule is responsible for the application of Oregon's statewide planning goals to newly incorporated cities, annexation, and urban development on rural lands (OAR 660-015). The core of this program comprises 19 statewide planning goals, two of which are applicable to energy: Goal 12, Transportation and Goal 13, Energy Conservation.

Goal 12 – Transportation (OAR 660-12-035)

Goal 12 states that the following standards must be used to evaluate and select transportation system alternatives: "the transportation system shall minimize adverse economic, social, environmental and energy consequences."

Goal 13 – Energy Conservation (OAR 660-015-0000(13))

Goal 13 states that land and uses developed on the land must be managed and controlled to maximize the conservation of all forms of energy, based on sound economic principles (OAR 660-015).

660-044-0020 – GREENHOUSE GAS EMISSIONS REDUCTION TARGET FOR THE PORTLAND METROPOLITAN AREA

Section 44 of OAR 660-44 outlines specific GHG reduction targets, for the years 2040 through 2050, applicable to the Portland area.

EXECUTIVE ORDER (EO) 20-04 – DIRECTING STATE AGENCIES TO TAKE ACTIONS TO REDUCE AND REGULATE GREENHOUSE GAS EMISSIONS

EO 20-04 directs certain state agencies to take specific actions to reduce emissions and mitigate the impacts of climate change and provides overarching direction to state agencies to exercise their statutory authority to help achieve Oregon's climate goals.

CLEAN FUELS PROGRAM ELECTRICITY 2021

The Oregon Department of Environmental Quality (DEQ) Administrative Order DEQ-7-2021 amends the Clean Fuels Program rules to advance methods to accelerate the generation and aggregation of clean fuel credits by utilities to advance transportation electrification and further incentivizes these activities.

CLEAN TRUCK RULES 2021

Administrative Order DEQ-17-2021 adopts California's medium- and heavy-duty diesel engine standards. The rulemaking adopts by reference a few of California's rules, including:

- The Advanced Clean Trucks rule, which requires manufacturers of medium- and heavy- duty vehicles to sell a certain percentage of zero-emission vehicles beginning with the 2024 vehicle model year.
- The Heavy Duty Low NO_X Omnibus rules, which require heavy-duty vehicle manufacturers to comply with tougher nitrogen oxide (NO_X) emission standards, overhaul engine testing procedures, and further extend engine warranties to ensure that NO_X emissions are reduced.
- Updates to the low-emission vehicle program rules to ensure they are identical to California's current light-duty vehicle emission standards.

CLIMATE PROTECTION PROGRAM

Administrative Order DEQ-27-2021 establishes a new Climate Protection Program to reduce GHG emissions and address the effects of climate change. This program sets limits on GHG emissions from significant sources in Oregon, including large stationary sources, transportation fuels, and other liquid and gaseous fuels; defines regulatory applicability and program requirements; and prioritizes equity by promoting benefits and alleviating burdens for environmental justice and impacted communities.

CLEAN FUELS PROGRAM EXPANSION 2022

Administration Orders DEQ-16-2022 and DEQ-17-2022 reduce the Clean Fuels Program annual average carbon intensity targets to 20% below 2015 levels by 2030 and 37% by 2035 and support the achievement of these new standards.

2.2.2.2 Washington Policies

STATE ENVIRONMENTAL POLICY ACT (SEPA) AND STATE IMPLEMENTING REGULATIONS, WASHINGTON ADMINISTRATION CODE (WAC) 197-11 AND 468-12

SEPA requires environmental review of development proposals that may have a significant adverse impact on the environment. If a proposed development is subject to SEPA, the project proponent is required to complete the SEPA checklist. The checklist includes questions relating to the development’s air emissions. The emissions that have traditionally been considered cover smoke, dust, and industrial and automobile emissions. An evaluation of GHG emissions is not currently required as part of the SEPA process.

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) GUIDANCE – PROJECT-LEVEL GREENHOUSE GAS EVALUATIONS UNDER NEPA AND SEPA (WSDOT 2018)

The WSDOT (2018) guidance outlines a standard analytical process and provides a template for addressing GHG emissions in environmental documentation for WSDOT projects. It also provides standard language and terminology and outlines the expectation of analysis for different types of projects under NEPA and SEPA.

GUIDANCE ON ADDRESSING AIR QUALITY, GREENHOUSE GAS EMISSIONS, AND ENERGY FOR WSDOT PROJECTS (WSDOT 2022)

The WSDOT (2022) guidance provides technical guidance to estimate quantitative impacts to air quality, energy, and GHG emissions. These analyses are addressed together because they often use the same tools, but each analysis has slightly different triggers. WSDOT has prepared guidance and templates to address the GHG and energy impacts from transportation projects.

WSDOT SECRETARY’S EO 1113: SUSTAINABILITY

EO 1113 directs employees to take actions that sustain economic, environmental, and societal prosperity for current and future generations through a focus on energy efficiency, pollution reduction, and enhanced resilience.

STATE EFFICIENCY AND ENVIRONMENTAL PERFORMANCE EO 20-01

EO 20-01 directs state agencies to achieve reductions in GHG emissions and eliminate toxic materials from state agency operations.

STATE AGENCY CLIMATE LEADERSHIP ACT

This act directs state agencies, including universities, colleges, and community and technical colleges, to lead by example in reducing their GHG emissions to 15% below 2005 baseline by 2020, 45% below 2005 levels by 2030, 70% below 2005 levels by 2040, and 95% below 2005 levels by 2050, with the end goal of achieving net zero.

CLEAN FUELS PROGRAM – WASHINGTON STATE DEPARTMENT OF ECOLOGY (ECOLOGY)

Ecology's Clean Fuels Program reduces the overall carbon intensity of transportation fuels used in the state by 20% below 2017 levels by 2035.

WASHINGTON CLEAN VEHICLES PROGRAM (CHAPTER 173-423 WAC) – ECOLOGY:

Ecology's Clean Vehicles Program includes the following requirements:

- Washington will adopt California's Heavy-Duty Engine and Vehicle Omnibus rules.
- By 2035, 100% of sales of light-duty vehicles sold in Washington will be electric.

CLIMATE COMMITMENT ACT – ECOLOGY

Ecology's cap-and-invest program aims to reduce statewide GHG emissions. This program works by setting an emissions limit, or cap, and then lowering that cap over time to ensure that Washington meets the GHG reduction commitments set in state law (95% reduction of GHGs by 2050).

2.3 Data Collection

Energy supply and demand in Washington and Oregon are generally characterized by energy supply sources and use sectors. The following sources provide information on general energy supply and demand:

- U.S. Department of Energy/Energy Information Administration
- Washington Office of the U.S. Department of Commerce
- Oregon Department of Energy

For example, resource adequacy is discussed in Oregon's 2022 Biennial Energy Report (Oregon Department of Energy 2022), and a review of the status of Washington's State Energy Strategy is included in the State's 2019 Biennial Energy Report (Washington State Department of Commerce 2018). Washington's State Energy Strategy was updated in 2021 using historical, existing, and future energy demand data from the Energy Information Administration.

In addition to the general resources describing energy supply and demand for Washington and Oregon, statewide GHG emission trends were retrieved from reports issued by Ecology and by the Oregon Department of Energy.

The analysis also used regional travel demand model data provided by the IBR Program's traffic analysts. Additional data specific to the Modified LPA, including construction cost and activity estimates, travel demand forecasts, and traffic and transit operations data, were collected by the IBR Program team.

2.4 Analysis Methods

The analysis methodology involved comparing the Modified LPA's potential adverse and beneficial effects to those of the No-Build Alternative pertaining to energy use and GHG emissions in compliance with NEPA, applicable state environmental legislation, and local and state planning and land use policies. The analysis includes the type and amount of energy that would be consumed, and GHGs emitted, in the building and operation of the Modified LPA. At a regional level, the analysis provides estimates of energy consumption and GHG emissions under the Modified LPA, compared to the No-Build Alternative, to help identify potential impacts and inform the decision-making process. The energy consumption and GHG emissions were estimated for analysis year 2015 to represent existing conditions, which corresponds to the base year of the regional travel demand model that serves as the basis for the regional emissions analysis. More recent regional data was not available. Energy and GHG emissions for the Modified LPA and the No-Build Alternative were estimated for 2045, the design year for the Modified LPA.

2.4.1 Significance Thresholds

There are no regulatory significance thresholds related to energy use or GHG emissions from transportation projects. Instead, substantial effects on energy use would occur if the Modified LPA increased demand to the point that the supply of energy was insufficient to meet existing and future projected demand, or if there were an increase in energy use that created concern in meeting the demand for energy.

While many jurisdictions desire to minimize GHG emissions and have identified long-term goals and reduction targets, there are no regulatory standards that quantifiably limit a project's GHG emissions.

2.4.2 Operational Effects Approach

The analysis examined the effects of the Modified LPA on energy use and GHG emissions associated with the operation and maintenance of components. Effects from operations are based on the amount of fuel energy used by on-road vehicles (including private, freight, and transit vehicles) and energy from electrical needs associated with the extension of light-rail transit in the study area. Effects from maintenance are based on periodic maintenance activities such as sweeping, restriping, vegetation management, and pavement preservation.

2.4.2.1 On-road Vehicle Operations

The EPA's MOtor Vehicle Emission Simulator (MOVES) model version MOVES3.1.0 was used to estimate energy consumption and GHG emissions from the roadway links in the study area. MOVES is the EPA's state-of-the-art tool for estimating emissions from highway vehicles. The model is based on analyses of millions of emission test results and considerable advances in the EPA's understanding of vehicle emissions. MOVES3.1.0 incorporates the latest emissions data and, compared to previous model versions, applies more sophisticated calculation algorithms and provides an improved user interface. It also accounts for new regulations (including the Heavy-Duty Greenhouse Gas Phase 2 rule and the SAFE Vehicles Rule) and. Table 2-1 summarizes the MOVES run specifications used for the energy and GHG analysis.

Table 2-1. MOVES Run Specification Options

MOVES Tab	Model Selections
Scale	• County Scale • Emission Rates Calculation Type
Time Span	• Hourly time aggregation • January and July • Weekday • Analysis years 2015 and 2045
Geographic Bounds	• Multnomah County was used to represent emissions from segments in Oregon, consistent with Metro's regional emissions model. [a] • Clark County was used to represent emissions from segments in Washington.
Vehicles/Equipment	• All on-road vehicle and fuel type combinations
Road Type	• Rural restricted, rural unrestricted, urban restricted, and urban unrestricted
Pollutants and Processes	• CO_2e, total energy consumption, and precursor pollutants needed to make the calculations • Processes included running exhaust
Advanced Features	• MOVES Advanced Features option was used to create a database for each state that accounts for the adoption of California's Low Emission Vehicle program.
Output	• Output was a table of emission rates in units of gram per mile or Joules per mile for each hour of a January weekday and July weekday, by roadway type, vehicle type, and speed bin.

a Although the study area spans multiple counties in Oregon, Multnomah County was used to represent all Oregon emissions in the metropolitan Portland area, consistent with Metro's approach to regional emissions modeling.
CO_2e = carbon dioxide equivalent, MMBtu = million British thermal units

MOVES input files were developed following EPA methodology using model defaults and data provided by DEQ and Ecology to represent regional climate conditions, fuel specifications, and fleet makeup. The EPA methodology does not include input files for electric vehicle use. For each alternative, two MOVES runs were created to determine the emission rates—one applicable to Oregon roadway segments using Oregon regional conditions and one applicable to Washington roadway segments using Washington regional conditions. Table 2-2 summarizes specific inputs and their sources.

Table 2-2. MOVES County Data Manager Inputs – No Electric Vehicles

County Data Manager Tab	Data Source – Oregon	Data Source - Washington
Source Type Population	DEQ	Ecology
Age Distribution	DEQ	Ecology
Fuel Supply, Fuel Usage Fraction, Fuel Formulation	DEQ	Ecology
Alternative Vehicle Fuel Type	MOVES default	MOVES default
Inspection/Maintenance Programs	DEQ	Ecology
Meteorological Data	DEQ	Ecology
Road Type Distribution [a]	DEQ	Ecology
Average Speed Distribution [a]	DEQ	Ecology
Vehicle Type VMT [a]	DEQ	Ecology

a These data are required to develop MOVES emission rates. Program-specific values were applied during post-processing.

DEQ = Oregon Department of Environmental Quality; Ecology = Washington Department of Ecology; VMT = vehicle miles traveled

Agency-supplied input files were used for the analysis of the Modified LPA, with the analysis year modified as necessary.

ELECTRIC VEHICLE CONSIDERATIONS

The EPA methodology does not provide MOVES defaults for electric vehicle use, and conservatively assumes that no electric vehicles are in the fleet. WSDOT and the Oregon Department of Transportation (ODOT) expect that the vehicle fleets in Oregon and Washington in 2045 will have a significant increase in electric vehicles due to laws in each state limiting sales of fossil-fuel powered passenger vehicles, which would result in a large reduction in GHG emissions. For the purposes of this analysis, all vehicles that are considered zero-emission vehicles (such as battery electric vehicles and hydrogen fuel cell electric vehicles) are assumed to be battery electric vehicles.

DEQ recommended a methodology for the vehicle fleet to account for expected electric vehicle penetration of passenger vehicles, medium trucks, and heavy trucks. WSDOT and ODOT reviewed the DEQ methodology and determined that these assumptions are applicable to the Washington and Oregon vehicle fleet for this GHG analysis. The recommendations are based on state mandates that will limit future sales of fossil-fuel-powered vehicles.

The gradual transition of medium and heavy trucks to electricity as a fuel type was accounted for by creating a weighted average for each emission factor that reflects the percentage of vehicles using each fuel type as shown in Table 2-3. DEQ developed these projections based on current alternative fuel vehicle data and may vary as more alternative fuel vehicles enter the regional fleet. These values are consistent with electric vehicle adoption assumptions included in the Oregon Statewide

Transportation Strategy (ODOT 2013) and the GHG emissions evaluation for the 2024-2027 Statewide Transportation Improvement Program (ODOT 2023).

Table 2-3. Fuel Assumptions for 2045 Analysis – with Electric Vehicle Assumptions

Vehicle Type	Fuel Type				
	Gasoline	Diesel	CNG	Ethanol	Electric
Passenger vehicles	46.0%	0.0%	0.0%	2.0%	52.0%
Medium Trucks	21.2%	50.5%	0.0%	9.1%	19.2%
Heavy Trucks	0.0%	88.0%	1.0%	0%	11.0%

CNG = compressed natural gas

Following the DEQ recommendations, the MOVES output was adjusted to reflect current assumptions for transitions to alternative fuels by 2045. MOVES emission factors were scaled by the proportion of electric vehicles to represent a reduced emission factor that was applied to the VMT by fuel type. For example, the passenger vehicle emission factor was multiplied by 48% and the applied to the total passenger vehicle VMT for each scenario. The adjustment applied to both the GHG emission factors and the total energy consumption emission factors.

ON-ROAD VEHICLE EMISSIONS CALCULATIONS

Link-by-link traffic data were obtained from the transportation analysis for the following three conditions:

- Existing Conditions (2015)
- No-Build Alternative (2045)
- Modified LPA (2045)

The link-by-link traffic data indicated the link length and roadway type and included volume and average modeled speed data for every hour of an average weekday. Volumes were provided by vehicle type (passenger vehicles, medium trucks, and heavy trucks) and accounted for expected changes to the vehicle mix in the future with or without the Modified LPA. The volume data were processed using the following assumptions; definitions can be found in the MOVES3 Technical Guidance (EPA 2020):

- Road Type Distribution – The roadway types and locations were mapped to the four MOVES roadway types: rural restricted, rural unrestricted, urban restricted, and urban unrestricted. The off-network road type was not used for this analysis.
- Average Speed Distribution – The link-level traffic data were provided for each hour of an average weekday. Speeds were mapped to 5-mile-per-hour speed bins that are used by MOVES.
- Vehicle Type Vehicle Miles Traveled (VMT) – VMT for each vehicle type was determined for each roadway link by multiplying the link volume by the link length. For each alternative, the VMT for each vehicle type was summarized by hour, road type, speed bin, and state.

The volume data were used to determine the total VMT for each vehicle type by hour, road type, speed bin, and state. The VMT data were multiplied by the corresponding MOVES emission rates to calculate total daily emissions of carbon dioxide equivalent (CO_2e) and total daily energy consumption for the following scenarios:

- Existing Conditions (2015)
- No-Build Alternative (2045) No Electric Vehicle Assumptions
- Modified LPA (2045) No Electric Vehicle Assumptions
- No-Build Alternative (2045) with Electric Vehicle Assumptions
- Modified LPA (2045) with Electric Vehicle Assumptions

FUEL CYCLE ASSUMPTIONS

In addition to the on-road vehicle emissions calculated using MOVES, the contribution from the fuel cycle was calculated. The fuel cycle for fossil-fuel-powered vehicles includes emissions released through extraction, refining, and transportation of fuels used by vehicles traveling in the study area. Fuel cycle emissions from fossil-fuel-powered vehicles were calculated by applying the FHWA fuel cycle factor (0.27) to the MOVES modeled results, as directed in the ODOT and WSDOT guidance. This fuel cycle factor applies to the national average fleet of vehicles, including gasoline, diesel, and compressed natural gas. It does not account for reduced fuel cycle emissions associated with renewable fuels.

Under the scenarios that account for future electric vehicles, it is assumed that in 2045, 52% of passenger vehicles will have zero tailpipe emissions of CO_2e. Fuel cycle emissions from the electric vehicles were calculated by using the value 0.000124 metric tons of CO_2e per mile, which was derived from estimates of the carbon intensity of the local power supply and estimates of the electricity needed to power an electric vehicle. ODOT provided data consistent with analyses being performed for the Climate Office that projected 2045 carbon intensity of electricity in Multnomah County of 0.773 pounds of CO_2e per kilowatt-hour based on observed 2012–2016 average electricity carbon intensity by utility provider (ODOT 2022). The average kilowatt hours of electricity needed to run a model year 2022 electric vehicle for 100 miles (expressed as kilowatt hours per 100 miles) were determined using data from the U.S. Department of Energy (2023). There are many methods to potentially evaluate the fuel cycle emissions from electric vehicles, and there is much uncertainty when predicting the carbon intensity of the electrical grid and the power requirements for electric vehicles. The method used in this analysis assumes a conservative value as Oregon utilities strive to be carbon neutral by 2040, Washington utilities strive to be carbon neutral by 2045, and vehicle technology continues to evolve.

For the purposes of this analysis, it was assumed that all zero-emission vehicles are battery electric vehicles. Fuel cycle emissions from hydrogen fuel cell electric vehicles would be estimated based on production details and the location of potential suppliers.

2.4.2.2 Transit Operations

GHG emissions associated with the operation of new transit vehicles, stations, and park and rides under the 2045 Modified LPA conditions were estimated using the Federal Transit Administration's (FTA's) Transit GHG Estimator version 3. The Transit GHG Estimator spreadsheet tool allows users to estimate the partial-lifecycle GHG emissions generated from (and the energy used in the construction, operation, and maintenance phases of) a project across select transit modes. The data used to estimate emissions from transit operations associated with the Modified LPA are summarized in

Table 2-4. There are no GHG emission estimates of transit vehicles, stations, or park and rides under the for 2045 No-Build conditions.

Table 2-4. Federal Transit Administration Greenhouse Gas Estimator Inputs for Modified LPA

Transit Component	Parameter	Input Value
Facility Operations	Combined square footage of stations	20,000 square feet
Light-Rail Vehicle Operations	Annual vehicle miles traveled	1,151,351 miles

2.4.2.3 Maintenance

GHG emissions and energy use from routine maintenance on the roadways and light-rail infrastructure proposed with the Modified LPA were evaluated using the Infrastructure Carbon Estimator (ICE) spreadsheet tool (see Section 2.4.3).

2.4.2.4 Additional Impact Considerations

Additional impacts were evaluated qualitatively, such as traffic congestion due to vehicle collisions and bridge openings that lead to energy consumption and GHG emissions. These changes are qualitatively discussed based on the availability of supporting data.

2.4.3 Construction Effects Approach

2.4.3.1 Infrastructure Carbon Estimator

The Modified LPA's construction effects on energy supply and GHG emissions were calculated using the ICE planning-level tool, Version 2.1.3. This tool was originally developed by the FHWA to estimate the lifecycle energy and GHG emissions from transportation infrastructure construction, maintenance, and operation. The most recent versions of the ICE are products of Transportation Pooled Fund Study TPF-5(362) led by Minnesota Department of Transportation (FHWA 2021). The ICE tool includes assumptions based on a nationwide database of construction bid documents, data collected from state departments of transportation, and consultation with transportation engineers and lifecycle analysis experts. These assumptions are based on sample projects and do not assume any additional technologies such as low-carbon materials or the use of alternative-fueled construction equipment.

Inputs to the ICE tool used to evaluate the Modified LPA were determined based on design drawings and are summarized in Table 2-5 through Table 2-8. Documentation within ICE and the user's guide does not recommended use of ICE to estimate emissions associated with bridges longer than 1,000 feet with high or deep spans. The inputs shown in Table 2-7 represent bridges and overpasses that would be constructed or reconstructed as part of the Modified LPA, with the exception of the large bridge structure over the Columbia River that is not within the intended use of ICE. Copies of the ICE tool are included in Appendix A.

Table 2-5. Federal Highway Administration Infrastructure Carbon Estimator – Roadway Inputs

Facility Type	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Realignment (lane miles)	Shoulder Improvement (centerline miles)
Urban Interstates/Expressways	32.00	5.91	9.87	0.54
Urban Principal Arterials	4.56	0.00	3.73	0.00
Urban Minor Arterials/Collectors	2.32	0.00	1.61	0.00

Table 2-6. Federal Highway Administration Infrastructure Carbon Estimator – Bicycle and Pedestrian Facilities

Project Type	New Construction	Resurfacing
Off-Street Bicycle or Pedestrian Path – Miles	2.828	0
On-Street Bicycle Lane – Lane Miles	8.500	0.253
On-Street Sidewalk – Miles	8.977	N/A

N/A = not applicable

Table 2-7. Federal Highway Administration Infrastructure Carbon Estimator – Bridges and Overpasses

Facility Type	Construct New Bridge/Overpass		Reconstruct Bridge/Overpass	
	Number of Bridges/Overpasses	Total Number of Lane Spans [a]	Number of Bridges/Overpasses	Total Number of Lane Spans [a]
Single-Span	2	2	4	16
Two-Span	2	12	5	40
Multi-Span (over Land)[b]	4	40	5	50
Multi-Span (over Water)[b]	0	0	0	0

a Total number of lane spans = number of bridges × average number of spans per bridge × average number of lanes per bridge

b Only bridges and overpasses less than 1,000 feet in length were evaluated with ICE

Table 2-8. Federal Highway Administration Infrastructure Carbon Estimator – Light-Rail Construction

Project Type	Track Miles
New Construction (at Grade)	1.30
New Construction (Elevated)	3.57
Converted or Upgraded Existing Facility - Track Miles	0.13
New Rail Station (Elevated) - Stations	3.00
Structured Parking	1,270 parking spaces [a]

a 1,270 parking spaces is the combined total of one parking structure with 700 spaces and a second parking structure with 570 spaces

Effects of construction delay to vehicle emissions were addressed qualitatively because the VMT affected by construction activities could not be quantified for use with ICE.

2.4.3.2 Bridge Construction

The ICE tool is not recommended for evaluations of bridges greater than 1,000 feet with high or deep spans because it would likely underestimate GHG emissions from large structures. For this element of the Modified LPA, the IBR Program team developed estimates of quantities of primary materials that would be used to construct the Columbia River bridges. Material quantities were estimated based on preliminary design plans for the following single-level fixed-span bridge configuration types: steel truss, steel plate girder, concrete segmental, and extradosed. A summary of principle material quantities and emission factors are shown in Table 2-9.

Table 2-9. Material Quantities Used to Estimate Emissions from Bridge Construction

Material	Steel Truss	Steel Plate Girder	Concrete Segmental	Extradosed
Structural Steel	39,470 ton	43,975 ton	18,539 ton	21,549 ton
Reinforcing Steel	9,024 ton	13,005 ton	14,716 ton	19,428 ton
4 ksi Concrete	51,243 CY	70,596 CY	66,268 CY	66,666 CY
=>5 ksi Concrete	71,016 CY	77,324 CY	120,366 CY	137,858 CY

CY = cubic yards, ksi = kilopound force per square inch

Environmental Product Declarations (EPD) available from the Embodied Carbon in Construction Calculator (EC3) tool were reviewed to identify life cycle emission factors representative of construction materials available in the Pacific Northwest. A range of high and low emission factors were retrieved to acknowledge the uncertainty associate with the specific products that will be used for construction, as presented in Table 2-10.

Table 2-10. Fuel Use Factors Used to Estimate Emissions From Bridge Construction

Material	Emission Factor – Low	Emission Factor – High
Structural Steel	0.6293 kg CO_2e/lb	0.9014 kg CO_2e/lb
Reinforcing Steel	0.3471 kg CO_2e/lb	0.4168 kg CO_2e/lb
4 ksi Concrete	183.2 kg CO_2e/CY	203.3 kg CO_2e/CY
=>5 ksi Concrete	202.8 kg CO_2e/CY	218.6 kg CO_2e/CY

kg CO_2e/CY = kilograms of carbon dioxide equivalent per cubic yard, kg CO_2e/lb = kilograms of carbon dioxide equivalent per pound

Construction fuel use was estimated using factors from the National Cooperative Highway Research Program's report on Fuel Usage Factors in Highway and Bridge Construction (NCHRP 2013), as summarized in Table 2-11. Transport fuel use was estimated by scaling fuel usage assumptions produced by ICE.

Table 2-11. Fuel Use Factors Used to Estimate Emissions from Bridge Construction

Material	Fuel Use per Unit
Structural Steel	0.004 gal/lb
Reinforcing Steel	0.004 gal/lb
4 ksi Concrete	4.70 gal/cf
=>5 ksi Concrete	4.15 gal/cf

gal/cf = gallons per cubic foot, gal/lb = gallons per pound, ksi = kilopound force per square inch

2.4.4 Climate Change Effects

The Climate Change Technical Report outlines the context of the IBR Program as it may affect, and be affected by, climate change. The Climate Change Technical Report evaluates climate change by incorporating draft guidance from the Council on Environmental Quality and addressing adaptation and resiliency considerations.

2.5 Coordination

The methods described in this chapter were developed in coordination with ODOT, WSDOT, DEQ, and Ecology.

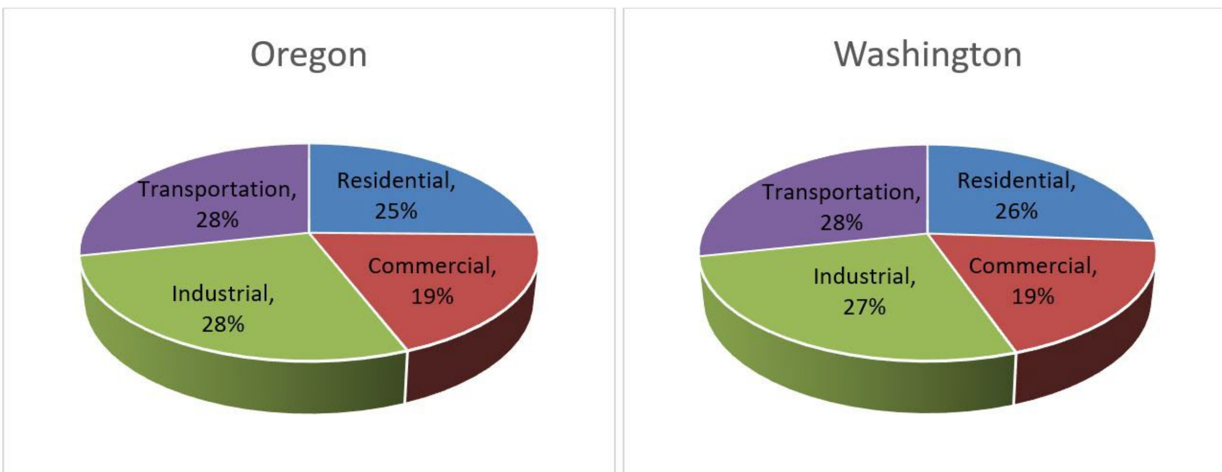
3. AFFECTED ENVIRONMENT

This chapter describes existing energy consumption and associated GHG conditions and trends in the study area that may be affected by or benefit from the Modified LPA.

3.1 Energy Consumption Trends

Transportation accounts for a major portion of the energy consumed in Oregon and Washington—approximately 28% for both states (Figure 3-1). Petroleum (e.g., gasoline, diesel fuel, and jet fuel) was the predominant source of transportation-related energy consumption in Oregon and Washington in 2020, at approximately 98% for each state (EIA 2022). Natural gas and electric vehicles accounted for the remaining 2% of transportation energy consumption.

Figure 3-1. State Energy Consumption by End-Use Sector, 2020



Source: EIA 2022

Oregon ranks number 29 of the 50 states in transportation energy consumption, with 279 trillion British thermal units (Btu) of transportation energy consumed in 2020 (EIA 2022). Washington ranks number 18, with 505 trillion Btu of transportation energy consumed. In comparison, Texas ranks first, with the consumption of approximately 2,840 trillion Btu of transportation energy in 2020.

On a per-capita basis, Oregon ranks number 35 of the 50 states in transportation energy consumption, at approximately 65.8 million Btu consumed per capita in 2020. Washington ranks number 38, with approximately 65.4 million Btu consumed per capita in 2020. In comparison, Alaska ranks first, at 224.7 million Btu of transportation energy consumed per capita in 2020.

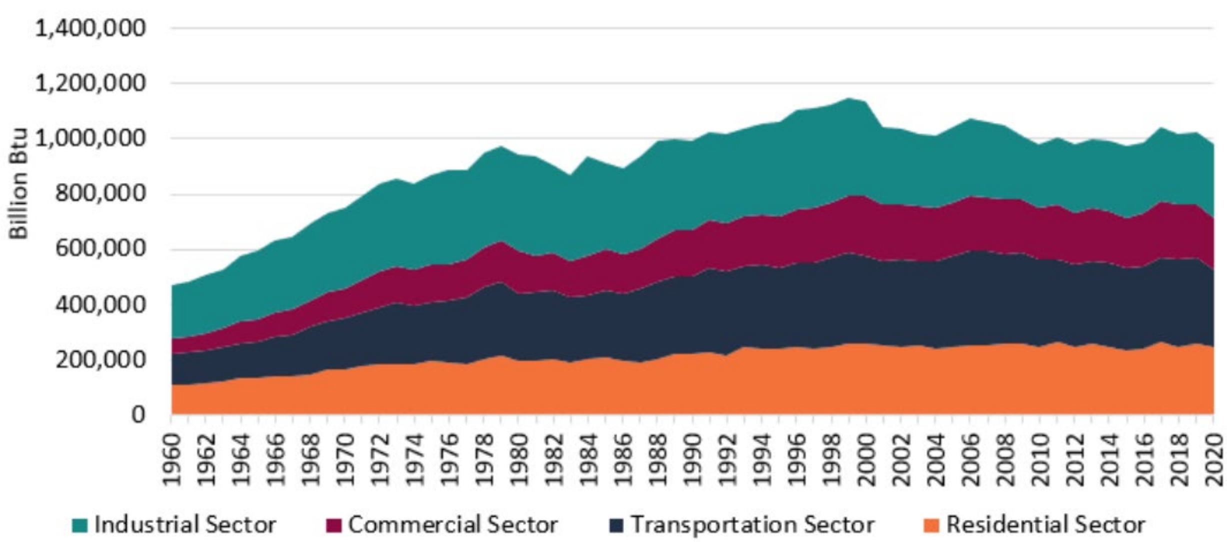
3.2 Greenhouse Gas Emissions Trends

During their operation, vehicles that run on fossil fuels emit a variety of gases, some of which are GHGs. There are also indirect GHG emissions associated with the production and transportation of these fossil fuels. Vehicles that run on electricity do not directly emit GHGs while in operation, but there are indirect emissions of GHGs from the production of electricity needed to power vehicles such as electric cars and light-rail.

The GHGs associated with the transportation sector are carbon dioxide, methane, and nitrous oxide, and they are often reported as CO_2e. CO_2e is a unit that provides a common scale for measuring the climate-related effects of different gases based on their global warming potential. GHG concentrations are not routinely measured at air pollutant monitors. However, agencies, companies, and individuals can calculate their emissions of GHG to monitor their contribution to global GHG levels. GHG emissions are usually estimated based on indicators with readily available data, such as fuel and energy consumption, which allows analysts to add up emissions estimates of different gases (e.g., to compile a national GHG inventory) and allows policymakers to compare emissions reduction opportunities across sectors and gases.

The Oregon Department of Energy delivers a report to the state Legislature every two years to educate and inform legislators and the public about current critical climate facts, policies, and strategies. The most recent report indicates that transportation (including highway, rail, and air transport) is the greatest contributor to GHG emissions in Oregon, followed by the residential and commercial sectors (Oregon Department of Energy 2022). Figure 3-2 summarizes Oregon's GHG emissions trends through 2020.

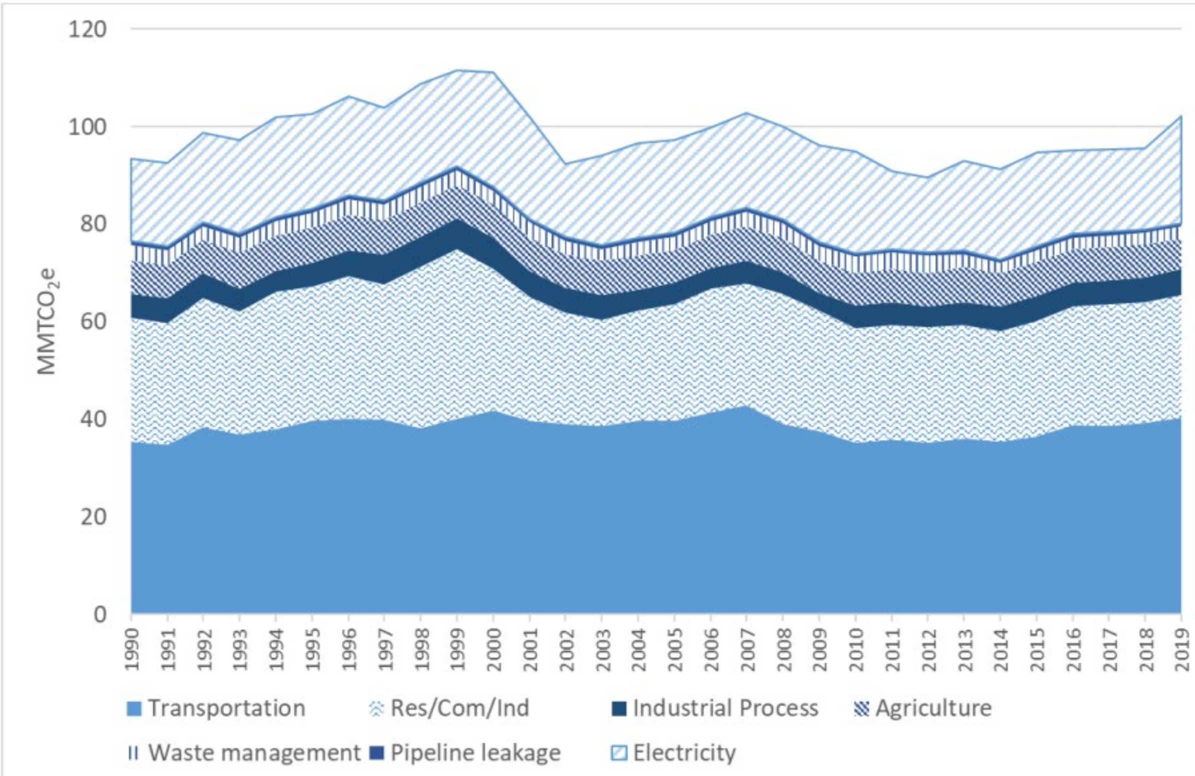
Figure 3-2. Oregon Greenhouse Gas Emissions Trends by End-Use Sector



Source: Oregon Department of Energy 2022

Ecology publishes an inventory of Washington's GHG emissions every two years, measuring the state's progress in reducing GHGs compared to a 1990 baseline. This inventory helps Ecology design policies to reduce GHG emissions and track progress toward meeting the state's reduction goals. The inventory is based on data from a variety of sources, such as the EPA and the U.S. Energy Information Administration (EIA). Figure 3-3 shows that transportation is the greatest contributor to GHG emissions in Washington and that GHG emissions have been increasing across all sectors for the past few years.

Figure 3-3. Washington Greenhouse Gas Emissions Trends by End-Use Sector



Source: Ecology 2022

3.3 National Energy Demand Projections

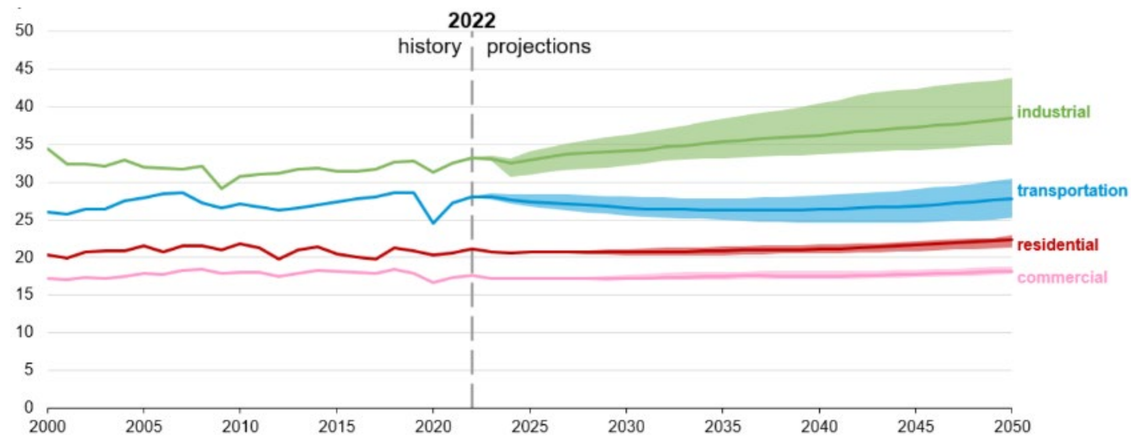
The national demand for energy depends on trends in population, economic activity, energy prices, and the adoption and implementation of technology.

The EIA collects, analyzes, and disseminates energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. The Annual Energy Outlook published in 2023 projects that energy consumption from light-duty vehicles will decline through the early 2040s as a result of fuel economy improvements, but will then rise due to increasing VMT for through 2050 (EIA 2023).

Projections in the Annual Energy Outlook focus on key factors driving longer-term demand for energy: growing economy and population; increasing use of renewables; increasing consumption of natural gas and electricity; and changing technology, behavior, and policy that affects energy efficiency in vehicles, end-use equipment, and lighting.

The EIA projects that energy consumption in the transportation sector will remain lower than its 2019 level through 2050 because travel greatly decreased in 2020 as a result of COVID-19 lockdowns and because assumed improvements in fuel economy offset projected resumed travel growth. Energy consumption by light- and heavy-duty vehicles is anticipated to remain lower than 2019 levels for the entire projection period. Efficiency improvements offset the consumption growth from light-duty vehicle travel growth through 2043 and partially offset the consumption growth from heavy-duty vehicle travel growth through 2036. Continued growth of on-road travel increases energy use later in the projection period because the travel demand for both light- and heavy-duty vehicles outpaces fuel economy improvements. The transportation sector includes air travel, which is projected to return to 2019 levels by 2030. Figure 3-4 shows the EIA projections for energy consumption by sector.

Figure 3-4. U.S. Energy Consumption by Sector, in Quadrillion British Thermal Units



Source: EIA 2023

4. OPERATIONAL EFFECTS

This chapter consists of two parts. The first part, Section 4.1, describes the change in operational energy consumed and GHG emissions between the No-Build Alternative and Modified LPA. For these alternatives, the operational effects are described at the regional level as annual emissions of CO_2e and annual energy use in million Btu.

The Modified LPA's operational effects on energy consumption and GHG emissions relate to the operations of the affected transportation facilities. Operations were analyzed for the vehicles using the roadway network, transit vehicles, and transit facilities. Data associated with transit and traffic operations were provided by the IBR Program team.

The second part, Section 4.24.1.4, discusses and evaluates two additional scenarios: the effects of collisions and the effects of bridge openings. These additional scenarios have localized impacts and are discussed qualitatively since neither condition is modeled at the regional scale.

4.1 No-Build Alternative and Modified LPA

This section describes the impacts from the No-Build Alternative and the Modified LPA in terms of roadway operations, transit operations, and ongoing maintenance of both roadway and transit facilities.

4.1.1 Roadway Operations

Estimated energy consumption and GHG emissions from vehicles using the roadway network are shown in Table 4-1. The results represent the contribution from vehicles using the roadway segments in the study area.

The results of the analysis showed that in 2045 conditions (No-Build Alternative or Modified LPA), energy consumption and GHG emissions are expected to be substantially lower than existing values for the region, which is consistent with national trends. Although the annual VMT in the study area would increase by 37% in 2045, energy consumption and GHG emissions would decrease substantially as compared to existing conditions, due to implementation of federal fuel and engine regulations, as described in Section 2.2.1.3. GHG emissions from the future conditions with the scenario that includes electric vehicles would be further reduced from the level of the existing conditions. The fuel cycle GHG emissions are higher under the 2045 Modified LPA than under the 2045 No-Build electric vehicle scenario because the 2045 Modified LPA includes GHG emissions associated with the production of electricity, as described in Section 2.4.2.1.

Under the scenarios that assume no electric vehicles and with electric vehicles, energy consumption and emissions would be similar under the No-Build Alternative and Modified LPA. The differences in energy consumption between the scenarios with and without electric vehicles would be approximately 18% because electric vehicles also require energy, but they shift the demand from petroleum to the electrical grid. The differences calculated by the MOVES model between the future 2045 emissions of the No-Build Alternative and the Modified LPA are less than 0.3%, which is not statistically meaningful. The extension of TriMet and C-TRAN service, tolling of the river crossing, and active transportation are helping to reduce the overall VMT from the added capacity associated with the Modified LPA. See the IBR Transportation Technical Report for more information. Additional information about the potential for induced demand is included in Chapter 6 of this report. There are no thresholds to determine the significance of energy consumption or GHG emissions.

To estimate the effects of the Modified LPA on a smaller scale, energy consumption and GHG emissions were also calculated using only traffic segments that are in the traffic assignment area shown in Table 4-2. The traffic assignment area is defined in the Transportation Technical Report as the area where the Modified LPA affects vehicle travel. At this scale, the future 2045 energy consumption and GHG emissions of the Modified LPA estimated to decrease by less than 0.3%, compared to the No-Build Alternative under the scenario that assumes no electric vehicles and the scenario with electric vehicles, which is also not a statistically meaningful difference.

Table 4-1. Daily Regional Energy Consumption and CO_2e Emissions

Parameter	Existing (2015)	No-Build (2045)	Modified LPA (2045)	Modified LPA Difference from No-Build (No EV Assumptions)	No-Build (2045) (with EV Assumptions)	Modified LPA (2045) (with EV Assumptions)	Modified LPA Difference from No-Build (with EV Assumptions)
Daily VMT [a]	43,017,600	59,042,000	58,950,700	-0.15%	59,042,000	58,950,700	-0.15%
Total Energy Consumption (mmBtu/day)	290,732	271,933	271,187	-0.27%	190,771	190,302	-0.25%
CO_2e Tailpipe Exhaust Emissions (MT CO_2e/day)	22,273	20,786	20,728	-0.28%	11,440	11,409	-0.26%
CO_2e Fuel Cycle Emissions[b] (MT CO_2e/day)	6,014	5,612	5,597	-0.28%	6,668	6,653	-0.22%
Total CO_2e Emissions (MT CO_2e/day)	28,286	26,398	26,325	-0.28%	18,108	18,063	-0.25%

Source: MOVES model output

a Daily VMT represents regional link-level data provided by the IBR transportation analysts for use for the MOVES analysis. The VMT used for the MOVES analysis could be slightly different from the Regional VMT reported in the Transportation Technical Report due to differences in the way VMT is allocated to specific roadway segments. Note that this daily VMT is different from that presented in the Air Quality Technical Report, which evaluates a specific roadway network.

b Fuel cycle emissions are from production and transport of fuels. Fuel cycle emissions from scenarios with EV assumptions are higher than scenarios with no EV assumptions because the upstream emissions from electricity production are higher than the upstream emissions from fossil fuel production.CO_2e = carbon dioxide equivalent; EV = electric vehicle; LPA = Locally Preferred Alternative; mmBtu/day = million British thermal units per day; MT = metric tons; VMT = vehicle miles traveled

Table 4-2. Daily Energy Consumption and CO_2e Emissions in Traffic Assignment Area

Parameter	Existing (2015)	No-Build (2045) (No EV Assumptions)	Modified LPA (2045) (No EV Assumptions)	Modified LPA Difference from No-Build (No EV Assumptions)	No-Build (2045) (with EV Assumptions)	Modified LPA (2045) (with EV Assumptions)	Modified LPA Difference from No-Build (with EV Assumptions)
Daily VMT	11,267,300	14,349,500	14,270,500	-0.55%	14,349,500	14,270,500	-0.55%
Total Energy Consumption (mmBtu/day)	76,557	67,466	66,704	-1.13%	47,863	47,380	-1.01%
CO_2e Exhaust Emissions (MT CO_2e /day)	5,864	5,160	5,102	-1.14%	2,886	2,854	-1.10%
CO_2e Fuel Cycle Emissions[a] (MT CO_2e /day)	1,583	1,393	1,377	-1.14%	1,644	1,630	-0.85%
Total CO_2e Emissions (MT CO_2e /day)	7,447	6,554	6,479	-1.14%	4,530	4,484	-1.01%

Source: MOVES model output

a Fuel cycle emissions are from production and transport of fuels. Fuel cycle emissions from scenarios with EV assumptions are higher than scenarios with no EV assumptions because the upstream emissions from electricity production are higher than the upstream emissions from fossil fuel production.

CO_2e = carbon dioxide equivalent; EV = electric vehicle; LPA = Locally Preferred Alternative; mmBtu/year = million British thermal units per year; MT = metric tons; VMT = vehicle miles traveled

4.1.2 Transit Operations

Table 4-3 summarizes the energy and GHG emissions due to electricity needs of increased transit vehicles, stations, and park-and-ride facilities with the Modified LPA. While no CO_2e would be emitted at the source of use, there would be CO_2e emissions associated with the production of electricity needed to provide power to electric light-rail vehicles and stations. The additional energy needs for new transit vehicles and new transit facilities are less than 6% of the energy consumption by on-road vehicles. There would also be electricity needs for lighting at park-and-ride facilities, but these emissions are not calculated by the FTA Transit GHG Estimator.

Table 4-3. Modified LPA Transit Operations Energy Consumption and CO_2e Emissions

Transit Element	Energy Consumption (mmBtu/year)	CO_2e Emissions (MT/year)
Light-Rail Vehicles	2,638	2,524
Transit Stations	1,146	129

Source: FTA Greenhouse Gas Emissions Estimator output (available in Appendix B)
CO_2e = carbon dioxide equivalent; LPA = Locally Preferred Alternative; mmBtu = million British thermal units; MT = metric tons

4.1.3 Roadway and Transit Maintenance

The impacts of routine maintenance for roadways, transit vehicles, and light-rail tracks were estimated for the Modified LPA. Roadway maintenance includes the emissions from vehicles performing routine maintenance activities such as sweeping, restriping, and landscaping. Table 4-4 summarizes the energy and GHG emissions from maintenance activities under the Modified LPA.

Table 4-4. Modified LPA Annualized Energy Consumption and CO_2e Emissions from Maintenance Activities

Project Element	Energy Consumption (mmBtu/year)	CO_2e Emissions (MT/year)
Annualized Value [a]	11,078	1,088

Source: ICE model output (available in Appendix A)
a Annualized value assumes a 30-year project life
CO_2e = carbon dioxide equivalent; LPA = Locally Preferred Alternative; mmBtu = million British thermal units; MT = metric tons

4.1.4 Design Options

For the Modified LPA's design options, this section discusses the potential change in energy consumption and GHG emissions from traffic operations. The potential change from construction activities is discussed in Section 5.1.1.

4.1.4.1 Two Auxiliary Lanes

As shown in Table 4-5, for the traffic assignment area the Modified LPA with two auxiliary lanes was evaluated using the same methodology as the Modified LPA with one auxiliary lane using the electric vehicle assumptions. Using the regional travel demand model this analysis of the long-term effects of the Modified LPA with two auxiliary lanes shows no statistical difference in energy use, GHG emissions, or pollutant emissions, compared to the Modified LPA with one auxiliary lane. There would be no additional impacts or benefits associated with this design option.

Table 4-5. Comparison of No-Build Alternative and the Modified LPA with One and Two Auxiliary Lanes Daily Energy Consumption and CO_2e Emissions in Traffic Assignment Area with Electric Vehicle Assumptions

Parameter	No-Build Alternative (2045)	Modified LPA with One Auxiliary Lane (2045)	Modified LPA with Two Auxiliary Lanes (2045)	Modified LPA with One Auxiliary Lane Difference from No-Build Alternative	Modified LPA with Two Auxiliary Lanes Difference from No-Build Alternative
Daily VMT	14,349,500	14,270,500	14,279,300	-0.55%	-0.49%
Total Energy Consumption (mmBtu/day)	47,863	47,380	47,371	-1.01%	-1.03%
CO_2e Exhaust Emissions (MT CO_2e/day)	2,886	2,854	2,853	-1.10%	-1.14%
CO_2e Fuel Cycle Emissions[a] (MT CO_2e/day)	1,644	1,630	1,630	-0.85%	-0.84%
Total CO_2e Emissions (MT CO_2e/day)	4,530	4,484	4,483	-1.01%	-1.03%

Source: MOVES model output

a Fuel cycle emissions are from production and transport of fuels. Fuel cycle emissions from scenarios with EV assumptions are higher than scenarios with no EV assumptions because the upstream emissions from electricity production are higher than the upstream emissions from fossil fuel production.

CO_2e = carbon dioxide equivalent; LPA = Locally Preferred Alternative; mmBtu/year = million British thermal units per year; MT = metric tons; VMT = vehicle miles traveled

As shown in Table 4-6, an additional analysis using operational model outputs for changes in speed and congestion on the I-5 corridor between No-Build Alternative, the Modified LPA with one auxiliary lane, and the Modified LPA with two auxiliary lanes was conducted to further refine the analysis of the Modified LPA with two auxiliary lanes in the traffic assignment area. The difference between the Modified LPA with one auxiliary lane and two auxiliary lanes would be less than 1%, which is not statistically meaningful. Comparing the Modified LPA with either one or two auxiliary lanes to the No-Build Alternative shows that reductions in GHG could be over 3% in the traffic assignment area. This refinement only reflects changes on the I-5 corridor and does not consider changes in the rest of the roadway network that could be affected.

Table 4-6. Comparison of No-Build Alternative and the Modified LPA with One and Two Auxiliary Lanes Daily Energy Consumption and CO_2e Emissions in Traffic Assignment Area with Electric Vehicle Assumptions and Refined I-5 Speeds

Parameter	No-Build Alternative (2045)	Modified LPA with One Auxiliary Lane (2045)	Modified LPA with Two Auxiliary Lanes (2045)	Modified LPA with One Auxiliary Lane Difference from No-Build Alternative	Modified LPA with Two Auxiliary Lane Difference from No-Build Alternative
Daily VMT	14,349,500	14,270,500	14,279,300	-0.55%	-0.49%
Total Energy Consumption (mmBtu/day)	48,969	47,744	47,545	-2.50%	-2.91%
CO_2e Exhaust Emissions (MT CO_2e/day)	2,966	2,880	2,866	-2.89%	-3.38%
CO_2e Fuel Cycle Emissions[a] (MT CO_2e/day)	1,666	1,637	1,634	-1.72%	-1.92%
Total CO_2e Emissions (MT CO_2e/day)	4,632	4,517	4,499	-2.47%	-2.86%

Source: MOVES model output

a Fuel cycle emissions are from production and transport of fuels. Fuel cycle emissions from scenarios with EV assumptions are higher than scenarios with no EV assumptions because the upstream emissions from electricity production are higher than the upstream emissions from fossil fuel production.

CO_2e = carbon dioxide equivalent; LPA = Locally Preferred Alternative; mmBtu/year = million British thermal units per year; MT = metric tons; VMT = vehicle miles traveled

4.1.4.2 Single-Level Fixed-Span Configuration

The Modified LPA with the single-level fixed-span configuration is similar to the Modified LPA with the double-deck fixed-span configuration, except that there would be fewer operational emissions due to the reduced profile grade of the single-level configuration (approximately 29 feet lower height).

4.1.4.3 Single-Level Movable-Span Configuration

The Modified LPA with the single-level movable-span configuration would be similar to the Modified LPA with the single-level fixed-span configuration, except:

- Increased air quality pollutant and GHG emissions due to vehicular idling during bridge openings, similar to the No-Build Alternative.
- Increased energy consumption and GHG emissions due to the electricity required to raise and lower the bridge, similar to the No-Build Alternative.

4.1.4.4 Interstate 5 Mainline Westward Shift

The Modified LPA with the westward shift of the I-5 mainline would have the same long-term effects on energy and GHG emissions as the Modified LPA with the centered I-5 mainline; there would be no additional impacts or benefits.

4.1.4.5 State Route 14 Interchange without Interstate 5 C Street Ramps

The Modified LPA without the C Street ramps at the I-5 and SR 14 interchange would result in additional congestion on local streets, which would result in 12 intersections not meeting acceptable operation criteria, compared to 10 intersections for the Modified LPA. This additional congestion and idling without the C Street ramps would decrease vehicle efficiency, which could result in increased energy consumption compared to the Modified LPA. Because this analysis is based on the regional travel demand model, this potential increase in energy consumption is not quantified.

4.1.4.6 Park and Rides

All of the park-and-ride site options could equally encourage transit use, which would generally have a beneficial effect on energy and GHG emissions and were accounted for in the regional travel demand model and reflected in the energy consumption modeling results for the Modified LPA. The design options for park-and-ride locations in downtown Vancouver would have the same discussion of long-term effects on energy and GHG emissions as the Modified LPA.

4.2 Additional Impact Considerations

This section describes the effects of two additional considerations based on other aspects of the Modified LPA that could affect operational energy consumption and CO_2e emissions: changes in highway safety (reduction in vehicle crashes) and the elimination of bridge openings. These additional considerations cannot be readily incorporated into the above estimates of energy consumption and CO_2e emissions. They are not modeled at the regional scale, but they can be qualitatively addressed at the local scale.

4.2.1 Long-Term Effects of Collisions

The Transportation Technical Report provides a list of existing deficiencies in highway geometries. Under the No-Build Alternative, increased congestion would exacerbate existing safety concerns and the frequency of collisions would likely increase. An increase in the frequency of collisions translates to slower operating speeds and increased energy consumption and CO_2e emissions.

Under the Modified LPA, the existing highway geometry deficiencies would be mitigated by adhering to current design standards, and the level of congestion would decrease, which would likely reduce the frequency of collisions. Also, the provision of shoulders for maintenance and emergency use during traffic incidents would reduce congestion and idling in the event of collisions. Reducing the frequency of collisions and providing shoulders for maintenance and emergency use during traffic incidents would also reduce energy consumption and CO_2e emissions compared to the No-Build Alternative.

It is difficult to quantify the effects of reducing collision frequencies associated with the Modified LPA for two primary reasons. First, there is no accepted industry-wide collision forecasting methodology. Second, each collision possesses a distinct set of characteristics that make it unique, difficult to model, and not representative of typical conditions. For example, the location, lane, duration/ clearance time, and time of day are some of the many characteristics that would greatly affect how the I-5 mainline operates and the effects on energy consumption and CO_2e emissions.

Collisions cannot be quantified with accuracy; however, as discussed in the Transportation Technical Report, the Modified LPA is expected to result in fewer collisions as a result of better operations and removal of existing design deficiencies compared to the No-Build Alternative, and, in turn, the operational energy consumption and CO_2e emissions would also be reduced.

4.2.2 Long-Term Effects of Bridge Openings

The existing Interstate Bridges between Vancouver and Portland have a relatively low vertical clearance, and bridge openings are required for some maritime traffic passage. Under the No-Build Alternative, the Interstate Bridges would not be replaced and bridge openings would continue to be required. Under the Modified LPA with the double-deck fixed-span and single-level fixed-span configurations, the existing Interstate Bridge would be replaced with a structure with higher vertical clearance that does not require bridge openings. Under the Modified LPA with the single-level movable-span configuration bridge openings would continue similar to the No-Build Alternative.

Historical bridge opening data are available from January 2015 through December 2019. During this five-year period, there was an average of 260 bridge openings per year. The duration of a bridge opening ranged from 5 to 30 minutes, with an average of 12 minutes per lift. The number of vehicles affected depends on the time of day, ranging from about 200 vehicles during nighttime hours to more than 8,000 vehicles for openings occurring at midday or in the evening. Consequently, the estimated vehicle queues caused by bridge openings ranged between 0.25 and 5 miles in both the northbound and southbound directions of I-5.

Vehicles delayed by a bridge opening can produce emissions while they are idling. While there is no standard methodology to estimate how many vehicles idle and how many drivers turn off their engines, it is expected that at least a portion of drivers on the highway leave their vehicles idling during a bridge opening. To assume that all vehicles are idling would be a great overestimation because many modern vehicles have a start-stop system that automatically stops the engine when the vehicle is stationary. ODOT and WSDOT have installed signage requesting that drivers turn off their engines while idling during a bridge opening to promote cleaner air quality.

Therefore, the Modified LPA with the double-deck fixed-span and single-level fixed-span configurations would result in lower energy consumption and GHG emissions from eliminating the need for bridge openings.

5. CONSTRUCTION EFFECTS

This estimate of energy use and GHG emissions for construction associated with the Modified LPA was developed based on data provided by the IBR Program team, as described in Section 2.4.3.

In addition to the analysis provided, the IBR Program is considering certification through a sustainability rating system (Envision) to evaluate the sustainability of construction-related choices and activities. As the Program progresses through the NEPA phase and into final design and construction contracting, the sustainability rating system assessment would be able to provide increasingly detailed analysis of the potential benefits and costs of such choices, with the intent of identifying feasible ways to reduce GHG emissions associated with construction materials, means, and methods. See Section 7.1 of the Climate Change Technical Report for more information.

5.1 Impacts from the No-Build Alternative and Modified LPA

The No-Build Alternative does not include construction that addresses the purpose and need of the IBR Program. Accordingly, there are no definable construction effects on energy consumption or GHG emissions associated with the No-Build Alternative.

While there is no construction proposed under the No-Build Alternative, it would be inaccurate to state that the No-Build Alternative would have no construction-related energy requirements or GHG emissions. For example, potholes may need filling, the I-5 bridge deck would likely need to be resurfaced and striped, and additional local capacity improvements may be needed to alleviate congestion along the I-5 mainline. While improvements such as these would be likely under the No-Build Alternative, cost estimates are outside the purview of this analysis, and therefore quantifiable energy consumption and GHG emissions cannot be calculated.

Construction impacts to energy consumption and GHG emissions from all elements of the Modified LPA except for the Columbia River bridge crossing are provided in Table 5-1. These values represent the sum of the total impacts over the construction period.

Table 5-1. Modified LPA Energy Consumption and CO_2e Emissions from Construction Activities – Excluding Bridge Structure

Project Element	Total Energy Consumption [a] (mmBtu)	Total CO_2e Emissions [a] (MT)
Materials	2,072,993	299,518
Transportation	102,549	10,045
Construction	188,086	18,423
Total	**2,363,628**	**327,986**

Source: ICE model output (available in Appendix A)

a Values calculated from the Federal Highway Administration’s Infrastructure Carbon Estimator Model

CO_2e = carbon dioxide equivalent; LPA = Locally Preferred Alternative; mmBtu = million British thermal units; MT = metric tons

Construction impacts to energy consumption and GHG emissions specific to the Columbia River bridges are provided in Table 5-2. These values represent the sum of the total impacts over the construction period. A high and low range of total emissions are provided to disclose the uncertainty associated with final bridge design and specific construction materials, as described in Section 2.4.3.2.

Table 5-2. Modified LPA Energy Consumption and CO_2e Emissions from Construction Activities – Bridge Structure Only

Project Element	Total Energy Consumption [a] (mmBtu)	Total CO_2e Emissions - Low [b] (MT)	Total CO_2e Emissions - High [b] (MT)
Materials	171,699	70,100	121,373
Transportation	5,245	2,351	4,070
Construction	60,445	12,190	16,015
Total	**237,389**	**84,641**	**141,459**

Source: Material quantity and EPD calculations (available in Appendix C)

a Values calculated from the Federal Highway Administration's Infrastructure Carbon Estimator Model

b Materials and Construction values calculated based on material quantity estimates, environmental product declarations, and fuel usage factors.

CO_2e = carbon dioxide equivalent; LPA = Locally Preferred Alternative; mmBtu = million British thermal units; MT = metric tons

The total project impacts are summarized in Table 5-3.

Table 5-3. Modified LPA Energy Consumption and CO_2e Emissions from All Construction Activities

Project Element	Total Energy Consumption [a] (mmBtu)	Total CO_2e Emissions - Low [b] (MT)	Total CO_2e Emissions - High [b] (MT)
Materials	2,244,692	369,618	420,891
Transportation	107,794	12,395	14,115
Construction	248,531	30,613	34,438
Total	**2,601,017**	**412,627**	**469,444**

Source: Material quantity and EPD calculations (available in Appendix C)

a Values calculated from the Federal Highway Administration's Infrastructure Carbon Estimator Model

b Materials and Construction values calculated based on material quantity estimates, environmental product declarations, and fuel usage factors.

CO_2e = carbon dioxide equivalent; LPA = Locally Preferred Alternative; mmBtu = million British thermal units; MT = metric tons

Construction of the Modified LPA is anticipated to last 9 to 15 years, impacting all modes of transportation within the study area as well as adjacent corridors. The Modified LPA could require nighttime closure of regional roadways, interchanges, and local roads during construction. Construction-related truck traffic for delivery of materials, equipment and for removal of materials/debris from demolition could also increase congestion and delays, particularly during periods of major construction. Closures during construction of the Modified LPA could temporarily affect transit operations and/or access to transit within the study area, sidewalks, bicycle facilities, and/or shared-use paths. Increased congestion due to temporary closures of roadways, transit facilities, and active transportation facilities could result in elevated vehicle emissions of CO2e. Closures would be limited to off-peak hours to minimize impacts to regional during peak travel periods.

5.1.1 Design Options

For the Modified LPA design options, this section describes the potential change in energy consumption from GHG emissions from construction activities. While it is expected that certain design options would require a greater volume of materials (e.g. the single-level movable-span configuration), and that a greater volume of materials would contribute more GHG emissions, design data to determine the material volumes would not be available until the final design process. GHG emissions from construction of the Modified LPA are presented in Table 5-2 as a range to reflect the uncertainty associated with construction material quantities for a single-level fixed-span bridge configuration. Material quantities required for the double-deck fixed-span configuration are most likely captured by this same range. The single-level moveable-span configuration would require a greater volume of materials, which would contribute more GHG emissions. Design data to determine volumes for a movable-span configuration would not be available until the final design process.

Emissions and energy consumption were estimated for the Modified LPA using the ICE planning-level model, which does not have the granularity to differentiate between the design options associated with roadway configurations. Estimates could be refined by using material quantity data similar to the bridge construction analysis, which would not be available until the final design process.

6. INDIRECT EFFECTS

The results presented in Table 4-1 and Table 4-2 include the indirect fuel cycle impacts that the Modified LPA would have on GHG emissions. Fuel cycle impacts result from the production and transport of purchased fuel and purchased electricity, which are considered in addition to tailpipe emissions. In addition, the energy and GHG analysis of the Modified LPA is based on travel demand modeling that includes expected growth and planned projects in the region. The Modified LPA is not expected to create other effects that would cause indirect impacts to energy use and GHG emissions.

The energy analysis of the Modified LPA is based on travel demand modeling that includes expected growth and planned projects in the region, including growth facilitated by the Modified LPA consistent with local and regional land use plans (see the Land Use Technical Report). The Modified LPA is not expected to create other effects that would cause indirect impacts to energy use and GHG emissions. Energy consumption could be affected by induced changes in patterns of land use, population density, or population growth. Land use changes would be expected to occur in compliance with local land use plans. The Land Use Technical Report evaluates the potential for induced land use growth associated with the Modified LPA.

7. MITIGATION

7.1 Long-Term Effects

7.1.1 Regulatory Requirements

State-level legislation and policy in Oregon and Washington support reducing emissions from transportation to minimize contributions to climate change; however, there are no specific requirements for mitigation in federal, state, or local regulations. The Program supports state, regional, and local goals to reduce GHG emissions. To help facilitate a shift from single-occupancy vehicles, the Program would improve and add multimodal transportation options, including:

- Extended light-rail
- Expanded active transportation facilities
- Demand management (e.g., variable-rate tolling)
- Operation and maintenance efficiencies

7.1.2 Program-Specific Mitigation

- Use energy-efficient electrical systems for transit stations and other electrical needs to decrease energy consumption.

7.2 Construction Effects

7.2.1 Regulatory Requirements

- In Oregon, comply with ODOT Standard Specifications Section 290.
- In Washington, company with WSDOT Standard Specifications Division 1-07.

7.2.2 Program-Specific Mitigation

- All work in Washington and Oregon will follow the WSDOT Environmental Manual, Chapter 425: Air Quality, Energy, and Greenhouse Bases, including:
    - Minimize delays to traffic during peak travel times.
    - Minimize unnecessary idling of on-site diesel construction equipment.
    - Educate vehicle operators to shut off equipment when not in active use to reduce emissions from idling.
    - Prepare a traffic control plan with detours and strategic construction timing (e.g., night work) to move traffic through the area and reduce backups and delays to the traveling public to the extent practicable.
- Continue to consider advances in energy-reducing and/or energy-saving materials and methods.

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APPENDIX A. INFRASTRUCTURE CARBON ESTIMATOR OUTPUT

	Annualized Energy Use		
	mmBTU	mmBTU	mmBTU
	Baseline	BAU	Mitigated
Materials	74,692	74,692	74,692
Transportation	3,589	3,589	3,589
Construction	8,248	8,248	8,248
O&M	11,078	11,078	11,078
Total	**97,607**	**97,607**	**97,607**

Highlighted value represents maintenance energy consumption

	Annualized Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	10,699	10,699	10,699
Transportation	352	352	352
Construction	808	808	808
O&M	1,088	1,088	1,088
Total	**12,946**	**12,946**	**12,946**

Highlighted value indicates GHG emissions from maintenance activites

	Total Energy Use		
	mmBTU	mmBTU	mmBTU
	Baseline	BAU	Mitigated
Materials	2,072,993	2,072,993	2,072,993
Transportation	102,549	102,549	102,549
Construction	188,086	188,086	188,086
O&M	332,346	332,346	332,346
Total	**2,695,974**	**2,695,974**	**2,695,974**

Highlighted values indicated total energy use from construction activities of all project elements except bridge

	Total Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	299,518	299,518	299,518
Transportation	10,045	10,045	10,045
Construction	18,423	18,423	18,423
O&M	32,642	32,642	32,642
Total	**360,628**	**360,628**	**360,628**

Highlighted values indicated GHG emissions during construction activities of all project elements except bridge

	Total Energy Use		
	mmBTU	mmBTU	mmBTU
	Baseline	BAU	Mitigated
Materials	171,699	171,699	171,699
Transportation	5,245	5,245	5,245
Construction	60,445	60,445	60,445
Total	**237,389**	**237,389**	**237,389**

Highlighted values indicate total energy use from construction of the bridge over the Columbia River

APPENDIX B. FEDERAL TRANSIT ADMINISTRATION GREENHOUSE GAS ESTIMATOR OUTPUT

Baseline Energy Use and GHG Emissions

Material Energy Use and Emissions		Energy use (mmBTU)	GHG emissions (MT CO2e)
Aggregate		82,893	4,381
Bitumen (Asphalt Binder)		45	4
Cement		1,240,463	231,197
Steel		484,492	34,164
Water		470	63
Total		1,808,362	269,810

Materials Transportation		Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)		79,934	7,830
Total		79,934	7,830

Construction Process		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		-	-
Construction fuel (DGEs)		42,628	4,175
Total		42,628	4,175

Operations and Maintenance		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		-	-
Maintenance fuel (DGEs)		10,990	1,076
Water		-	-
Total		10,990	1,076

APPENDIX C. MATERIAL QUANTITY CALCULATIONS

Construction GHG Estimates

6/13/2024

	MTCO2e from Project excluding Bridge	MTCO2e from Bridge Structure Method	MTCO2e from Bridge Structure Value - low	MTCO2e from Bridge Structure Value - high	MTCO2e Project Total - ICE (excluding bridge) plus EPD bridge - LOW	MTCO2e Project Total - ICE (excluding bridge) plus EPD bridge - HIGH	
Materials	299,518	Replace with material quantity and EPD method	70,100	121,373	369,618	420,891	
Transportation	10,045	Scale from ICE	2,351	4,070	12,395	14,115	* scaled from ICE outputs
Construction	18,423	Estimate based on NCHRP fuel use factors	12,190	16,015	30,613	34,438	* Lifecycle emissions; assumes B5 Diesel (5% biofuel)
Subtotal	**327,986**		**84,641**	**141,459**	**412,627**	**469,444**	
O&M	32,642	N/A no change	-	-	32,642	32,642	
Total	**360,628**	-	**84,641**	**141,459**	**445,269**	**502,087**	

Bridge Quantity and Fuel GHG

Summary of Quantities

	Structural Steel	Reinforcing Steel	4 ksi Concrete	=>5 ksi Concrete
Steel Truss	39,470 TON	9,024 TON	51,243 CY	71,016 CY
Steel Plate Girder	43,975 TON	13,005 TON	70,596 CY	77,324 CY
Concrete Segmental	18,539 TON	14,716 TON	66,268 CY	120,366 CY
Extrados	21,549 TON	19,428 TON	66,666 CY	137,858 CY

	High Emissions Estimate MT CO_2e						
Crossing Structure	Structural Steel	Reinforcing Steel	4 ksi Concrete	=>5 ksi Concrete	Total		% difference from max
Steel Truss	71,156	7,522	10,418	15,524	104,620		-14%
Steel Plate Girder	79,278	10,841	14,352	16,903	121,373		0%
Concrete Segmental	33,423	12,267	13,472	26,312	85,474		-30%
Extrados	38,849	17,260	13,553	30,136	99,798		-18%

	Low Emissions Estimate MT CO_2e						
Crossing Structure	Structural Steel	Reinforcing Steel	4 ksi Concrete	=>5 ksi Concrete	Total	absolute difference from max	% difference from max
Steel Truss	49,677	6,264	9,388	14,402	79,731	(13,258)	-14%
Steel Plate Girder	55,347	9,028	12,933	15,681	92,989	-	0%
Concrete Segmental	23,334	10,216	12,140	24,410	70,100	(22,889)	-25%
Extrados	27,122	14,374	12,213	27,958	81,666	(11,322)	-12%

	National Average Estimate MT CO_2e						
Crossing Structure	Structural Steel	Reinforcing Steel	4 ksi Concrete	=>5 ksi Concrete	Total		% difference from max
Steel Truss	63,384	6,893	10,287	15,041	95,606	(15,496)	-14%
Steel Plate Girder	70,619	9,934	14,172	16,377	111,102	-	0%
Concrete Segmental	29,772	11,242	13,303	25,493	79,811	(31,292)	-28%
Extrados	34,606	14,841	13,383	29,198	92,028	(19,074)	-17%

Fuel Emission Factor	kg CO2e/gal	
R99 (see note)	5.06	used for below, based on Oregon Clean Fuels Forecast, Dec 2023
Standard diesel	13.2	B5 Diesel, 2023

	Fuel usage estimates (NCHRP factors)					Total Emissions	
Crossing Structure	Structural Steel	Reinforcing Steel	4 ksi Concrete	=>5 ksi Concrete	Total Gallons	With R99 Emission Factor	With B5 Diesel
Steel Truss	315,758	72,191	240,842	294,716	923,507	4,672.95	12,190.29
Steel Plate Girder	351,797	104,037	331,801	320,893	1,108,528	5,609.15	14,632.57
Concrete Segmental	148,315	117,728	311,460	499,517	1,077,020	5,449.72	14,216.67
Extrados	172,392	155,422	313,330	572,112	1,213,256	6,139.07	16,014.98

R99 notes: City of Portland will require R99 at all pumps by 2030; phase in began in 2024

https://www.portland.gov/bps/climate-action/renewable-fuel-standard/documents/proposed-rfs-administrative-rules/download
https://www.portland.gov/bps/climate-action/renewable-fuel-standard

Embodied Carbon Emission Factors

All structural steel is assumed to be plate. Reinforcing steel is assumed to be rebar (60 psi). 4 ksi concrete is assumed to have no other limitations and =>5 ksi concrete is assumed to be 5 ksi

All data is from EC3, Oregon and Washington specific
Assumptions are kept to a minimum, except where specified

	Structural Steel-Plate per lb	Steel Cables--Reinforcing steel 275 psi	Reinforcing Steel 60 psi per lb	4 ksi Concrete per 1yd3	=>5 ksi Concrete per 1 yd3	
High	0.9014	0.4168	0.4168	203.3	218.6	
Low	0.6293	0.3471	0.3471	183.2	202.8	
National Average	0.80295	0.38195	0.38195	200.75	211.8	shown for reference, used WA/OR numbers in calculations
High	1.018	0.4168	0.4168	218	220.4	shown for reference, used WA/OR numbers in calculations
Low	0.5879	0.3471	0.3471	183.5	203.2	shown for reference, used WA/OR numbers in calculations

Fuel Usage	**Value**	**Units**
Steel	0.004	gal/lb
Substructure (4ksi)	4.7	gal/cf
Superstructure (>5ksi)	4.15	gal/cf

From NCHRP study, exhibit 3-25

Exhibit 3-25. Structures fuel use per unit.

Task Description	Fuel Use Per Unit	Units
Reinforcing Steel	0.004	Gallons/L.B.
Steel Beams	0.180	Gallons/L.F.
Substructure Concrete	4.700	Gallons/C.Y.
Superstructure Concrete	4.150	Gallons/C.Y.