FINAL

Climate Change Technical Report

I-5 Rose Quarter Improvement Project

Oregon Department of Transportation

January 8, 2019

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Appendices

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[1] Appendix D includes written descriptions of all figures referenced in this Technical Report. If needed, additional figure interpretation is available from the ODOT Senior Environmental Project Manager at (503) 731-4804.

Acronyms and Abbreviations

API	Area of Potential Impact
CAP	Climate Action Plan
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
EB	eastbound
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
GHG	greenhouse gas
I-405	Interstate 405
I-5	Interstate 5
I-84	Interstate 84
ICE	Infrastructure Carbon Estimator
MOVES	Mobile Vehicle Emission Simulator
MT	metric tons
mvmt	million vehicle miles travelled
N_2O	nitrous oxide
NB	northbound
NEPA	National Environmental Policy Act
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
OSTI	Oregon Sustainable Transportation Initiative
RTP	*Regional Transportation Plan*
SAC	Stakeholder Advisory Committee
SB	southbound
SPIS	Safety Priority Index System
WB	westbound

Executive Summary

The I-5 Rose Quarter Improvement Project (Project) is located in Portland, Oregon, along the 1.7-mile segment of Interstate 5 (I-5) between Interstate 405 (I-405) to the north and Interstate 84 (I-84) to the south. The Project also includes the interchange of I-5 and N Broadway and NE Weidler Street (Broadway/Weidler interchange) and the surrounding transportation network, from approximately N/NE Hancock Street to the north, N Benton Avenue to the west, N/NE Multnomah Street to the south, and NE 2nd Avenue to the east. The purpose of the Project is to improve the safety and operations on I-5 between I-405 and I-84, the Broadway/Weidler interchange, and adjacent surface streets in the vicinity of the Broadway/Weidler interchange. In achieving the purpose, the Project would also support improved local connectivity and multimodal access in the vicinity of the Broadway/Weidler interchange.

This *Climate Change Technical Report* analyzes possible climate change impacts that could result from the Project in terms of potential increases in GHG emissions. This is done by comparing existing conditions (2017) to the potential emission changes for no action (No-Build Alternative) and the proposed action (Build Alternative) for design year 2045. The Area of Potential Impact for this analysis is the same as the Project Area plus roadways in the Project Area meeting specific criteria for inclusion in the analysis.

Efforts to affect climate change typically occur programmatically at national, state, or regional levels as opposed to the project level and are based on regulations that control emissions at a much broader level and focus on planning efforts to affect greenhouse gas (GHG) emissions reductions. GHG emissions contribute to global climate change. There are no regulations that control Project-level GHG emissions for transportation projects.

Although GHG reduction actions are generally regulated, planned, and implemented at a larger scale than project level, a Project-level analysis was completed to provide information to the public and decision-makers regarding the GHG emissions for the Project. Emission sources addressed in the analysis include operational (tailpipe), construction, and maintenance activities. The methods used in this analysis included indirect, direct, and cumulative effects by using life-cycle emissions estimation methods appropriate to project-level analysis.

Figure ES-1 shows the estimated regional transportation system GHG emissions in comparison to the future 2045 No-Build and Build Alternative emissions in the Project Area. The GHG emissions from the Build Alternative are below levels from the No-Build Alternative and would not increase global or regional GHG emissions in a meaningful way.

Figure ES-1. Projected Regional GHG Emissions

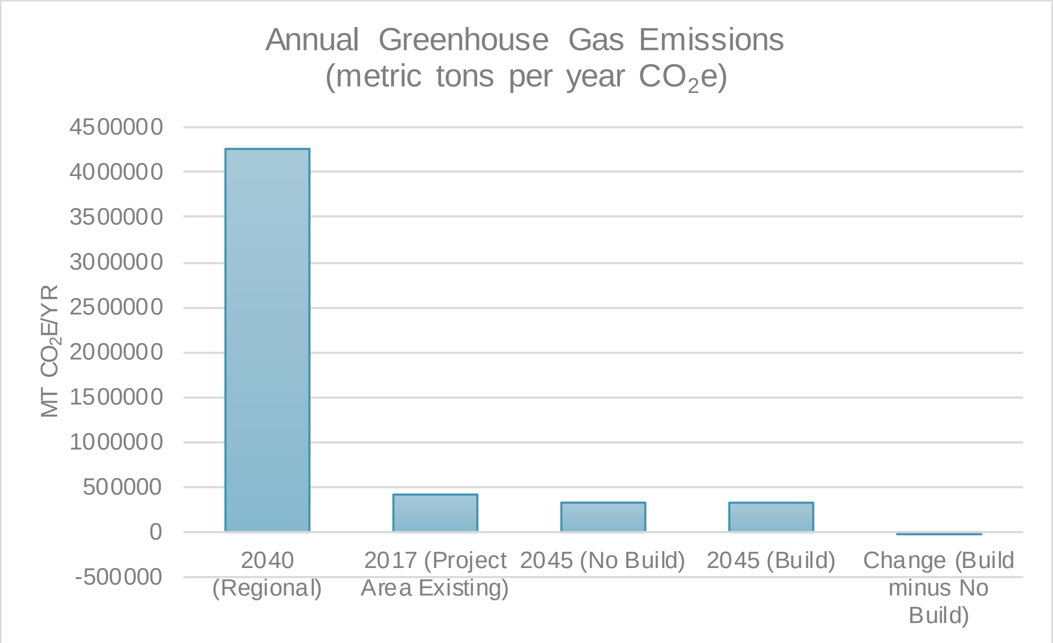

Table ES-1 shows GHG emissions estimates for 2017 existing conditions and for future (2045) No-Build and Build Alternatives. The data in Table ES-1 show relatively large decreases in GHG emissions over time (an approximate 22 percent decrease) and a small decrease in emissions from the No-Build to the Build Alternative.

Table ES-1. GHG (MT CO_2e per year)

Source	2017 (CO2e)	2045 No-Build (CO2e)	2045 Build (CO2e)
Tailpipe	417,156	327,536	326,762
Fuel Cycle	112,632	88,435	88,226
Construction and Maintenance		134	175
Total	529,788	416,105	415,163

Notes: CO_2e = carbon dioxide equivalent; MT = metric tons. The construction schedule assumes dates of construction 2023–2027.

Global climate change is the cumulative result of numerous emissions sources contributing to global atmospheric GHG concentrations. There is presently no recognized scientific methodology for attributing specific climatological changes to the emissions resulting from a specific transportation project.

Additionally, the large decreases in emissions from existing to future year show the more meaningful effects of changes in vehicle emissions because of federal, state, and local efforts to develop more stringent fuel economy standards, improve inspection and maintenance programs, and transition to cleaner, low-carbon fuels for motor vehicles. These programmatic reductions far outweigh differences attributable to the Build Alternative relative to the No-Build Alternative.

Statewide, climate change is expected to cause extreme heat and precipitation events to occur more frequently. Expected climate change effects identified for the Willamette Valley include declining snowpack, earlier snowmelt, and greater summer water demand. These effects are anticipated to create potential issues from water scarcity and wildfires. Water scarcity and wildfires are not expected to affect the Project directly. Although Project-level resilience could be affected by increased stormwater runoff at facilities (due to increase in storm intensity or duration), this analysis does not address design planning elements pertaining to resiliency.

1 Introduction

1.1 Project Location

The I-5 Rose Quarter Improvement Project (Project) is located in Portland, Oregon, along the 1.7-mile segment of Interstate 5 (I-5) between Interstate 405 (I-405) to the north (milepost 303.2) and Interstate 84 (I-84) to the south (milepost 301.5). The Project also includes the interchange of I-5 and N Broadway and NE Weidler Street (Broadway/Weidler interchange) and the surrounding transportation network, from approximately N/NE Hancock Street to the north, N Benton Avenue to the west, N/NE Multnomah Street to the south, and NE 2nd Avenue to the east.

Figure 1 illustrates the Project Area in which the proposed improvements are located. The Project Area represents the estimated area within which improvements are proposed, including where permanent modifications to adjacent parcels may occur and where potential temporary impacts from construction activities could result.

1.2 Project Purpose

The purpose of the Project is to improve the safety and operations on I-5 between I-405 and I-84, of the Broadway/Weidler interchange, and on adjacent surface streets in the vicinity of the Broadway/Weidler interchange and to enhance multimodal facilities in the Project Area.

In achieving the purpose, the Project would also support improved local connectivity and multimodal access in the vicinity of the Broadway/Weidler interchange and improve multimodal connections between neighborhoods located east and west of I-5.

1.3 Project Need

The Project would address the following primary needs:

- **I-5 Safety:** I-5 between I-405 and I-84 has the highest crash rate on urban interstates in Oregon. Crash data from 2011 to 2015 indicate that I-5 between I-84 and the merge point from the N Broadway ramp on to I-5 had a crash rate (for all types of crashes[2]) that was approximately 3.5 times higher than the statewide average for comparable urban interstate facilities (ODOT 2015a).

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[2] Motor vehicle crashes are reported and classified by whether they involve property damage, injury, or death.

Figure 1. Project Area

  - Seventy-five percent of crashes occurred on southbound (SB) I-5, and 79 percent of all the crashes were rear-end collisions. Crashes during this 5-year period included one fatality, which was a pedestrian fatality. A total of seven crashes resulted in serious injury.
  - The Safety Priority Index System (SPIS) is the systematic scoring method used by the Oregon Department of Transportation (ODOT) for identifying potential safety problems on state highways based on the frequency, rate, and severity of crashes (ODOT 2015b). The 2015 SPIS shows two SB sites in the top 5 percent and two northbound (NB) sites in the top 10 percent of the SPIS list.
  - The 2015 crash rate on the I-5 segment between I-84 and the Broadway ramp on to I-5 is 2.70 crashes per million vehicle miles. The statewide average for comparable urban highway facilities is 0.77 crashes per million vehicle miles travelled (mvmt).
  - The existing short weaving distances and lack of shoulders for accident/incident recovery in this segment of I-5 are physical factors that may contribute to the high number of crashes and safety problems.
- **I-5 Operations:** The Project Area is at the crossroads of three regionally significant freight and commuter routes: I-5, I-84, and I-405. As a result, I-5 in the vicinity of the Broadway/Weidler interchange experiences some of the highest traffic volumes in the State of Oregon, carrying approximately 121,400 vehicles each day (ODOT 2017), and experiences 12 hours of congestion each day (ODOT 2012a). The following factors affect I-5 operations:
  - Close spacing of multiple interchange ramps results in short weaving segments where traffic merging on and off I-5 has limited space to complete movements, thus becoming congested. There are five on-ramps (two NB and three SB) and six off-ramps (three NB and three SB) in this short stretch of highway. Weaving segments on I-5 NB between the I-84 westbound (WB) on-ramp and the NE Weidler off-ramp, and on I-5 SB between the N Wheeler Avenue on-ramp and I-84 eastbound (EB) off-ramp, currently perform at a failing level-of-service during the morning and afternoon peak periods.
  - The high crash rate within the Project Area can periodically contribute to congestion on this segment of the highway. As noted with respect to safety, the absence of shoulders on I-5 contributes to congestion because vehicles involved in crashes cannot get out of the travel lanes.
  - Future (2045) traffic estimates indicate that the I-5 SB section between the N Wheeler on-ramp and EB I-84 off-ramp is projected to have the most critical congestion in the Project Area, with capacity and geometric constraints that result in severe queuing.
- **Broadway/Weidler Interchange Operations:** The complexity and congestion at the I-5 Broadway/Weidler interchange configuration is difficult to navigate for vehicles (including transit vehicles), bicyclists, and pedestrians, which impacts

access to and from I-5 as well as to and from local streets. The high volumes of traffic on I-5 and Broadway/Weidler in this area contribute to congestion and safety issues (for all modes) at the interchange ramps, the Broadway and Weidler overcrossings of I-5, and on local streets in the vicinity of the interchange.

  - The Broadway/Weidler couplet provides east-west connectivity for multiple modes throughout the Project Area, including automobiles, freight, people walking and biking, and Portland Streetcar and TriMet buses. The highest volumes of vehicle traffic on the local street network in the Project Area occur on NE Broadway and NE Weidler in the vicinity of I-5. The N Vancouver Avenue/N Williams couplet, which forms a critical north-south link and is a Major City Bikeway within the Project Area with over 5,000 bicycle users during the peak season, crosses Broadway/Weidler in the immediate vicinity of the I-5 interchange.
  - The entire length of N/NE Broadway is included in the Portland High Crash Network—streets designated by the City of Portland for the high number of deadly crashes involving pedestrians, bicyclists, and vehicles.[3]
  - The SB on-ramp from N Wheeler and SB off-ramp to N Broadway experienced a relatively high number of crashes per mile (50-70 crashes per mile) compared to other ramps in the Project Area during years 2011-2015. Most collisions on these ramps were rear-end collisions.
  - Of all I-5 highway segments in the corridor, those that included weaving maneuvers to/from the Broadway/Weidler ramps tend to experience the highest crash rates:
    - SB I-5 between the on-ramp from N Wheeler and the off-ramp to I-84 (SB-S5) has the highest crash rate (15.71 crashes/mvmt).
    - NB I-5 between the I-84 on-ramp and off-ramp to NE Weidler (NB-S5) has the second highest crash rate (5.66 crashes/mvmt).
    - SB I-5 between the on-ramp from I-405 and the off-ramp to NE Broadway (SB-S3) has the third highest crash rate (4.94 crashes/mvmt).

- **Travel Reliability on the Transportation Network:** Travel reliability on the transportation network decreases as congestion increases and safety issues expand. The most unreliable travel times tend to occur at the end of congested areas and on the shoulders of the peak periods. Due to these problems, reliability has decreased on I-5 between I-84 and I-405 for most of the day. Periods of congested conditions on I-5 in the Project Area have grown over time from morning and afternoon peak periods to longer periods throughout the day.

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[3] Information on the City of Portland’s High Crash Network is available at https://www.portlandoregon.gov/transportation/54892.

1.4 Project Goals and Objectives

In addition to the purpose and need, which focus on the state's transportation system, the Project includes related goals and objectives developed through the joint ODOT and City of Portland N/NE Quadrant and I-5 Broadway/Weidler Interchange Plan process, which included extensive coordination with other public agencies and citizen outreach. The following goals and objectives may be carried forward beyond the National Environmental Policy Act (NEPA) process to help guide final design and construction of the Project:

- Enhance pedestrian and bicycle safety and mobility in the vicinity of the Broadway/Weidler interchange.
- Address congestion and improve safety for all modes on the transportation network connected to the Broadway/Weidler interchange and I-5 crossings.
- Support and integrate the land use and urban design elements of the Adopted N/NE Quadrant Plan (City of Portland et al. 2012) related to I-5 and the Broadway/Weidler interchange, which include the following:
  - Diverse mix of commercial, cultural, entertainment, industrial, recreational, and residential uses, including affordable housing
  - Infrastructure that supports economic development
  - Infrastructure for healthy, safe, and vibrant communities that respects and complements adjacent neighborhoods
  - A multimodal transportation system that addresses present and future needs, both locally and on the highway system
  - An improved local circulation system for safe access for all modes
  - Equitable access to community amenities and economic opportunities
  - Protected and enhanced cultural heritage of the area
  - Improved urban design conditions
- Improve freight reliability.
- Provide multimodal transportation facilities to support planned development in the Rose Quarter, Lower Albina, and Lloyd.
- Improve connectivity across I-5 for all modes.

2 Project Alternatives

This technical report describes the potential effects of no action (No-Build Alternative) and the proposed action (Build Alternative).

2.1 No-Build Alternative

NEPA regulations require an evaluation of the No-Build Alternative to provide a baseline for comparison with the potential impacts of the proposed action. The No-Build Alternative consists of existing conditions and any planned actions with committed funding in the Project Area.

I-5 is the primary north-south highway serving the West Coast of the United States from Mexico to Canada. At the northern portion of the Project Area, I-5 connects with I-405 and the Fremont Bridge; I-405 provides the downtown highway loop on the western edge of downtown Portland. At the southern end of the Project Area, I-5 connects with the western terminus of I-84, which is the east-west highway for the State of Oregon. Because the Project Area includes the crossroads of three regionally significant freight and commuter routes, the highway interchanges within the Project Area experience some of the highest traffic volumes found in the state (approximately 121,400 average annual daily trips). The existing lane configurations consist primarily of two through lanes (NB and SB), with one auxiliary lane between interchanges. I-5 SB between I-405 and Broadway includes two auxiliary lanes.

I-5 is part of the National Truck Network, which designates highways (including most of the Interstate Highway System) for use by large trucks. In the Portland-Vancouver area, I-5 is the most critical component of this national network because it provides access to the transcontinental rail system, deep-water shipping and barge traffic on the Columbia River, and connections to the ports of Vancouver and Portland, as well as to most of the area’s freight consolidation facilities and distribution terminals. Congestion on I-5 throughout the Project Area delays the movement of freight both within the Portland metropolitan area and on the I-5 corridor. I-5 through the Rose Quarter is ranked as one of the 50 worst freight bottlenecks in the United States (ATRI 2017).

Within the approximately 1.5 miles that I-5 runs through the Project Area, I-5 NB connects with five on- and off-ramps, and I-5 SB connects with six on- and off-ramps. Drivers entering and exiting I-5 at these closely spaced intervals, coupled with high traffic volumes, slow traffic and increase the potential for crashes. Table 1 presents the I-5 on- and off-ramps in the Project Area. Table 2 shows distances of the weaving areas between the on- and off-ramps on I-5 in the Project Area. Each of the distances noted for these weave transitions is less than adequate per current highway design standards (ODOT 2012b). In the shortest weave section, only 1,075 feet is available for drivers to merge onto I-5 from NE Broadway NB in the same area where drivers are exiting from I-5 onto I-405 and the Fremont Bridge.

Table 1. I-5 Ramps in the Project Area

I-5 Travel Direction	On-Ramps From	Off-Ramps To
Northbound	• I-84 • N Broadway/N Williams Avenue	• NE Weidler Street/NE Victoria Avenue • I-405 • N Greeley Avenue
Southbound	• N Greeley Avenue • I-405 • N Wheeler Avenue/N Ramsay Way	• N Broadway/N Vancouver Avenue • I-84 • Morrison Bridge/Highway 99E

Notes: I = Interstate

Table 2. Weave Distances within the Project Area

I-5 Travel Direction	Weave Section	Weave Distance
Northbound	I-84 to NE Weidler Street/NE Victoria Avenue	1,360 feet
Northbound	N Broadway/N Williams Avenue to I-405	1,075 feet
Southbound	I-405 to N Broadway	2,060 feet
Southbound	N Wheeler Avenue/N Ramsay Way to I-84	1,300 feet

Notes: I = Interstate

As described in Section 1.3, the high volumes, closely spaced interchanges, and weaving movements result in operational and safety issues, which are compounded by the lack of standard highway shoulders on I-5 throughout much of the Project Area.

Under the No-Build Alternative, I-5 and the Broadway/Weidler interchange and most of the local transportation network in the Project Area would remain in its current configuration, with the exception of those actions included in the Metro 2014 *Regional Transportation Plan* (RTP) financially constrained project list (Metro 2014a).[4] One of these actions includes improvements to the local street network on the Broadway/Weidler corridor within the Project Area. The proposed improvements include changes to N/NE Broadway and N/NE Weidler from the Broadway Bridge to NE 7th Avenue. The current design concept would remove and reallocate one travel lane on both N/NE Broadway and N/NE Weidler to establish protected bike lanes and reduce pedestrian crossing distances. Proposed improvements also include

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[4] Metro Regional Transportation Plan ID 11646. Available at: https://www.oregonmetro.gov/sites/default/files/Appendix%201.1%20Final%202014%20RTP%20%20Project%20List%208.5x11%20for%20webpage_1.xls

changes to turn lanes and transitions to minimize pedestrian exposure and improve safety. The improvements are expected to enhance safety for people walking, bicycling, and driving through the Project Area. Implementation is expected in 2018-2027.

2.2 Build Alternative

The Project alternatives development process was completed during the ODOT and City of Portland 2010-2012 N/NE Quadrant and I-5 Broadway/Weidler Interchange planning process. A series of concept alternatives were considered following the definition of Project purpose and need and consideration of a range of transportation-related problems and issues that the Project is intended to address.

In conjunction with the Stakeholder Advisory Committee (SAC) and the public during this multi-year process, ODOT and the City of Portland studied more than 70 design concepts, including the Build Alternative, via public design workshops and extensive agency and stakeholder input. Existing conditions, issues, opportunities, and constraints were reviewed for the highway and the local transportation network. A total of 19 full SAC meetings and 13 subcommittee meetings were held; each was open to the public and provided opportunity for public comment. Another 10 public events were held, with over 100 attendees at the Project open houses providing input on the design process. Of the 70 design concepts, 13 concepts advanced for further study based on SAC, agency, and public input, with six concepts passing into final consideration.

One recommended design concept, the Build Alternative, was selected for development as a result of the final screening and evaluation process. The final I-5 Broadway/Weidler Facility Plan (ODOT 2012a) and recommended design concept, herein referred to as the Build Alternative, were supported by the SAC and unanimously adopted in 2012 by the Oregon Transportation Commission and the Portland City Council.[5] The features of the Build Alternative are described below.

The Build Alternative includes I-5 mainline improvements and multimodal improvements to the surface street network in the vicinity of the Broadway/Weidler interchange. The proposed I-5 mainline improvements include the construction of auxiliary lanes (also referred to as ramp-to-ramp lanes) and full shoulders between I-84 to the south and I-405 to the north, in both the NB and SB directions. See Section 2.2.1 for more detail.

Construction of the I-5 mainline improvements would require the rebuilding of the N/NE Weidler, N/NE Broadway, N Williams, and N Vancouver structures over I-5.

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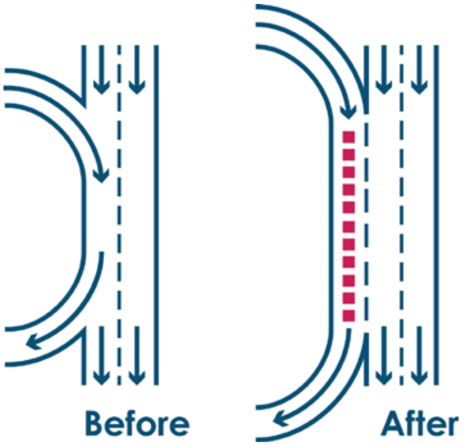
[5] Resolution No. 36972, adopted by City Council October 25, 2012. Available at: https://www.portlandoregon.gov/citycode/article/422365

With the Build Alternative, the existing N/NE Weidler, N/NE Broadway, and N Williams overcrossings would be removed and rebuilt as a single highway cover structure over I-5 (see Section 2.2.2). The existing N Vancouver structure would be removed and rebuilt as a second highway cover, including a new roadway crossing connecting N/NE Hancock and N Dixon Streets. The existing N Flint Avenue structure over I-5 would be removed. The I-5 SB on-ramp at N Wheeler would also be relocated to N/NE Weidler at N Williams, via the new Weidler/ Broadway/Williams highway cover. A new bicycle and pedestrian bridge over I-5 would be constructed at NE Clackamas Street, connecting Lloyd with the Rose Quarter (see Section 2.2.4.3).

Surface street improvements are also proposed, including upgrades to existing bicycle and pedestrian facilities and a new center-median bicycle and pedestrian path on N Williams between N/NE Weidler and N/NE Broadway (see Section 2.2.4.4).



What are Ramp-to-Ramp or Auxiliary Lanes?

Ramp-to-Ramp lanes provide a direct connection from one ramp to the next. They separate on-and off-ramp merging from through traffic, and create better balance and smoother maneuverability, which improves safety and reduces congestion.

2.2.1 I-5 Mainline Improvements

The Build Alternative would modify I-5 between I-84 and I-405 by adding safety and operational improvements. The Build Alternative would extend the existing auxiliary lanes approximately 4,300 feet in both NB and SB directions and add 12-foot shoulders (both inside and outside) in both directions in the areas where the auxiliary lane would be extended. Figure 2 illustrates the location of the proposed auxiliary lanes. Figure 3 illustrates the auxiliary lane configuration, showing the proposed improvements in relation to the existing conditions. Figure 4 provides a cross section comparison of existing and proposed conditions, including the location of through lanes, auxiliary lanes, and highway shoulders.

A new NB auxiliary lane would be added to connect the I-84 WB on-ramp to the N Greeley off-ramp. The existing auxiliary lane on I-5 NB from the I-84 WB on-ramp to the NE Weidler off-ramp and from the N Broadway on-ramp to the I-405 off-ramp would remain.

The new SB auxiliary lane would extend the existing auxiliary lane that enters I-5 SB from the N Greeley on-ramp. The existing SB auxiliary lane currently ends just south of the N Broadway off-ramp, in the vicinity of the Broadway overcrossing structure.

Figure 2. Auxiliary Lane/Shoulder Improvements

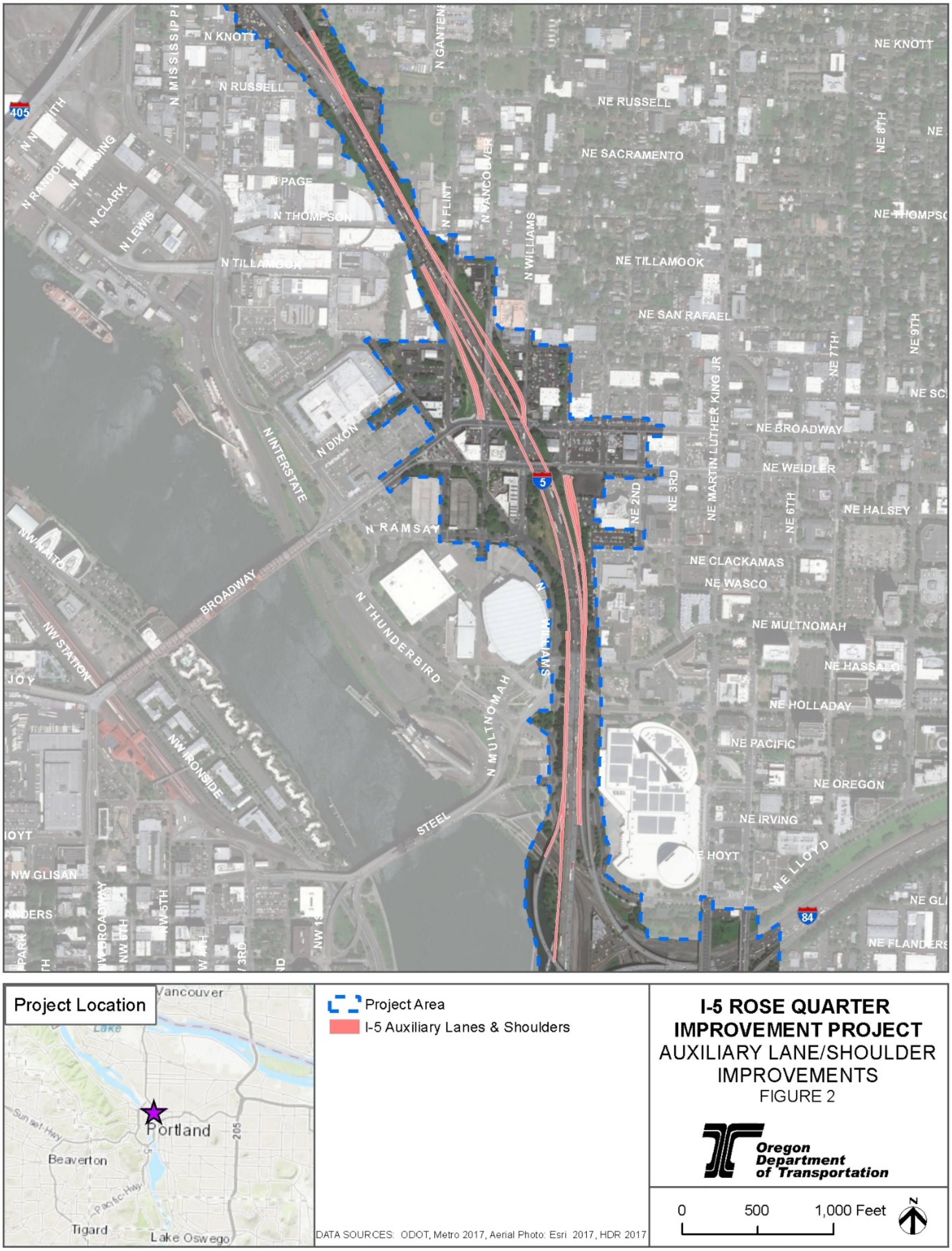


Figure 3. I-5 Auxiliary (Ramp-to-Ramp) Lanes – Existing Conditions and Proposed Improvements

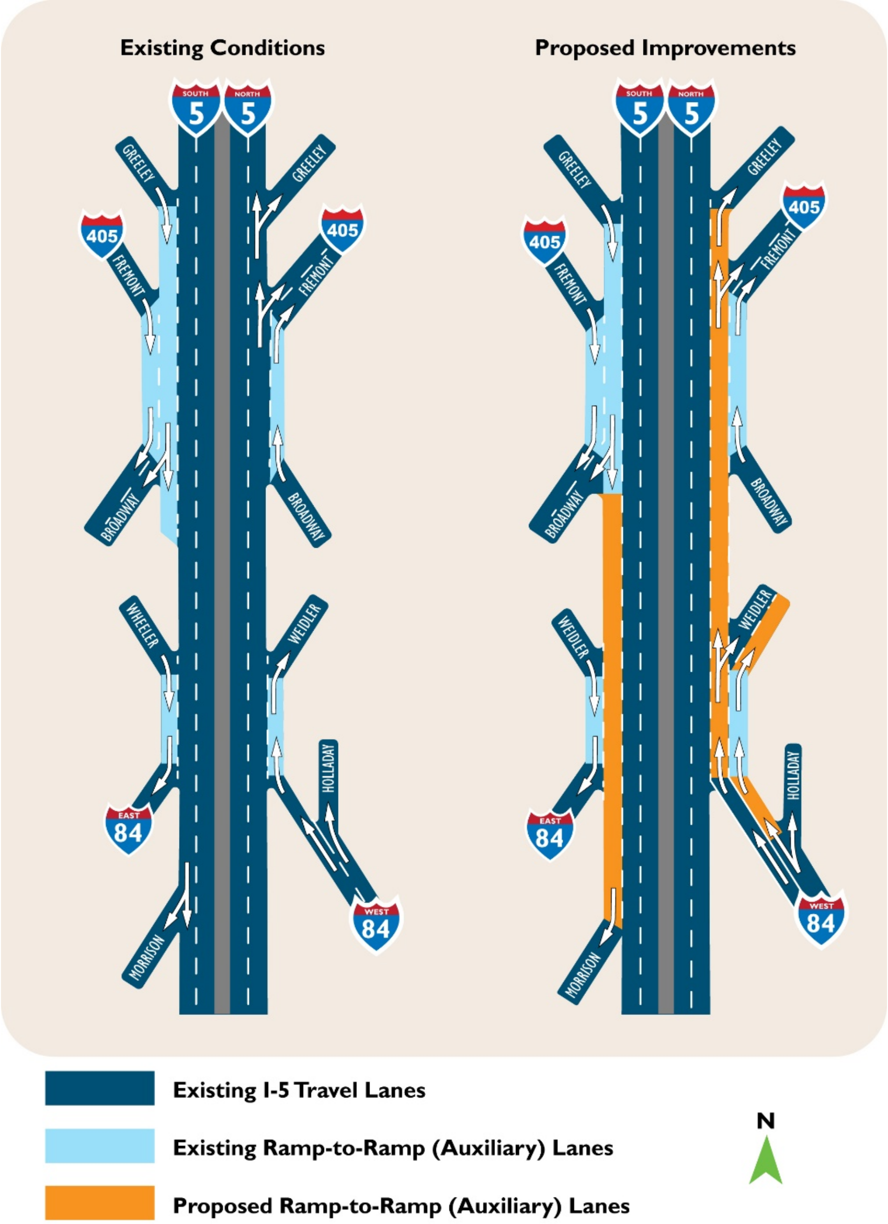
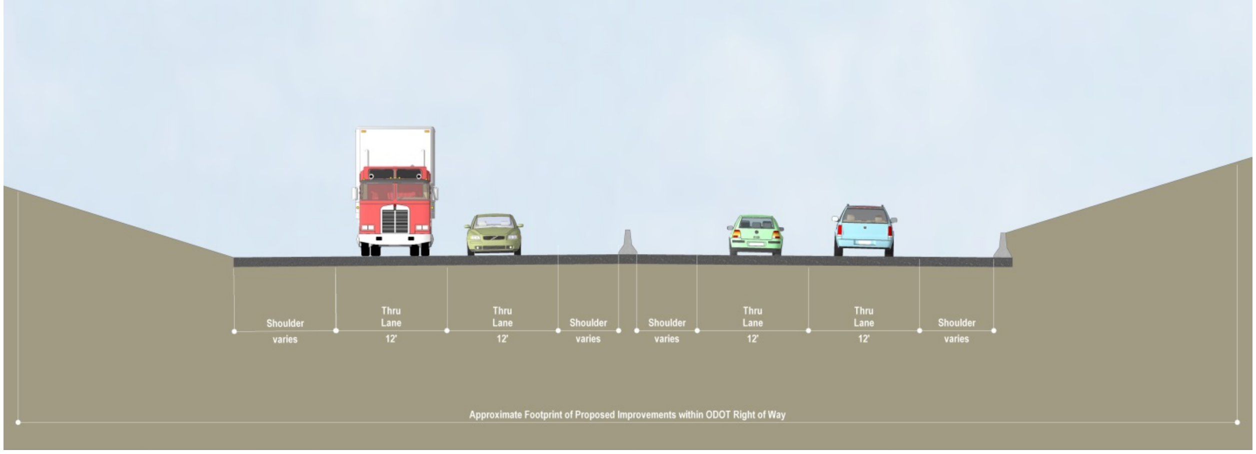
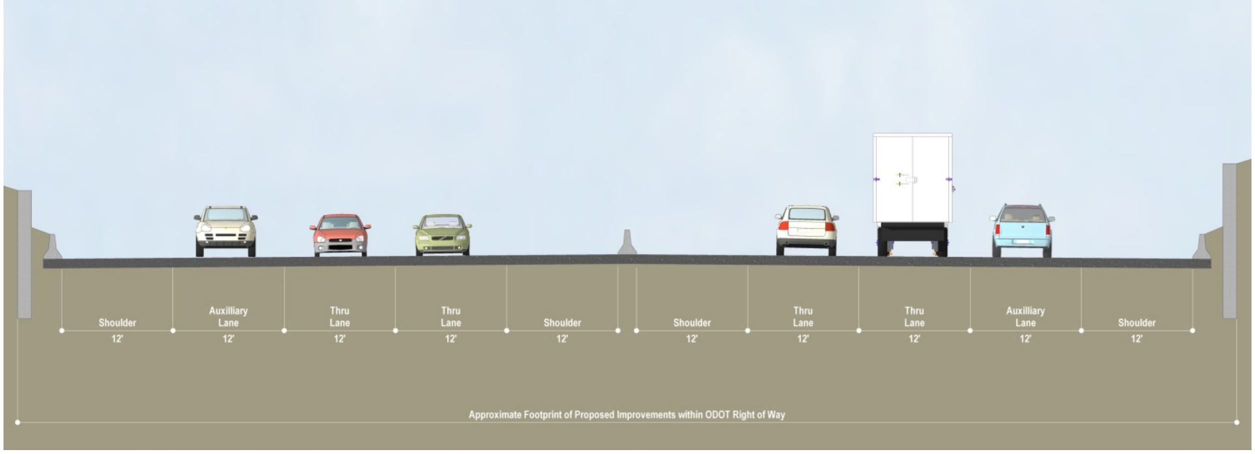


Figure 4. I-5 Cross Section (N/NE Weidler Overcrossing) – Existing Conditions and Proposed Improvements



Existing Lane Configuration



Proposed Lane Configuration

Under the Build Alternative, the SB auxiliary lane would be extended as a continuous auxiliary lane from N Greeley to the Morrison Bridge and the SE Portland/Oregon Museum of Science and Industry off-ramp. Figure 4 presents a representative cross section of I-5 (south of the N/NE Weidler overcrossing within the Broadway/Weidler interchange area), with the proposed auxiliary lanes and shoulder, to provide a comparison with the existing cross section.

The addition of 12-foot shoulders (both inside and outside) in both directions in the areas where the auxiliary lanes would be extended would provide more space to allow vehicles that are stalled or involved in a crash to move out of the travel lanes. New shoulders would also provide space for emergency response vehicles to use to access an incident within or beyond the Project Area.

No new through lanes would be added to I-5 as part of the Build Alternative; I-5 would maintain the existing two through lanes in both the NB and SB directions.

2.2.2 Highway Covers

2.2.2.1 Broadway/Weidler/Williams Highway Cover

To complete the proposed I-5 mainline improvements, the existing structures crossing over I-5 must be removed, including the roads and the columns that support the structures. The Build Alternative would remove the existing N/NE Broadway, N/NE Weidler, and N Williams structures over I-5 to accommodate the auxiliary lane extension and new shoulders described in Section 2.2.1.

The structure replacement would be in the form of the Broadway/Weidler/Williams highway cover (Figure 5). The highway cover would be a wide bridge that spans east-west across I-5, extending from immediately south of N/NE Weidler to immediately north of N/NE Broadway to accommodate passage of the Broadway/Weidler couplet. The highway cover would include design upgrades to make the structure more resilient in the event of an earthquake.

The highway cover would connect both sides of I-5, reducing the physical barrier of I-5 between neighborhoods to the east and west of the highway while providing additional surface area above I-5. The added surface space would provide an opportunity for new and modern bicycle and pedestrian facilities and public spaces when construction is complete, making the area more connected, walkable, and bike friendly.

Figure 5. Broadway/Weidler/Williams and Vancouver/Hancock Highway Covers

2.2.2.2 N Vancouver/N Hancock Highway Cover

The Build Alternative would remove and rebuild the existing N Vancouver structure over I-5 as a highway cover (Figure 5). The Vancouver/Hancock highway cover would be a concrete or steel platform that spans east-west across I-5 and to the north and south of N/NE Hancock. Like the Broadway/Weidler/Williams highway cover, this highway cover would provide additional surface area above I-5. The highway cover would provide an opportunity for public space and a new connection across I-5 for all modes of travel. A new roadway connecting neighborhoods to the east with the Lower Albina area and connecting N/NE Hancock to N Dixon would be added to the Vancouver/Hancock highway cover (see element "A" in Figure 6).

2.2.3 Broadway/Weidler Interchange Improvements

Improvements to the Broadway/Weidler interchange to address connections between I-5, the interchange, and the local street network are described in the following subsections and illustrated in Figure 6.

2.2.3.1 Relocate I-5 Southbound On-Ramp

The I-5 SB on-ramp is currently one block south of N Weidler near where N Wheeler, N Williams, and N Ramsay come together at the north end of the Moda Center. The Build Alternative would remove the N Wheeler on-ramp and relocate the I-5 SB on-ramp north to N Weidler. Figure 6 element "B" illustrates the on-ramp relocation.

2.2.3.2 Modify N Williams between Ramsay and Weidler

The Build Alternative would modify the travel circulation on N Williams between N Ramsay and N Weidler. This one-block segment of N Williams would be closed to through-travel for private motor vehicles and would only be permitted for pedestrians, bicycles, and public transit (buses) (Figures 6 and 7). Private motor vehicle and loading access to the facilities at Madrona Studios would be maintained.

2.2.3.3 Revise Traffic Flow on N Williams between Weidler and Broadway

The Build Alternative would revise the traffic flow on N Williams between N/NE Weidler and N/NE Broadway. For this one-block segment, N Williams would be converted from its current configuration as a two-lane, one-way street in the NB direction with a center NB bike lane to a reverse traffic flow two-way street with a 36-foot-wide median multi-use path for bicycles and pedestrians. These improvements are illustrated in Figures 6 and 7.

Figure 6. Broadway/Weidler Interchange Area Improvements

Photo Source: Google Earth

Figure 7. Conceptual Illustration of Proposed N Williams Multi-Use Path and Revised Traffic Flow

The revised N Williams configuration would be designed as follows:

- Two NB travel lanes along the western side of N Williams to provide access to the I-5 NB on-ramp, through movements NB on N Williams, and left-turn movements onto N Broadway.
- A 36-foot-wide center median with a multi-use path permitted only for bicycles and pedestrians. The median multi-use path would also include landscaping on both the east and west sides of the path.
- Two SB lanes along the eastern side of N Williams to provide access to the I-5 SB on-ramp or left-turn movements onto NE Weidler.

2.2.4 Related Local System Multimodal Improvements

2.2.4.1 New Hancock-Dixon Crossing

A new roadway crossing would be constructed to extend N/NE Hancock west across and over I-5, connecting it to N Dixon (see Figure 6, element “E”). The new crossing would be constructed on the Vancouver/Hancock highway cover and would provide a new east-west crossing over I-5. Traffic calming measures would be incorporated east of the intersection of N/NE Hancock and N Williams to discourage use of NE Hancock by through motor vehicle traffic. Bicycle and pedestrian through travel would be permitted (see Figure 6, element “F”).

2.2.4.2 Removal of N Flint South of N Tillamook and Addition of New Multi-Use Path

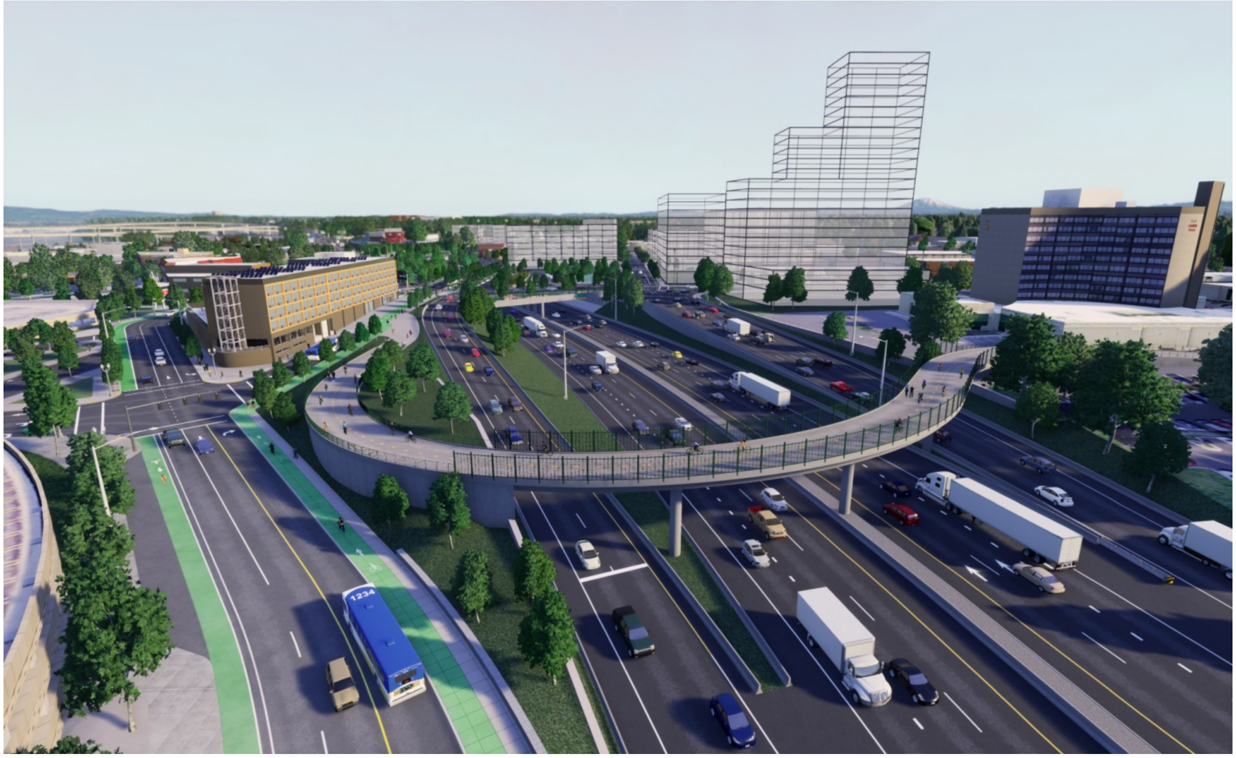
The existing N Flint structure over I-5 would be removed, and N Flint south of N Russell Street would terminate at and connect directly to N Tillamook (see Figure 6, element “G”). The portion of Flint between the existing I-5 overcrossing and Broadway would be closed as a through street for motor vehicles. Driveway access would be maintained on this portion of N Flint to maintain local access.

A new multi-use path would be added between the new Hancock-Dixon crossing and Broadway at a grade of 5 percent or less to provide an additional travel route option for people walking and biking. The new multi-use path would follow existing N Flint alignment between N Hancock and N Broadway (see Figure 6, element “G”).

2.2.4.3 Clackamas Bicycle and Pedestrian Bridge

South of N/NE Weidler, a new pedestrian- and bicycle-only bridge over I-5 would be constructed to connect NE Clackamas Street near NE 2nd Avenue to the N Williams/ N Ramsay area (see Figure 6, element “H,” and Figure 8). The Clackamas bicycle and pedestrian bridge would offer a new connection over I-5 and would provide an alternative route for people walking or riding a bike through the Broadway/Weidler interchange.

Figure 8. Clackamas Bicycle and Pedestrian Crossing



2.2.4.4 Other Local Street, Bicycle, and Pedestrian Improvements

The Build Alternative would include new widened and well-lit sidewalks, Americans with Disabilities Act-accessible ramps, high visibility and marked crosswalks, widened and improved bicycle facilities, and stormwater management on the streets connected to the Broadway/Weidler interchange.[6]

A new two-way cycle track would be implemented on N Williams between N/NE Hancock and N/NE Broadway. A two-way cycle track would allow bicycle movement in both directions and would be physically separated from motor vehicle travel lanes and sidewalks. This two-way cycle track would connect to the median multi-use path on N Williams between N/NE Broadway and N/NE Weidler.

The bicycle lane on N Vancouver would also be upgraded between N Hancock and N Broadway, including a new bicycle jug-handle at the N Vancouver and N Broadway intersection to facilitate right-turn movements for bicycles from N Vancouver to N Broadway.

Existing bicycle facilities on N/NE Broadway and N/NE Weidler within the Project Area would also be upgraded, including replacing the existing bike lanes with wider, separated bicycle lanes. New bicycle and pedestrian connections would also be made between the N Flint/N Tillamook intersection and the new Hancock-Dixon connection.

These improvements would be in addition to the new Clackamas bicycle and pedestrian bridge, upgrades to bicycle and pedestrian facilities on the new Broadway/Weidler/Williams and Vancouver/Hancock highway covers, and new median multi-use path on N Williams between N/NE Broadway and N/NE Weidler described above and illustrated in Figure 6.

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[6] Additional details on which streets are included are available at http://i5rosequarter.org/local-street-bicycle-and-pedestrian-facilities/

3 Regulatory Framework

Efforts to affect climate change typically occur programmatically at national, state, or regional levels as opposed to the project level. Federal and state actions are based on regulations that control emissions at a much broader level and focus on planning efforts to affect greenhouse gas (GHG) emissions reductions. There are no regulations that control project-level GHG emissions for transportation projects. The following sections discuss the broader regulations and policies to provide background information regarding GHG emissions and emissions reductions efforts.

3.1 Federal

Many federal regulations and policies affect GHG emissions—in particular, federal policies that promote alternative energy development or drive fossil fuel use down or toward lower GHG emitting fuels reduce GHG emissions. Federal regulations that improve the energy efficiency of buildings (commercial and residential), vehicles, or machinery that use fossil fuels directly, or indirectly, promote a reduction in GHG emissions.

Actions specific to transportation emissions reductions at the federal level focus on reducing energy consumption by increasing the fuel economy of cars and light trucks, promoting alternative fuels, encouraging transportation alternatives over single occupancy vehicles, and improving the efficiency of the overall transportation system. Specific to transportation planning for roadways, the Federal Highway Administration (FHWA) provides tools and guidance for practical implementation of its policies through its Energy and Emissions programs. The focuses of these programs are to work with states and metropolitan areas to achieve the following (FHWA n.d.-a):

- Improve system performance, efficiency, and project delivery.
- Expand transportation choices.
- Reduce emissions and other environmental impacts.
- Establish a national network of alternative fueling infrastructure.

3.2 State

Oregon has developed regulations and policies to aggressively reduce GHG emissions in various economic sectors. Specific to transportation-related GHG emissions reductions, the Oregon Sustainable Transportation Initiative (OSTI) published the Oregon Statewide Transportation Strategy (OSTI 2013). The Statewide Transportation Strategy developed a vision to guide GHG emissions reductions to meet the GHG reduction goals in Oregon Revised Statute 468A.205. The goal was a 75 percent reduction below 1990 levels in GHG emissions from the transportation sector. The strategy recognizes that the 75 percent goal may not be achievable without action at the national level but outlines plausible measures to achieve a 60 percent reduction below 1990 levels. The strategies are intentionally flexible and include measures in the following categories of system improvements:

- Vehicle and engine technology advancements
- Fuel technology advancements
- Enhanced system and operations performance
- Transportation options
- Efficient land use
- Pricing and funding mechanisms

Specific measures called for in the strategy include increasing the proportion of fuel efficient vehicles; continuing investment in compact, multimodal mixed-use communities; implementing intelligent transportation system technology; and innovatively financing a cleaner transportation system. Recent action in support of the strategies includes the Oregon Clean Fuels program with a mandated goal to reduce the carbon intensity of transportation fuels by 10 percent in 10 years (DEQ 2016a).

3.3 Regional and Local

3.3.1 Metro

In response to a 2009 mandate from the Oregon Legislature for Metro to develop and implement a strategy to reduce per capita GHG emissions from cars and small trucks by 2035, Metro published the *2014 Climate Smart Strategy* (Metro 2014b). The strategy outlines nine key policy recommendations to reduce GHG emissions of light-duty vehicles. These recommendations focus on both local and regional land use and transportation plans as well as expected advancements in cleaner, low-carbon fuels and more fuel-efficient vehicles. According to Metro’s Climate Smart Strategy, the recommended policies are as follows:

- **Implement adopted local and regional land use plans.** Implementing local plans by incorporating population growth within existing urban areas as much as possible and expanding the urban growth boundary only when necessary focuses growth in designated centers, corridors, and employment areas.
- **Make transit convenient, frequent, accessible, and affordable**. Providing reduced fares, increasing the frequency of transit service, prioritizing transit signals, and adding bus lanes makes transit faster and more convenient.
- **Make biking and walking safe and convenient.** Approximately 45 percent of all trips made by car in the region are less than 3 miles. A complete, safe active transportation network is essential to transitioning from reliance on motor vehicles for short trips.

- **Make streets and highways safe, reliable, and connected.** Building a network of local and major connections shortens trips, improves access, and helps preserve the capacity and function on highways for freight and long trips. Targeted widening of streets and highways helps manage congestion and supports travel across the region.
- **Use technology to actively manage the transportation system.** Using information and technology to manage travel demand and traffic flow helps improve safety and boost efficiency.
- **Provide information and incentives to expand the use of travel options.** Public awareness strategies promoting eco-driving and employer-based outreach efforts preserve road capacity and reduce congestion.
- **Make efficient use of vehicle parking and land dedicated to parking.** Efficiency improvements include designating preferential parking spaces for electric vehicles, carshare vehicles, carpools, and freight truck loading and unloading areas. More efficient use of parking may encourage other forms of transportation rather than the single-occupant vehicle.
- **Support Oregon's transition to cleaner, low-carbon fuels and more fuel-efficient vehicles.** Policies such as developing a reliable network of public and private electric vehicle charging stations and providing consumer and business incentives to make the purchase of hybrid and electric vehicles more affordable have been implemented on the state and local level.
- **Secure adequate funding for transportation investments.** Federal and state funding for local transportation system needs have historically been financed through gas taxes and other user fees. With increased fuel efficiency, these revenues are declining, which has resulted in a reduced ability to maintain and improve existing transportation infrastructure. Local Oregon governments have increasingly turned to tax levies and road maintenance fees to provide additional funding.

3.3.2 Multnomah County and the City of Portland

Multnomah County and the City of Portland adopted a Climate Action Plan (CAP) that outlines local strategies to address climate change. The CAP's overarching goal is to reduce carbon emissions by 80 percent below 1990 levels by 2050. The CAP identifies over 170 actions to be completed or in progress by 2020. These actions include the following targeted strategies to reduce transportation system emissions (City of Portland and Multnomah County 2015):

- Create vibrant neighborhoods where 80 percent of residents can easily walk or bicycle to meet all basic daily, non-work needs and have safe pedestrian or bicycle access to transit.
- Reduce daily per capita vehicle miles traveled by 30 percent from 2008 levels.

- Improve the efficiency of freight movement within and through the Portland metropolitan area.
- Increase the fuel efficiency of passenger vehicles to 40 miles per gallon and manage the road system to minimize emissions.
- Reduce the lifecycle carbon emissions of transportation fuels by 20 percent.

Additionally, in April 2017, the City of Portland and Multnomah County published the *Climate Action Plan Progress Report*. According to this report, since 1990, Portland's population has increased 33 percent, while carbon emissions have fallen 41 percent per capita (City of Portland and Multnomah County 2017).

The City of Portland CAP (2015) identified specific risk drivers associated with climate change:

- Hotter, drier summers with more frequent high-heat days increase incidences and intensities of drought and wildfires.
- Warmer, wetter winters increase the incidence and magnitude of damaging floods and landslides.

4 Methodology and Data Sources

The analysis presented in the *Climate Change Technical Report* assessed possible climate change impacts that could result from the Project. This information will support the NEPA document evaluating environmental impacts of the proposed transportation improvements.

The traffic data used in the GHG analysis were provided by the City of Portland (May 29, 2018, 2:57 PM dataset) and included a roadway identifier, traffic volume, vehicle miles traveled, speed, and allocation of volumes to light-duty vehicles, medium trucks, and heavy trucks for each roadway link. Traffic data were broken out into a data set representing expected traffic operations for four analysis periods: AM peak period (7 AM–9 AM), PM peak period (4 PM–6 PM), daytime off-peak period (6 AM–7 PM, excluding peak periods), and nighttime off-peak period (7 PM–6 AM). These periods were used to calculate daily and annual traffic parameters.

Data used as input to estimate construction and maintenance emissions were taken from preliminary Project design drawings (prepared April through August 2017) supplied by ODOT.

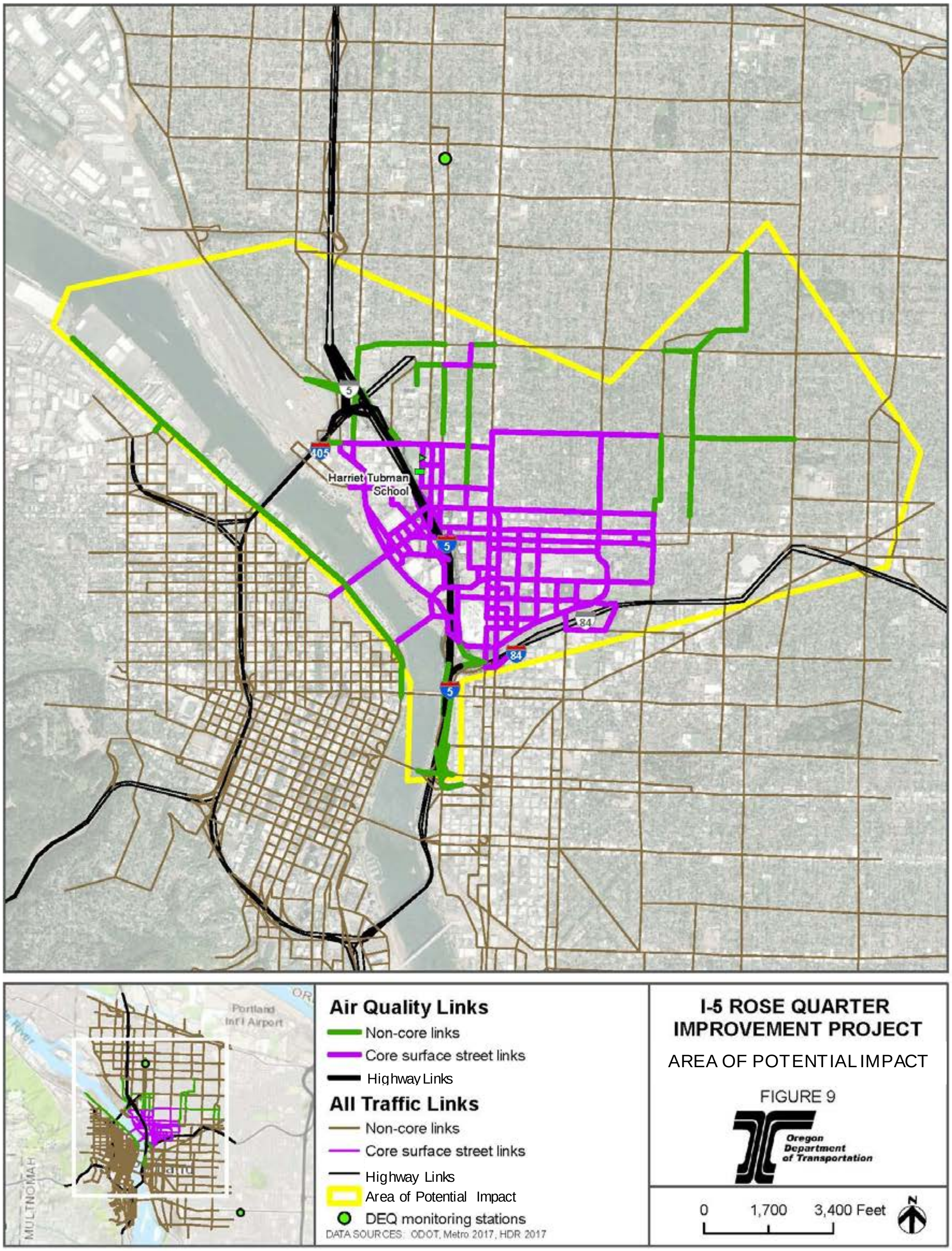
4.1 Project Area and Area of Potential Impact

Global climate change is the cumulative result of emissions sources worldwide contributing to global atmospheric GHG concentrations. However, for the purposes of this Project-level analysis, a smaller analysis area was necessary to effectively compare GHG emissions from the future Build and No-Build Alternatives. The Area of Potential Impact (API) for climate change is the same as the Project Area, plus roadways that could experience changes in congestion (e.g., traffic volumes and speed) sufficient to expect a meaningful change in emissions between the Build and No-Build conditions (Figure 9). The same API was used for the air quality analysis for this Project (ODOT 2019). To analyze the GHG effects of the Project, roadway links in the Project Area plus roadway links that meet the following criteria between No-Build and Build conditions were included:

- ± Five percent or more change in annual average daily traffic
- ± Five percent or more change in travel time
- ± Five percent or more change in travel time delay resulting from intersection delay

A larger analysis area that included emissions from the entire Portland metropolitan area was evaluated but did not as effectively show the changes resulting from the Build Alternative.

Figure 9. Area of Potential Impacts



4.2 Resource Identification and Evaluation

Although GHG reduction actions are generally regulated, planned, and implemented at a larger scale than project level, a Project-level analysis was completed to provide information to the public and decision-makers regarding potential GHG emission-related effects of the Project. Emission sources addressed in this analysis include operational (tailpipe), construction and maintenance activities, and construction material production and transport.

4.3 Assessment of Impacts

The expected GHG emissions of the Project were quantified. The methodology used for analysis of GHG emissions was developed in review and consultation with FHWA and ODOT. A general methodology meeting occurred on October 5, 2017. Following the meeting, a written draft methodology was reviewed by both agency's staff. The following emissions were evaluated using the described methods.

- **Operational (tailpipe).** Emissions resulting from changes in traffic volumes and speeds were estimated using the U.S. Environmental Protection Agency (EPA) Mobile Vehicle Emission Simulator (MOVES) emissions model, version 2014a. Model input assumptions were the same as those used for the air quality analysis documented in the *Air Quality Technical Report* for the Project (ODOT 2019). Emissions were estimated for the existing conditions (2017) and for future Build and No-Build Alternatives in 2045. Fuel cycle emissions were estimated using the FHWA fuel cycle factor of 0.27 (WSDOT 2018) to account for emissions released during fuel extraction, refining, and transport prior to use by vehicles in the Portland metropolitan area. Model input parameters are included in Appendix A. Additional information on MOVES modeling is included in the *Air Quality Technical Report* (ODOT 2019).
- **Construction and Maintenance Activities.** Emissions were quantified using the FHWA Infrastructure Carbon Estimator (ICE) Tool (FHWA n.d.-b). The ICE tool uses information about construction, production of materials used in construction, and maintenance materials and activities over the life of the project to estimate GHG emissions for roadways and parking facilities, bridges, public transportation, and bicycle and pedestrian facilities. The ICE Tool estimates emissions for upstream energy production and emissions associated with raw materials extraction, materials production and transportation; direct emissions for transport of materials to the site, fuel used in construction equipment, and fuel used in maintenance activities. Appendix B includes data sources used for construction and maintenance emission estimates.

Information regarding GHG emissions are presented on a life cycle basis using an assumed life for a highway project of 30 years, with an assumed resurfacing period of 15 years.

4.4 Cumulative Impacts

The cumulative impacts analysis considered the Project's impacts combined with other past, present, and reasonably foreseeable future actions that would result in environmental impacts in the Project Area. Because transportation impacts typically occur on a broader, system-wide scale, the Project team considered actions within and immediately beyond the Project Area. The cumulative impact assessment qualitatively assessed the magnitude of impacts associated with projects listed in the financially constrained element of Metro's RTP (Metro 2014a) and other shorter-term projects identified by the City of Portland and TriMet (summarized in the memorandum in Appendix C), in combination with anticipated Project impacts.

To some extent, climate change analysis is inherently cumulative because it often looks at regional analysis including emissions from many sources over a large area. This report focuses on potential cumulative changes in GHG emissions based on comparing estimated Project emissions to current estimates of GHG emissions in the City of Portland.

5 Affected Environment

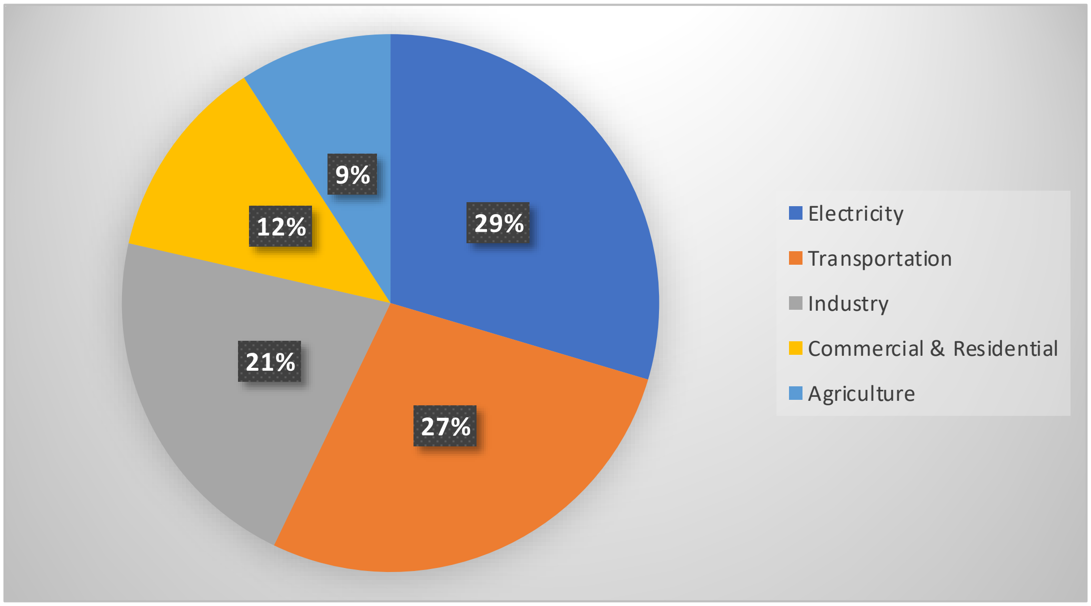
Climate change is a long-term shift in statistical weather patterns, including shifts in averages. For example, the shift could show up as a change in temperature or precipitation for a given place and time of year, from one decade to the next. Certain naturally occurring gases, such as carbon dioxide (CO_2) and water vapor, trap heat in the atmosphere, causing a greenhouse effect. As a result, these gases are referred to as GHGs. Burning of fossil fuels, such as oil, coal, and natural gas, is adding CO_2 to the atmosphere.

GHG emissions that contribute to climate change are a global issue affected by the cumulative results of the actions of the entire world population and the policy decisions of governments worldwide. Globally, economic and population growth continue to be the most important drivers of increases in CO_2 from fossil fuel combustion (IPCC 2014). Agriculture, deforestation, and other land-use changes have been the second-largest contributors (EPA n.d.-a). The potential effects of climate change include effects on sea level, drought, local weather patterns, and large storm events such as hurricanes.

The largest source of GHG emissions from human activities in the United States is from burning fossil fuels for electricity, heat, and transportation. Figure 10 shows 2015 U.S. GHG emissions allocation by economic sector (EPA n.d.-b). Not shown in Figure 10, but providing a balancing effect, the Land Use and Forest sector offset GHG by 12 percent (a GHG sink) because managed forests and other lands absorb CO_2.

Recent data from the U.S. Energy Information Administration (EIA) indicate that transportation surpassed electricity production as the largest source of CO_2 emissions in the United States in late 2016 (EIA n.d.). EIA data show cars and light-duty trucks as the source of 61 percent of the transportation emissions, with medium- and heavy-duty vehicles producing approximately 23 percent of transportation emissions.

Figure 10. Total U.S. GHG Allocation by Sector in 2015



Source: EPA, n.d.-a

In Oregon, GHG emissions peaked in 1999 and declined to within 1 to 2 percent of 1990 emissions by 2013 (Oregon Global Warming Commission 2015). However, preliminary data for 2015 show increases in statewide emissions. Oregon is a leader in renewable energy policies. With the passage of Senate Bill 1547, Oregon is set to become the first state to be coal-free by 2030. Based on preliminary 2015 data, the transportation sector is currently the largest source of GHG emissions in Oregon at approximately 37 percent, followed by electricity use at 30 percent (DEQ 2016b). Based on 2014 data from the U.S. Energy Administration, Oregon has the fifth lowest economic energy intensity (metric tons [MT] of energy-related carbon dioxide per million chained 2009 dollars of Gross Domestic Product [EIA 2017]). States with lower 2014 economic energy intensity are New York, Massachusetts, Connecticut, and California.

The *Third Oregon Climate Assessment Report* (OCCRI 2017) identifies the primary risks associated with climate change in Oregon. Statewide, extreme heat and precipitation events are expected to become more frequent. Area-specific effects are discussed based on the following regions:

- For coastal areas – sea level rise, ocean acidification, and potential shifts in forest vegetation; potential issues with increased erosion and flooding; negative effects for fisheries
- For the Willamette Valley – declining snowpack, earlier snowmelt, and greater summer water demand; potential issues from water scarcity and wildfires in summer; increased flooding and landslide events in winter
- For the Cascade Range – declining snowpack and potential shifts in forest vegetation types; potential effects to wildlife from earlier peak low flow and lower summer low flows in rivers and more wildfires

- For Eastern Oregon – declining snowpack and potential shifts in forest vegetation, rangeland, and sagebrush habitats; potential issues related to wildlife effects from warming streams, more frequent wildfires, and improving habitat for invasive species.

6 Environmental Consequences

The state and federal investments in transportation projects are made to improve conditions of the multimodal transportation network. In general, project-level actions that can help reduce GHG emissions include the following:

- Reduce stop-and-go conditions
- Improve roadway speeds to a moderate level
- Improve intersection traffic flow to reduce idling
- Create safer and more efficient freight movement.

The GHG emissions from the Project are the result of the combustion of fuel that produces emissions of CO_2, methane (CH_4), and nitrous oxide (N_2O). To compare effects between alternatives or scenarios, it is useful to have a single common descriptor. The descriptor used to compare GHG emissions is the carbon dioxide equivalent (CO_2e) emissions. CO_2e converts all the emitted GHGs to a common global warming potential expressed in terms of the equivalent amount of CO_2.

6.1 No-Build Alternative

As described in Section 2.1, the No-Build Alternative consists of existing conditions and other planned and funded transportation improvement projects that would be completed in and around the Project Area by 2045.

6.1.1 Direct Impacts

Under the No-Build Alternative, the proposed I-5 mainline and Broadway/Weidler interchange area improvements would not be constructed, and the current road system would remain in place. Estimated operational and construction and maintenance emissions are described in the following subsections.

6.1.1.1 Operational Emissions

The operational emissions for the Project include tailpipe emissions from vehicles using Project Area roadways and upstream emissions from the fuel cycle to account for the emissions released during fuel extraction, refining, and transport. Table 3 presents projected CO_2e emissions for 2017 existing conditions and for the 2045 No-Build Alternative for the Project. Tailpipe emissions were estimated by modeling affected Project links using the EPA MOVES 2014a model. Fuel cycle emissions are directly proportional to the amount of fuel used. These emissions were calculated by applying the FHWA fuel cycle factor of 0.27 to the tailpipe GHG emissions.

Table 3. Operational GHG Emissions (MT CO_2e per year)

Source	2017	2045 No-Build
Tailpipe	417,156	327,536
Fuel Cycle	112,632	88,435
Total	**529,788**	**415,971**

Source: MFA 2018

Notes: CO_2e = carbon dioxide equivalent, GHG = greenhouse gas; MT = metric tons

When compared to existing conditions in 2017, the 2045 No-Build operational emissions show an approximate 22 percent decrease. This decrease in future GHG emissions can be attributed to federal, state, and local efforts to develop more stringent fuel economy standards and inspection and maintenance programs, as well as transition to cleaner, low-carbon fuels for motor vehicles.

6.1.1.2 Construction and Maintenance Emissions

Construction GHG emissions include emissions generated because of material processing, emissions produced by on-site construction equipment, and emissions arising from traffic delays due to construction. Maintenance GHG emissions include routine activities such as restriping, sweeping, snow removal, and vegetation management that occur on an on-going basis over time.

The FHWA ICE tool was used to estimate GHG emissions for the No-Build Alternative. The No-Build Alternative would have on-going maintenance operations over time. In addition, because the current condition of the pavement is deteriorating, it was assumed a moderate reconstruction would be required during the period of comparison for the Build Alternative. Maintenance and roadway rehabilitation of the affected project links for the No-Build Alternative are estimated to generate approximately 134 MT CO_2e emissions per year. The FHWA ICE tool allows for an accounting of impacts over the life cycle of transportation facilities, including ongoing rehabilitation needs. Generally, roadways require resurfacing after 15 years. It was assumed that the Project Area would be due for resurfacing within the first 5 years of the Project lifespan and again after 15 years.

Upstream emissions from material production for routine resurfacing account for an approximate 72 percent of CO_2e emissions or 97 MT per year. This includes emissions from mining and crushing of sand and gravel, asphalt and cement production, mixing processes, and transport.

Table 4 presents the GHG emissions results for the No-Build Alternative.

Table 4. No-Build Alternative Maintenance Generated Annual GHG Emissions (MT per year)

Source	Roadway-Rehabilitation	Roadway - Maintenance	Total
Upstream Emissions - Materials	97	--	97
Direct Emissions - Construction	15	--	15
Direct Emissions – Routine Maintenance	--	22	22
Total	112	22	134

Source: MFA 2018
Notes: GHG = greenhouse gas; MT = metric tons

6.1.2 Indirect Impacts

No indirect GHG emission impacts are expected as a result of the No-Build Alternative.

6.2 Build Alternative

6.2.1 Direct Impacts

6.2.1.1 Operational Emissions

GHG emissions for the No-Build and Build Alternatives were compared for both highway and surface streets and are summarized in Table 5. The total 2045 Build Alternative operational emissions are projected to result in an approximate 0.2 percent decrease when compared to the 2045 No-Build Alternative. This slight decrease can be attributed to reduced congestion and fewer starts and stops across the Project Area.

Table 5. Build Scenario Operational GHG Emissions (MT CO_2e per year)

Source	GHG Emissions (MT per year)					
	Highway		Surface Streets		Total	
	2045 No-Build	2045 Build	2045 No-Build	2045 Build	2045 No-Build	2045 Build
Tailpipe	177,935	172,741	149,601	154,021	327,536	326,762
Fuel Cycle	48,042	46,640	40,392	41,586	88,435	88,226
Total	225,977	219,382	189,994	195,607	415,971	414,988

Source: MFA 2018.
Notes: CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; MT = metric tons. Rounding makes addition appear inconsistent.

Table 6 presents the estimated 2045 Build Alternative annual operational emissions in comparison to existing conditions. Like the No-Build Alternative, the Build Alternative would result in an approximate 22 percent decrease in operational GHG emissions from 2017.

Table 6. GHG Emissions for Total Operations (MT CO_2e per year)

Source	Total Pollutant Emissions (tons per year)			Percent Change (%)		
	2017 Existing	2045 No Build	2045 Build	2017 to 2045 No Build	2017 to 2045 Build	2045 No Build to 2045 Build
Tailpipe	417,156	327,536	326,762	-22	-22	-0.2
Fuel Cycle	112,632	88,435	88,226	-22	-22	-0.2
Total	529,788	415,971	414,988	-22	-22	-0.2

Notes: CO_2e = carbon dioxide equivalent, GHG = greenhouse gas; MT = metric tons. The slight difference between the Build and No-Build Alternatives is masked by rounding.

6.2.1.2 Construction and Maintenance Emissions

Apart from the new Clackamas Street bicycle/pedestrian crossing, emissions calculations for bicycle facilities in the Project Area were not included. The proposed bicycle facility modifications included for the Build Alternative primarily involve restriping or realignment but not completely new facilities. Table 7 presents construction and maintenance GHG emissions results for the Build Alternative.

Table 7. Build Scenario Construction and Maintenance Annual GHG Emissions (MT CO_2e per year)

Annual GHG Emissions (MT CO_2e per year)					
Source	Roadway- New Construction	Roadway- Rehabilitation	Roadway- Maintenance	Bridges	Total
Upstream Emissions Materials	50	48	--	17	115
Direct Emissions Construction	23	7	--	4	34
Direct Emissions Maintenance	--	--	26	--	26
Total	73	55	26	21	175

Source: MFA 2018

Notes: CO_2e = carbon dioxide equivalent, GHG = greenhouse gas; MT = metric tons

6.2.2 Indirect Impacts

The indirect GHG emissions effects of the Build Alternative would be minor. Indirect GHG emissions from the Build Alternative are included in the direct estimates presented using a fuel factor to account for upstream emissions to produce and transport the fuel. The Build Alternative is a safety improvement project that would not substantially improve highway capacity and would not be expected to induce growth or create other effects that would cause indirect impacts. In addition, the estimated GHG emissions include indirect emissions sources based on a life-cycle approach for materials, construction, and maintenance activities.

6.3 Cumulative Effects

Cumulative impacts are environmental effects that result from the incremental effect of the proposed action when added to other past, present, and reasonably foreseeable future action, regardless of what agency or person undertakes those other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (Title 40 Code of Federal Regulations 1508.7).

The analysis of cumulative impacts involves a series of steps conducted in the following order:

- Identify the resource topics that could potentially experience direct or indirect impacts from construction and operation of the proposed project.
- Define the geographic area (spatial boundary) within which cumulative impacts will be assessed, as well as the time frame (temporal boundary) over which other past, present, and reasonably foreseeable future actions will be considered.
- Describe the current status or condition of the resource being analyzed, as well as its historical condition (prior to any notable change) and indicate whether the status or condition of the resource is improving, stable, or in decline.
- Identify other actions or projects that are reasonably likely to occur within the area of potential impact during the established time frame and assess whether they could positively or negatively affect the resource being analyzed.
- Describe the combined effect on the resource being analyzed when the direct and indirect impacts of the project are combined with the impacts of other actions or projects assumed to occur within the same geographic area during the established time frame.

6.3.1 Spatial and Temporal Boundaries

The geographic area used for the cumulative impact analysis is the same as the API described in Section 4.1 and shown on Figure 9. The time frame for the cumulative impact analysis extends from the beginning of large-scale urban development in and around the Project Area to 2045, the horizon year for the analysis of transportation system changes.

6.3.2 Past, Present, and Reasonably Foreseeable Future Actions

The past, present, and reasonably foreseeable future actions that were considered in assessing cumulative effects are summarized in the following subsections.

6.3.2.1 Past Actions

Past actions include the following:

- Neighborhood and community development
    - Historical development of the Portland area and accompanying changes in land use
    - Development of the local transportation system (including roads, bicycle and pedestrian facilities, and bus transit)
    - Utilities (water, sewer, electric, and telecommunications)
    - Parks, trails, bikeways
- Commercial and residential development in and around the Project Area
    - Veterans Memorial Coliseum (1960)
    - Lloyd Center (1960)
    - Legacy Emanuel Medical Center (1970)
    - Oregon Convention Center (1990)
    - Rose Garden (1995)
- Regional transportation system development
    - Marine terminal facilities on the Willamette River
        - Port of Portland (1892)
        - Commission of Public Docks (1910)
        - Port of Portland (1970; consolidation of Port of Portland and Commission of Public Docks)
    - Freight rail lines (late 1800s and early 1900s)
    - Highways
        - I-84 (1963)
        - I-5 (1966)
        - I-405 (1973)
    - Rail transit system
        - MAX light rail (1986)
        - Portland Streetcar (2001)

6.3.2.2 Present Actions

Present actions include the ongoing operation and maintenance of existing infrastructure and land uses, including the following:

- Ongoing safety improvements for bicycles and pedestrians
- Local and regional transportation system maintenance
- Utility maintenance

6.3.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions included projects listed in the financially constrained element of Metro's RTP (Metro 2014a) and other shorter-term projects and service improvements identified by the City of Portland and TriMet (Appendix C). These projects were assumed to be in place under the No-Build Alternative. It was also assumed that these projects would be designed according to applicable agency standards.

6.3.3 Results of Cumulative Impacts Analysis

Large reductions in GHG emissions are required to mitigate global climate change. Even small increases in GHG emissions can contribute to cumulative effects and should be considered in the context of overall emission reduction goals. Table 8 presents a summary of the estimated cumulative annual GHG emissions from the No-Build and Build Alternatives. These estimates include indirect emissions.

Table 8. Estimated Annual GHG Emissions (MT CO_2e per year)

Source	Annual GHG Emissions (MT CO_2e/year)	
	No Build	Build
Operational Emissions	415,971	414,988
Construction and Maintenance Emissions	134	175
Total	416,105	415,163

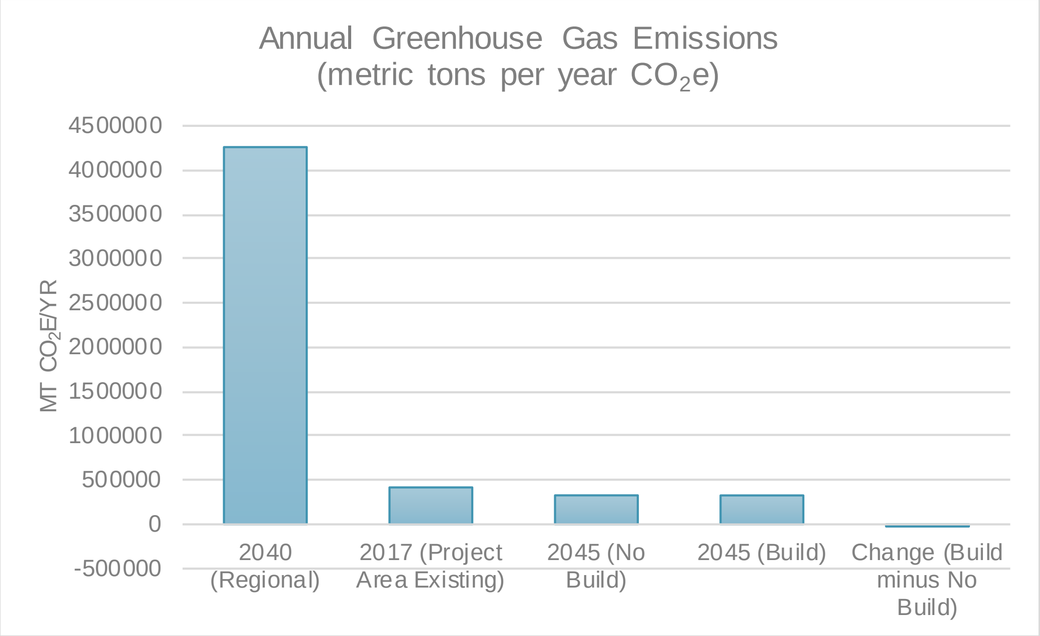
Source: MFA 2018

Notes: CO_2e = carbon dioxide equivalent, GHG = greenhouse gas; MT = metric tons. Construction and maintenance emissions annualized over the 30-year Project life span.

Although regulations applicable to stationary sources, such as factories, are not applicable to highway projects, they can be used as a guide in evaluating the magnitude of emissions from a highway project. Division 200 of Oregon Administrative Rules (OAR) 340 addresses *de minimis* limits for stationary sources. The annual GHG emissions decrease from the No-Build to the Build condition would not apply to the 2,500 MT CO_2e per year *de minimis* threshold specified in OAR 340-200-0020. If this Project were a stationary source, the emissions would be below the threshold indicating a need for permitting or action.

When comparing the projected change in GHG emissions from the No-Build to Build condition to the most current GHG emissions estimate for the Portland metropolitan area, the decrease in emissions from the Project are equivalent to an approximate 0.02 percent of the Regional emissions. Figure 11 presents this comparison.

Figure 11. Projected Regional GHG Emissions



Source: MFA 2018 and Metro 2018

The regional emissions estimates were supplied by Metro. They are the results from final 2040 modeling of the Portland area for GHG planning purposes, which was completed in November 2018.

These estimates are based on the list of financially constrained projects identified in the 2014 RTP produced by Metro, which includes transportation activities, but may not include the other reasonably foreseeable future actions identified by the City of Portland and TriMet, such as short-term, service-related, and/or non-transportation projects. Due to the lack of quantitative data available on these projects, only a qualitative evaluation of their relevance is possible. While the anticipated GHG emissions from these types of projects have the potential for detrimental and beneficial short- and long-term impacts to GHGs, they would likely remain localized and small in scale compared to the regional transportation system. Therefore, their omission from the estimates above would not change the interpretation of the scale of the Build Alternative in comparison to existing local and regional factors contributing to climate change.

7 Avoidance, Minimization, and Mitigation Measures

Estimated GHG emissions from the No-Build and Build Alternatives are below levels typically considered to have an adverse effect on global climate change. Mitigation is not proposed for the construction, maintenance, or operating emissions.

ODOT would consider how the effects of climate change may impact stormwater collection facilities during final design of the Project elements.

8 Conclusion

Global climate change is the cumulative result of numerous emissions sources contributing to global atmospheric GHG concentrations. There is presently no scientific methodology for attributing specific climatological changes to the emissions resulting from a specific transportation project.

GHG emissions from the Build Alternative are estimated to be slightly lower than the No-Build Alternative. Additionally, the estimated large decreases in emissions from existing conditions to future conditions (2045) are the result of changes in vehicle emissions due to federal, state, and local efforts to develop more stringent fuel economy standards, inspection and maintenance programs, and transition to cleaner, low-carbon fuels for motor vehicles.

9 Preparers

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Natalie Liljenwall (Reviewer)	Air Quality and Climate Change	B.S. and M.S., Environmental Engineering	21
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