I-5 ROSE QUARTER
IMPROVEMENT PROJECT

20% Design Package (Refined Facility Plan / NEPA Design Concept)

I-5 Rose Quarter Improvement Project

K19071

Task: 11.1.5

ODOT EA: PE002591000J71

Portland, Oregon

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Acronyms and Abbreviations

2012 Facility Plan	October 2012 N/NE Quadrant Plan and I-5 Broadway-Weidler Facility Plan
AASHTO	American Association of State Highway and Transportation Officials
ABC	Accelerated Bridge Construction (ABC)
ADA	American Disabilities Act
Agency	Oregon Department of Transportation (ODOT)
AHJ	Authority Having Jurisdiction
API	Area of Potential Impact
APTA	American Public Transportation Association
BDM	Bridge Design Manual
BDS	Bureau of Development Services
BES	Bureau of Environmental Services
BMCL	base mounted service cabinet with illumination
BOS	bus-on-shoulders
CCIM	Central City in Motion
CIA	Contributing Impervious Area
City	City of Portland
CM/GC	Construction Manager General Contractor
Consultant	HDR Engineering, Inc. and subconsultant partners
CRCP	continuously reinforced concrete pavement
CSA	combined sewer area
CSP	concrete sewer pipe
CTC	Cost-to-Complete
DBE	Disadvantaged Business Enterprise
DEQ	Department of Environmental Quality
E	east
EA	Environmental Assessment
EB	eastbound
EWP	Early Work Package
FAHP	Federal-Aid Highway Program
FFFS	fixed fire-fighting system
FHWA	Federal Highway Administration
FLS	Fire and Life Safety
FONSI	Finding of No Significant Impact
GDM	Geotechnical Design Manual
GDR	Geotechnical Data Report
GER	Geotechnical Engineering Report
GULD	General Use Level Designation
HDM	Highway Design Manual
I-405	Interstate 405
I-5	Interstate 5
I-84	Interstate 84

IGA	Intergovernmental Agreement
ITS	Intelligent Transportation Systems
LED	light-emitting diode
LRFR	Load and Resistance Factor Ratings
LRT	light rail transit
LTS	level of tolerable stress
MCTD	Motor Carrier Transportation Division
MFD	Missoula Flood Deposits
MOT	Maintenance of Traffic
MOU	memorandum of understanding
MP	milepost
MSE	mechanically stabilized earth
MUTCD	Manual on Uniform Traffic Control Devices
N	north
NACTO	National Association of City Transportation Officials
NB	northbound
NE	northeast
NEC	National Electrical Code
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
OMSI	Oregon Museum of Science and Industry
ORS	Oregon Revised Statute
PBOT	Portland Bureau of Transportation
PCC	Portland Cement Concrete
Project	I-5 Rose Quarter Improvements Project
PSI	Portland Streetcar Incorporated
PTZ	pan-tilt-zoom
QPL	Qualified Products List
RAME	Region Access Management Engineer
RCBG	reinforced concrete box girder
RDG	Roadside Design Guide
ROW	Right-of-way
RRFB	rectangular rapid flashing beacon
S	south
SB	southbound
SE	southeast
SRM	Sandy River Mudstone
SUE	Subsurface Utility Engineering
TAPE	Technology Assessment Protocol – Ecology

TCRP	Transit Cooperative Research Program
TSP	Transportation System Plan
TPAR	Temporary Pedestrian Accessible Routes
UPRR	Union Pacific Railroad
v/c	volume-to-capacity
VMS	variable-message signs
VSS	variable speed signs
W	west
WB	westbound

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Memorandum Purpose

The purpose of the 20% Design Memorandum is to provide the Oregon Department of Transportation (ODOT) and its partners with an update of the working design concepts and the assumed technical solutions for the Interstate 5 (I-5) Rose Quarter Improvements Project (the Project). The 20% Design Memorandum has been informed through extensive coordination and multiple subteam focus work sessions and is intended to further advance the coordination and resolution of comments and feedback received through the 15% Basis of Design and the Revised Baseline submittal packages. Specifically, the 20% Design Memorandum:

1. Provides a technical refinement of the conceptual solutions contained within the October 2012 N/NE Quadrant Plan and I-5 Broadway-Weidler Facility Plan (2012 Facility Plan) and as evaluated during the National Environmental Policy Act (NEPA) Phase.
2. Attempts to resolve review comments provided as part of previous design submittals.
3. Acts as a Construction Management / General Contractor (CM/GC) onboarding tool to provide the technical design considerations and working design assumptions.
4. Communicates Project information to ODOT and its partnering stakeholders for further refinement of transportation safety and operational improvements and development of community place-making decisions.
5. Aligns the conceptual solutions with any Project modifications within the Final NEPA FONSI / Revised EA document.

This document consists of a comprehensive narrative supported by appendices that address specific technical concepts throughout the Project area. These concepts include operational and safety improvements to I-5, as well as City of Portland street improvements for active transportation and transit. The narrative is summarized as follows:

- Chapter 1: Project Overview, Benefits, Description, Study Zone Approach, Revisions to the NEPA Conceptual Design, and Design Schedule
- Chapter 2: Design Standards and Criteria
- Chapter 3: Other Project Drivers
- Chapter 4: Project Study Zone Descriptions and Revised Concept Findings
- Chapter 5: Maintenance of Traffic Approach During Construction

Note: While the 20% Design Memorandum contains technical solutions as conceptualized in the 2012 Facility Plan and as derived from the Project's NEPA phase, it is not reflective of final scope decisions. Rather, all information within this memorandum should be considered as working assumptions until final scope decisions are made by the Oregon Transportation Commission (OTC) and the Oregon Legislature. Information presented within this memorandum will inform both the Project’s public engagement process and ongoing coordination with partner agencies. Information presented within this CM/GC Design Handoff Package Memorandum will inform both the Project's public engagement process and further collaboration with partner agencies. The assumed concepts contained herein may be modified based on CMGC input, stakeholder and community input, and additional technical information gathered as a natural part of the design progression process.

1 Project Overview

In the early 1960s, during an era of highway building nationwide, the building of I-5, combined with other public and private developments and urban renewal, disconnected the community, and resulted in displacement – namely the displacement of the African American community out of the central city. The well-connected street grid was disrupted, leaving limited options for crossing I-5, and the historically black Albina neighborhood became physically separated from other neighborhoods.

The Project was created by ODOT and the City of Portland (City), using input from the local community over a period of several years. After looking at more than 70 options, a preferred concept was recommended to move forward to address long-standing safety, operational issues, and connection concerns in the area.

1.1 Project Benefits

The Project is imagining a new Rose Quarter and Albina area, where cars and freight trucks on I-5 have more space and time to merge while traveling through the area; where people walking and biking can comfortably cross a bridge over I-5 that is designed just for them; where getting from the Broadway Bridge to the Lloyd area feels less daunting for those who walk, bike, use transit, and drive. The following are a summary of the key Project benefits, resulting in a safer and more reliable I-5, a better connected community, and opportunities for economic growth:

A SAFER AND MORE RELIABLE I-5. Three Interstates (I-5, I-84, and I-405) intersect in the short distance between the Morrison Bridge and the Fremont Bridge, creating the biggest transportation bottleneck in the state of Oregon. This outdated design with closely spaced interchanges and no shoulders has resulted in this section of I-5 having the highest crash rate in the state. With the following improvements, the Project will reduce frequent crashes, improve safety, and increase traveler reliability.

This includes:

- New ramp-to-ramp lanes (auxiliary lanes) along I-5, which will save approximately 2.5 million hours of vehicle delay each year and reduce crashes up to 50 percent.
- Full shoulders along I-5 between I-84 and I-405, providing space for disabled vehicles to move out of traffic and for emergency responders to move to and through the area.
- A space that accommodates potential future bus-on-shoulders (BOS) operations between I-84 and I-405.
- Relocating the I-5 southbound (SB) on-ramp from N Wheeler Avenue to N Weidler Street.

A BETTER CONNECTED COMMUNITY. The Project creates new connections across I-5 and more space for people walking and biking, so everyone can travel more safely and conveniently through the Rose Quarter and Albina areas. These improvements include:

- A pedestrian- and bicycle-only bridge over I-5, from NE Clackamas Street to the Rose Quarter.
- New, upgraded pedestrian and bicycle facilities in the area of Broadway/Weidler and N Vancouver Avenue/N Williams Avenue.
- A cover over the highway where bridges cross over I-5 providing additional space to support community connections and compliment the urban development opportunities.

- Improved pedestrian and bicycle access to transit (Portland Streetcar, TriMet bus, and TriMet MAX lines).
- A direct road connection over I-5 between N Hancock Street to N Dixon Street.
- Improved transit and vehicle travel reliability for local streets and reduction of automobile conflicts with bicycle and pedestrians by rerouting I-5 SB on-ramp traffic from N Vancouver Ave to N Williams Ave.

GREATER ECONOMIC GROWTH. This Project is an opportunity to reconnect the Lower Albina area and enhance continuity to north (N) and northeast (NE) neighborhoods. By making travel easier, providing more options, and creating more space for people to move through, the Project will support future economic and redevelopment opportunities.

1.2 Project Description

The Project adds auxiliary lanes and shoulders to reduce congestion and improve safety on the west coast's principal north-south freeway and redesigns the local street network. The Project will smooth traffic flow on I-5 between Interstate 84 (I-84) and Interstate 405 (I-405) where three interstates intersect and feature the biggest traffic bottleneck in Oregon. The Project also will improve community connections by redesigning overpasses and reconnecting neighborhood streets, enhancing public spaces, and promoting economic development opportunities. The Project's transportation improvements allow the City to implement the development goals for the north/northeast area and realize the key elements of the City's Central City 2035 Plan.

The Project is located in Portland, Oregon, along the 1.8-mile segment of I-5 between I-405 to the north (milepost [MP] 303.2), inclusive of the Greeley exit ramp connection, and the Morrison Bridge exit (US 26 and 99E) to the south (S) (MP 301.4). The Project also includes the interchanges between: (1) I-5 and I-84; and (2) I-5 and NE Broadway and NE Weidler Streets (the Broadway/Weidler Interchange) and the surrounding transportation network, from approximately NE Hancock Street to the N, N Benton Avenue to the west (W), NE Multnomah Street to the S, and NE Second Avenue to the east (E).

Key assumptions that affect the entirety of this 20% Design Memorandum include:

- The Project scope is consistent with the intent of the conceptual solutions contained within the 2012 Facility Plan and as evaluated during the NEPA Phase, with its contemplated elements.
- The Project will be constructed through as combination of Early Work Packages (EWPs) and a main construction package.
- Consistency with the NEPA FONSI / Revised EA and City of Portland capital project plans, such as the City of Portland's Broadway/Weidler Central City in Motion (CCIM) Corridor Project, a road reorganization project which includes removal of a travel lane on portions of N/NE Broadway and N/NE Weidler immediately east and west of the Project area.

1.2.1 I-5 Mainline Safety and Operational Improvements

I-5 mainline improvements include the construction of auxiliary lanes and full shoulders between I-84 to the south and I-405 to the north, in both the northbound (NB) and SB directions as follows:

- Extending the SB 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. The existing 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 (OMSI) exit ramp. In the SB direction highway shoulders will be increased between the N Broadway off-ramp and the I-84 eastbound exit ramp.

- Adding a new NB auxiliary lane and adding full shoulders from the I-84 westbound (WB) to I-5 NB entrance ramp to the N Greeley Avenue exit ramp.
- Adding new N Vancouver Avenue/N Hancock Street highway cover to the N and S of NE Vancouver Avenue and N Hancock Street.

1.2.2 N/NE Broadway/NE Weidler Interchange Improvements

The Broadway/Weidler Interchange improvements address connections between I-5, the interchange, and the local street network; they include the following:

- Relocating the I-5 SB entrance ramp from N Wheeler Avenue to NE Weidler Street.
- Widening the I-5 NB to NE Weidler Street exit ramp.

1.2.3 Multimodal Improvements to City Streets

The Project's multimodal improvements are intended to create a safe environment for pedestrians, bicyclists, and transit within the Project area while providing additional modal options and improved access for non-automobile modes. The improvements include the following:

- Providing a strong pedestrian circulation network that promotes pedestrian activity by creating safe and convenient access to local destinations and transit facilities.
- Adding new N/NE Broadway/NE Weidler/NE Williams highway cover from immediately south of NE Weidler Street to immediately north of NE Broadway to accommodate the existing NE Broadway/NE Weidler couplet.
- Modifying N Williams Avenue between N Ramsay Way and NE Weidler Street to pedestrians, bicycles, local access, and public transit (bus) use only.
- Revising N Williams Avenue between NE Weidler Street and NE Broadway to a contraflow two-way street (two NB lanes and two SB lanes) with an approximate 36-foot-wide median multiuse facility for pedestrians and NB bicycles.
- Extending NE Hancock Street west, connecting it to N Dixon Street on the N Vancouver Avenue/N Hancock Street highway cover. Removing N Flint Avenue (and structure) between N Tillamook Street and NE Broadway.
- Adding a new multiuse path connecting the new Hancock-Dixon road crossing to the intersection of N Flint Avenue and NE Broadway.
- Adding a new Clackamas Pedestrian and Bicycle Bridge crossing over I-5 to connect NE Clackamas Street near NE 2nd Avenue to the N Williams Avenue/N Ramsay Way/N Wheeler Avenue area.
- Adding a raised protected bicycle lane, sidewalk, and lighting on N Vancouver Avenue between NE Hancock Street and NE Broadway.
- Upgrading existing bicycle facilities on NE Broadway and NE Weidler Street within the Project area with wider, raised protected bicycle lanes.

- Adding a new SB bike lane and NB bicycle and sidewalk facilities on the east side of N Williams Avenue (formerly Wheeler Avenue) between N Ramsay Way and NE Multnomah Street.
- Adding a new access pathway between NE Flint Avenue and NE Vancouver Avenue, which may serve as a future multiuse path as identified in the 2012 Facility Plan.
- The Project will consider infill of existing sidewalk gaps within the project area.

1.2.4 Other Project Improvements

The Project's other improvements generally include constructing or reconstructing the following elements:

- Freeway pavements
- Highway structure widenings
- New undercrossing structures
- Public transit facilities directly impacted by the Project
- New retaining walls and noise walls
- American Disabilities Act (ADA) compliant ramps, sidewalks, and multiuse paths
- Drainage and water quality improvements
- Traffic signals, ramp meters, and signage
- Utility facilities
- Landscaping and aesthetic features

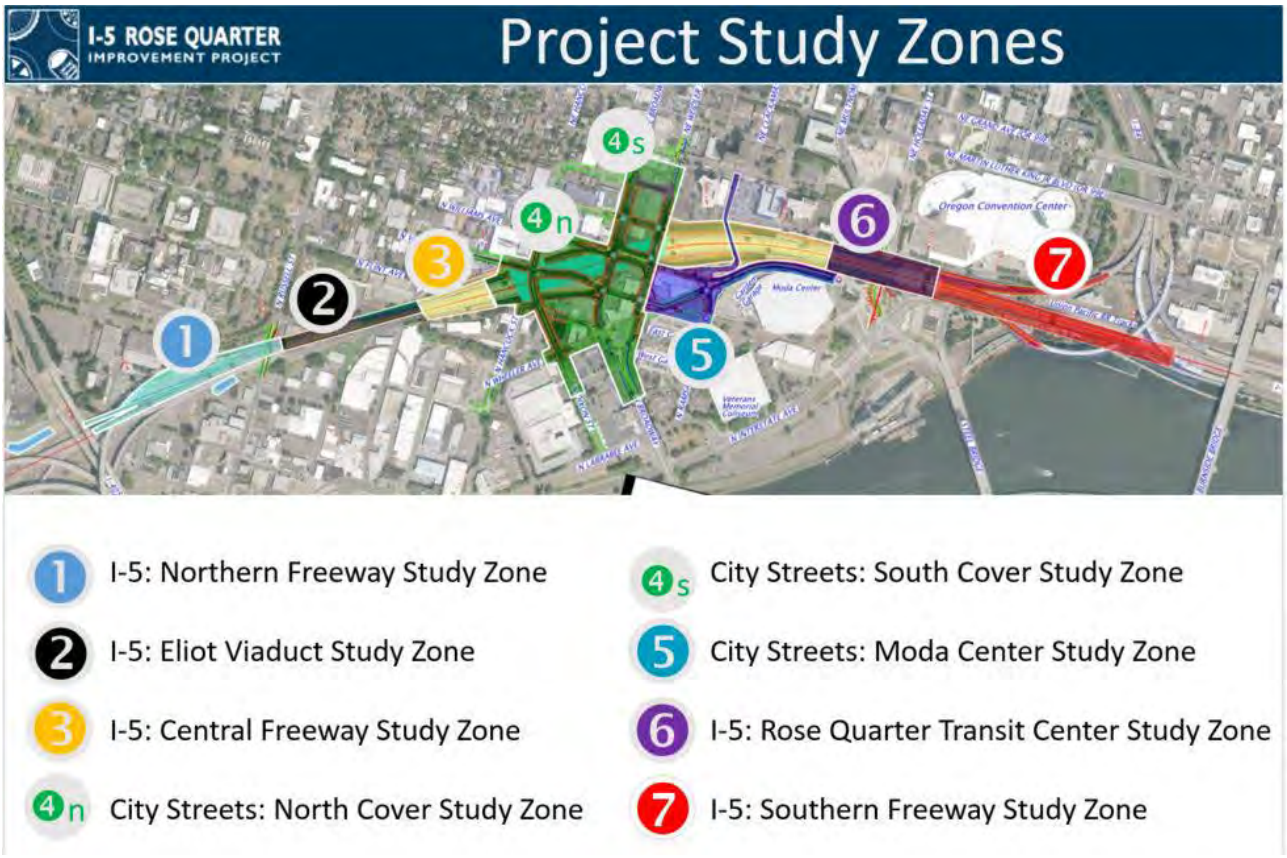
1.2.5 Community Outreach Performed to Date

ODOT, in partnership with the City of Portland, conducted extensive public engagement from the start of the NEPA Phase (July 2017) to now (November 2020). While the Project team studied potential environmental benefits and impacts, ODOT and the City engaged with communities about the proposed Project features, the environmental study, and how to provide input on the Project. Additionally, extensive outreach and stakeholder engagement was conducted as part of the 2012 Facility Plan. Just prior to and during the public comment period, the NEPA phase team conducted outreach to inform the public, interested stakeholders, and environmental justice interests about the environmental study findings. This input also informed the design refinements contained in this 20% Design Memorandum.

1.3 Project Study Zones

To facilitate the design refinement process, the Project was dissected into seven geographic study zones, as shown in Figure 1. A discussion of each study zone, as well as a general Project-wide section, can be found in Chapters 1.5 and 4. A discussion of Project-wide drivers can be found in Chapter 3.

Figure 1. Geographic Study Zones



These study zones can generally be described as follows:

- **Study Zone 1: Northern Freeway (See Chapter 4.1)** is the northernmost Project area, which includes several existing viaduct structures that comprise the I-5/I-405 interchange area. As a part of this Project, modifications to the existing interchange area include:
    - An addition of a NB auxiliary lane, shoulder, and safety recovery taper at the I-5 NB to Greeley Avenue exit ramp.
    - Widening of the I-5 NB to I-405 SB exit ramp.
    - Modifications to N Russell Street to accommodate I-5 mainline structure widening for the new auxiliary lane and shoulders.
- **Study Zone 2: Eliot Viaduct (See Chapter 4.2)** begins at the south end of the I-5/I-405 interchange viaduct. This zone includes approximately 550 linear feet of “on-grade” interstate mainline and 430 linear feet of viaduct widening.

    Project elements include:

    - I-5 NB pavement reconstruction and widening, and construction of a retaining wall to accommodate a new NB auxiliary lane and shoulders.
    - Widening of the existing I-5 NB Eliot Viaduct.
    - Reconstruction of the existing Eliot Viaduct retaining wall.
    - Construction of noise walls in the NB direction adjacent to the Harriet Tubman Middle School and Lillis Albina City Park.

- **Study Zone 3: Central Freeway (See Chapter 4.3)** includes approximately 3,000 linear feet of existing freeway. The Project will reconstruct the existing roadway section with new continuously reinforced concrete pavement (CRCP). To balance achieving the I-5 vertical clearance while minimizing grade differential impacts to the local streets network and surrounding built environment, the Project will lower the existing freeway profile through the highway cover.

  The Project maintains the existing freeway centerline and will reconstruct the existing N/NE Broadway and NE Weidler Street interchange ramps. Extensive use of retaining walls are included within this zone to minimize additional impacts associated with the construction of the auxiliary lane in each direction.

- **Study Zones 4n and 4s: North & South Cover Areas (See Chapter 4.4)** are composed of the City's local street network within the Broadway/Weidler Interchange area. It is generally bordered by NE Hancock Street/N Dixon Street on the north, NE Weidler Street on the south, N Wheeler Avenue on the west, and NE 1st Avenue on the east. It includes Portland Streetcar (City of Portland) on NE Broadway and NE Weidler Streets, as well as several north-south and east-west bus lines (TriMet) and one express bus service between the Lloyd District and Vancouver, WA (C-Tran). These areas exclude I-5 and the entrance and exit ramps included in Study Zone 3. As a part of this Project, the following elements of the local street network include:
  - Removal of the existing overcrossing structures at NE Weidler Street, N/NE Broadway, and N Williams Avenue and replacement with a single highway cover structure over I-5.
  - Removal and replacement of the existing N Vancouver Avenue overcrossing structure with an expanded highway cover over I-5, including a new roadway crossing at N Hancock Street and N Dixon Street.
  - Removal of the existing overcrossing structure at N Flint Avenue.
  - Upgrades to existing pedestrian and bicycle facilities, including a new center median pedestrian and a NB bicycle path on N Williams Avenue between NE Weidler Street and N/NE Broadway.
  - Reconstruction of NE Weidler Street and N/NE Broadway with upgraded pedestrian and bicycle facilities, matching the City's planned road reorganization project cross section at the east and west ends of the Project.
- **Study Zone 5: Moda Center (See Chapter 4.5)** comprises the City's local street network around the Moda Center. The zone is south of NE Weidler Street, north of NE Multnomah Street, and excludes I-5 and the entrance and exit ramps, which are included in other zones. It includes several bus lines (TriMet and C-Tran) circulating around the Moda Center. As a part of this Project, the following local street system elements included are:
  - Modifications to the Moda Center access, including a reconfiguration of the N Wheeler Avenue/N Williams Avenue/N Ramsay Way intersection.
  - Upgrades to existing pedestrian and bicycle facilities, including a new SB bike lane and addition of NB bike facilities and a sidewalk on the east side of N Williams Avenue between N Ramsay Way and NE Multnomah Street.
  - Construction of the Clackamas Pedestrian and Bicycle Bridge, a new crossing over I-5 connecting N Ramsay Way on the west and NE Clackamas Street on the east.

- **Study Zone 6: Rose Quarter Transit Center (See Chapter 4.6)** includes an auxiliary lane extension in both the NB and SB directions. This results in a widening of the existing I-5 NE Holladay Street/NE Hassalo Street viaduct, a widening and reconstruction of approximately 330 linear feet of at-grade roadway. In addition to items summarized above, Project modifications include:
    - Widening of the existing NE Holladay Street/NE Hassalo Street viaduct.
    - Rehabilitation of the existing SB NE Holladay Street/NE Hassalo Street viaduct bridge deck (funded by non-project sources).
    - Reconstruction of existing freeway retaining walls and construction of a NB noise wall.
    - Temporary impacts to the Rose Quarter light rail transit station as a result of new bridge columns and structure widening.
    - Construction of additional columns along Multnomah Street within the existing sidewalk.
- **Study Zone 7: Southern Freeway (See Chapter 4.7)** is the southernmost portion of the Project that spans over NE Lloyd Boulevard, Union Pacific Railroad (UPRR) tracks near the I-5/I-84 Banfield interchange. In the SB direction, the Project will modify a portion of the I-5 SB to I-84 EB flyover connection and extend an auxiliary lane to the I-5 SB Morrison exit ramp. In addition to the items summarized above, Project modifications include:
    - In the NB direction, the Project will provide a two-lane I-84 WB to I-5 NB entrance ramp through a combination of restriping and widening of the existing ramp.
    - Construction of new bridge columns along NE Lloyd Boulevard.
    - Relocate median barrier and restripe both NB and SB travel lanes to accommodate the SB auxiliary lane extension to the Morrison exit ramp.
    - Retrofit NB and SB bridge rails with crash compliant bridge railing.
    - Strengthening of existing median overhang to support traffic lanes.
    - The Eastbank Esplanade will remain open during construction.

1.4 20% Design Refinements from Revised Baseline Design

As part of the 20% design, many refinements and assumptions have been implemented that differ, to varying degrees, with the design concepts assumed during the NEPA Phase. These differences are a natural part of design progression, as concepts are refined from a 5 percent (NEPA Phase) level of design to the current level of design. The design progression performed focused engineering studies on the selected NEPA alternative. Table 1 summarizes design refinements and changes to assumptions made between this 20% Design Package and the prior Revised Baseline milestone. Elements not listed in the table are consistent with the concepts developed during the prior design milestone. Similar tables summarizing prior design updates from each preceding milestone were included within the Project's Revised Baseline and 15% Basis of Design Memorandums. These tables have also been provided within Appendix S of this document. The concepts are based on best available information and will be vetted with stakeholders and the public as design progresses. Future design refinements should also be expected as the level of analysis is increased, additional technical information is gathered, and further community input is provided.

The intent of the design refinements is to enhance the technical solutions, address comments received during the NEPA phase's public comment period, resolve comments and implement feedback received during subteam meetings, and reduce design-associated risks prior to

estimating the Project's cost. The refinements implemented within this 20% Design Memorandum are consistent with the findings of the NEPA FONSI / Revised EA, inclusive of its defined Purpose and Need and Area of Potential Impact (API).

Additional information related to these revisions and the comprehensive set of working design assumptions are provided within Chapter 4 of this 20% Design Memorandum.

Table 1. Design Updates since the Revised Baseline

Study Zone	Topic	Revised Baseline Assumption	20% Design Concept	Rationale for Design Progression Change
1	None	N/A	N/A	N/A
2	None	N/A	N/A	N/A
3	Revised girder size and replaced cover board with sacrificial concrete	Fire cover board with BT48 girders and partially lowered I-5 mainline profile.	Fire cover board with BT60 girders. Includes accommodation for remote video inspection. Lowered I-5 Mainline profile through highway cover for additional structure depth.	BT60 girders provide additional structural capacity and open cover landscaping. The use of cover board with remote video inspection provides a balance for fire protection with long term maintenance and inspection needs.
4n	Signalized intersection at Hancock St and Vancouver Ave	Intersection signalized	Intersection not signalized. Hancock stop sign controlled.	Intersection does not meet signal warrants. Concept refinements have eliminated the need for the bike transition from Vancouver to 2-way Williams Ave facility. Removing signal also enhances through bike and bus operations.
4n	Vancouver Ave roadway cross section	Section includes one bus only lane and two general purpose travel lanes.	Section includes one bus only lane, one general purpose lane, and on-street parking.	Increased traffic performance and reduces intersection crossing exposure at Broadway intersection. A consensus could not be reached on a final preferred layout for this topic with the Project agency partners. As a result, an alternative layout is provided in Appendix R. The preferred layout will be coordinated with Project agency partners and resolved after the 20% milestone.

Table 1. Design Updates since the Revised Baseline

Study Zone	Topic	Revised Baseline Assumption	20% Design Concept	Rationale for Design Progression Change
4n	Williams Ave cross section north of Broadway	On-street parking on west side of Williams removed. Sidewalk level bike lane with new westside curbline.	On-street parking maintained on both sides. Street level bike lane with no change to existing curblines.	More flexibility for future cross section usage (bus only lane). A consensus could not be reached on a final preferred layout for this topic with the Project agency partners. As a result, several alternative layouts are provided in Appendix R. The preferred layout will be coordinated with Project agency partners and resolved after the 20% milestone.
4n	Williams Ave bus stop and transition	Three general purpose travel lanes with far side bus stop approximately 150 feet from Broadway.	Two general purpose travel lanes and a bus only lane with far side bus stop approximately 50 feet from Broadway.	Three general purpose lanes not needed for traffic operations. A consensus could not be reached on a final preferred layout for this topic with the Project agency partners. As a result, an alternative layout is provided in Appendix R. The preferred layout will be coordinated with Project agency partners and resolved after the 20% milestone.
4s	Easterly crosswalk at Weidler St and N Vancouver Ave	Close crosswalk on the east side of intersection.	Provide protected pedestrian crossing at easterly crosswalk.	Improved pedestrian connectivity in Pedestrian District can be achieved without degrading traffic performance.

Table 1. Design Updates since the Revised Baseline

Study Zone	Topic	Revised Baseline Assumption	20% Design Concept	Rationale for Design Progression Change
4s	Weidler/Vancouver lane configuration	Dedicated right turn lane provided.	Dedicated right turn lane eliminated.	Increased traffic performance. A consensus could not be reached on a final preferred layout for this topic with the Project agency partners. As a result, an alternative layout is provided in Appendix R. The preferred layout will be coordinated with Project agency partners and resolved after the 20% milestone.
4s	Bike lane configuration at Weidler St and Williams Ave	NB and SB bike movement provided on Williams between Weidler and Ramsay.	Revised bicycle and pedestrian storage areas on SW corner. Elimination of SB bikes on Williams between Weidler and Ramsay.	Increased storage area for pedestrians and bicycles waiting at signal. Increased safety for pedestrians and bicycles by eliminating conflicting movements.
5	Ramsay Way Multimodal Cross Section	Curbside bi-directional bike facility on north side with sidewalk to the outside.	Curbside sidewalk with bi-directional bike facility to the outside on north side of Ramsay.	Reduced intersection conflicts with bike and pedestrian movements.
5	Clackamas Pedestrian and Bicycle Bridge Western Touchdown configuration	Pedestrian and bicycle “roundabout.”	Pedestrian and bicycle mixing zone with direction connections to Ramsay and Williams.	City preference for no pedestrian and bicycle roundabout. The preferred design concept will be coordinated with Project agency partners and resolved after the 20% milestone.

Table 1. Design Updates since the Revised Baseline

Study Zone	Topic	Revised Baseline Assumption	20% Design Concept	Rationale for Design Progression Change
5	Modified Williams Ave cross section south of Ramsay	SB shared bike/auto lane, NB multi-use path.	SB and NB bike lanes or SB bike lane and NB multi-use path.	Increased safety by providing more separation among modes. A consensus could not be reached on a final preferred layout for this topic with the Project agency partners. As a result, several alternative layouts are provided in Appendix R. The preferred layout will be coordinated with Project agency partners and resolved after the 20% milestone.
6	Wall 14 & 15 design alternative	Soldier pile tie-back walls with anchor block.	Soldier pile tie-back walls with Dead-man anchor piles.	More cost-effective wall design with reduced construction duration.
7	Southbound structure widening	Bridge widening extends to the Morrison exit ramp	Widening terminates south of the UPRR railroad tracks. The southbound auxiliary lane to the Morrison exit ramp is accommodated by a combination of median barrier relocation and restriping of the NB and SB travel lanes.	Included within the FONSI / Revised EA based on comments received during Draft EA. Adjustment removes conflicts with the Eastbank Esplanade and all in-water-work associated with new foundations.
7	I-5 SB to I-84 EB exit ramp alignment and structure widening	Exit ramp and structure on new alignment	Shift exit ramp to match new mainline travel lanes and safety shoulders. Widening of the existing exit ramp structure and transition to match existing flyover exit ramp.	Avoids additional bridge work including structure replacement over the UPRR railroad and Eastbank Esplanade while still accommodating the new SB auxiliary lane.

1.5 Project Preliminary and Final Design Phase Schedule

At present, the Preliminary and Final Design Phases are anticipated to extend from 2019 to 2023. The first step of Preliminary Design, called the Conceptual Design Phase, culminates in this 20% Design Package Submittal. The second step of Preliminary Design is the development of a Draft and Final 30% Design Package. These submittals, along with formal approval in 2021, establishes the detailed Project scope and refined concepts for implementation in the Final Design Phase.

Prior to the completion of the Preliminary Design phase, a number of key primary decisions and assumptions will be required to guide the Final Design Phase. Some of these items include the highway cover shape and use, Fire and Life Safety (FLS) preliminary recommendations for FLS design criteria and countermeasures, and assumptions for Early Work packages (EWPs). Additionally, input received from public involvement and Project stakeholders will be used to guide the solutions within the Preliminary and Final Design phases.

The Final Design Phase, consisting of 60%, 90%, pre-100%, and 100% submittal milestones, is scheduled for completion in 2023. During the Final Design Phase, EWPs will be developed for construction ahead of the main construction package. The EWP identification and planning process are still in development, however a preliminary list of EWP activities and assumptions have been identified within this 20% Design Memorandum. These EWP strategies will continue to be refined and advanced through the collective input of the participating agencies and the CM/GC.

1.5.1 Early Work Package Assumptions

The Project team has developed a range of potential EWPs that can be advanced through Final Design and construction in advance of a comprehensive “Main Construction Package.” These potential EWPs take into consideration the Project’s objectives including, but not limited to, providing early Disadvantaged Business Enterprise (DBE) contracting opportunities, managing Project risk, and reducing overall Project budget and schedule. Through a preliminary screening process, the Project team developed two distinct EWPs for consideration. As part of the CM/GC on-boarding process and ongoing Project stakeholder engagement, these potential EWPs will be further vetted and refined until a final EWP delivery strategy is adopted.

1.5.1.1 Early Work Package A (North End)

This EWP is envisioned to include the entirety of Study Zone 1 which is the I-5/I-405 interchange area structure widening along with the northern most stormwater treatment site. This work can be completed efficiently and independently from any other work south of this Project area. The work presents possible DBE contracting opportunities as well as advances the type of bridge and foundation work in the construction timeline that would otherwise be on the Project’s critical path for construction completion.

1.5.1.2 Early Work Package B & C (South End)

This EWP is envisioned to include the entirety of Study Zone 6 and Study Zone 7. Originally, the Project team considered only EWP B and the NB structure work along the I-84 WB to I-5 NB entrance ramp structure, as these areas are entirely within existing right-of-way (ROW). After further evaluation, the SB widening within Study Zone 7 was also recommended to be included within this EWP, to provide additional construction efficiency and minimize the potential

maintenance of traffic (MOT) and construction work zone impacts of separate packages. The team has also recommended that Wall 13 be considered as a Project scope contingency item to be considered as part of this EWP, as it provides for additional early DBE contracting opportunities and will provide additional area for further construction staging areas and enhanced MOT with later phases. The work within this EWP can be completed efficiently and independently from any other work north of this Project area. As with EWP A, EWP B & C also present possible DBE contracting opportunities and advance the type of bridge and foundation work in the construction timeline that would otherwise be on the Project's critical path for construction completion. It also allows for any disruption to the existing light rail transit services - that may be required for the highway structure work - to occur prior to east/west travel disruptions within the Broadway/Weidler interchange.

1.5.1.3 Other Potential Early Work Package Elements

Although not assigned specifically to an EWP, other Project elements could be contracted earlier than the Main Construction Package that would provide Project benefit. These elements, ultimately to be determined by the CMGC contractor, include but are not limited to:

- Building(s) demolition
- Staging Yard Preparation
- Early materials procurement (such as temporary Streetcar rails)
- Utility relocations
- Other DBE focused elements (such as retaining walls)

1.5.2 Project Design Schedule and Assumptions

This schedule does not assume the preparation of a new environmental document, such as a future Revised EA for a significant change not identified within the 20% Design Package. Further, the Preliminary and Final Design Phase milestones may need to be revised should new environmental documentation, beyond standard NEPA re-evaluations, be required.

The Preliminary Design Phase milestones are provided below:

- 15% Basis of Design Memo Submittal = October 8, 2019
- *Cost-to-Complete (CTC) Report Submittal (by others) = February 1, 2020*
- Revised Baseline Concept Package = May 21, 2020
- 20% Design Submittal = December 4, 2020
- EWP A Draft 30% Package Submittal = May, 2021 (Assumption)
- EWP B/C Draft 30% Package Submittal = June, 2021 (Assumption)
- Main Package Draft 30% Package Submittal = December, 2021 (Assumption)
- Final 30% Package Submittal = Spring, 2022 (Assumption)
- 30% Approval (aka, Final Design Phase start) = Spring, 2022 (Assumption)

2 Design Standards and Governing Criteria Methodology

The following section outlines the Project's governing design criteria and standards that have been applied to the 20% Design Memo. The Project improvements range in jurisdiction and authority and include a number of overseeing agencies, including but not limited to ODOT, Federal Highway Administration (FHWA), City of Portland, and TriMet. In addition to these

controlling design criteria, a range of adopted plans exist within the Rose Quarter improvements area that may affect the design elements included within this Project. These multijurisdictional design authorities, policies, and plans will continue to be used to inform and guide Project design beyond the 20% Design.

2.1 Freeway

I-5 is an urban Interstate Freeway under ODOT jurisdiction and authority. The freeway elements for this Project are being developed in accordance with the Highway Design Manual (HDM) Section 1.3.2.2 ODOT 4R/New Design Standards. In cases where specific design criteria is not identified within the HDM, American Association of State Highway and Transportation Officials' (AASHTO) "A Policy on Geometric Design of Highways and Streets – 2011" is to be used. This 20% Design Memorandum's Appendix L outlines the required standards, and existing and proposed conditions for the roadway features within the Project limits. Additionally, Appendix K includes a list of design elements that are anticipated to not meet facility standards and require Design Exceptions. Other applicable design standards include:

- ODOT 2012 Highway Design Manual
- ODOT Mobility Procedures Manual
- AASHTO Roadside Design Guide (RDG), 4th edition
- FHWA Policy on Additional Access to the Interstate System
- UPRR – BNSF Railway Guidelines for Railroad Grade Separations Projects

2.2 Local Streets and Facilities

Local Streets and Facilities includes improvements and modifications to pedestrian, bicycle, transit, and auto facilities on the City-owned street network. Local streets refers to City-owned streets, and not specifically the streets with a Local Street functional classification. The Project includes construction on the following streets:

- N Hancock Street/N Dixon Street – between N Ross Avenue and N Williams Avenue
- N/NE Broadway– between N Benton Avenue and NE 2nd Avenue
- NE Weidler Street – between N Benton Avenue and NE 2nd Avenue
- N Wheeler Avenue – between N Dixon Street and N Williams Avenue
- N Flint Avenue – between N Hancock Street and NE Broadway
- N Vancouver Avenue – between N Tillamook Street and N Wheeler Avenue
- N Williams Avenue – between N Hancock Street and NE Multnomah Street
- NE Victoria Avenue – between NE Broadway and NE Weidler Street
- NE 1st Avenue (temporary construction for Streetcar) – between NE Broadway and NE Weidler Street
- N Ramsay Way – between N Flint Avenue and N Williams Avenue
- N Russell Street – between N Ross Avenue and N Commercial Avenue
- Construction of I-5 widening will occur over NE Multnomah Street, NE Holladay Street, and NE Lloyd Boulevard. Modifications or reconstruction of these street cross sections are not anticipated, however, the City may require sidewalk modifications based on impacts from additional I-5 columns.

These local streets are under City of Portland jurisdiction and authority. The local street elements for this Project are being developed in accordance with the following:

City of Portland

- Design Guide for Public Street Improvements (1993)
- 2035 Transportation System Plan (TSP) (2018)
- Designing for Truck Movements and Other Large Vehicles in Portland (2008)
- Pedestrian Design Guide (1998)
- Standard Drawings (most recent effective date)
- Standard Construction Specifications
- ADA Compliant Curb Ramp Design and Construction Criteria and Forms (scoping, design, construction criteria)
- Traffic Design Manual, Vol 1: Permanent Traffic Control and Design (2020)
- Traffic Design Manual, Vol 2: Temporary Traffic Control (2019)
- Portland Protected Bicycle Lane Planning and Design Guide (2019)
- Sign Code Book (2018) Central City Fundamental Design Guidelines (2001)
- Bicycle Plan for 2030 (2010)
- Lloyd District Design Standards
- Broadway-Weidler Corridor Plans
- PedPDX; Portland's Citywide Pedestrian Plan (2019)
- Lloyd District Transportation Projects Special Design District
- Lloyd District Transportation Capital Improvements District-wide Design Criteria
- Special Design Guidelines for the Design Zone of the Lloyd District of the Central City Plan
- PBOT/ODOT/BPS Central City 2035 N/NE Quadrant Plan
- PCC 17.28.110 Driveways-Permits and Conditions

National Association of City Transportation Officials (NACTO)

- Urban Street Design Guide (2013)
- Urban Bikeway Design Guide (2014)
- Transit Street Design Guide (2016)
- Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities (2017)
- Don't Give Up at the Intersection: Designing All Ages and Abilities Bicycle Crossings (2019)

AASHTO

- "A Policy on Geometric Design of Highways and Streets – 2011"
- Guide for the Development of Bicycle Facilities (2012)

ODOT

- ODOT ADA Curb Ramp Process – Project Requirements (2020)
- Blueprint for Urban Design (2020)

FHWA

- Manual on Uniform Traffic Control Devices (MUTCD) (2009)

This 20% Design Memorandum's Appendix L outlines the required standards, and existing and proposed conditions for the roadway features within the Project limits. Additionally, Appendix K

includes a list of design elements anticipated to not meet facility standards and will require Design Exceptions.

2.3 Traffic Engineering

2.3.1 Traffic Operations

ODOT HDM Chapter 10.12.3 specifies for a volume-to-capacity (v/c) ratio not exceeding 0.75 for freeway mainline, weave sections, ramp junctions, and ramp terminals in the Build Alternative design year. Both the NB and SB weave sections within Study Zone 1 are anticipated to operate slightly above a v/c ratio of 0.75, requiring a Design Exception for design life. The proposed NB and SB weaving section within Study Zone 6 is projected to operate with a v/c ratio near 1.0 during the 2045 design year. A Design Exception for design life is anticipated. Other freeway segments are anticipated to perform below a v/c ratio of 0.75 in the design year.

The ODOT HDM design standard for v/c ratio at interchange ramp terminals are not to exceed 0.75 during the 20-year design life of the Project. Additionally, the Project's 95th percentile queue lengths must also be less than the available storage length at signalized intersections. If either of these criteria are not satisfied, a Design Exception will be required and sought. Anticipated Design Exceptions and approvals are listed in Appendix K.

City capacity standards should follow Administrative Rule TRN 10.27 to protect future land use cases in this area. In addition, the provisions in Chapter 2 of the TSP under Performance Measures item "m" (page 31) would apply:
https://www.portlandoregon.gov/citycode/article/41049

2.3.2 Transit Design

TriMet operates several fixed-route bus and light rail transit (LRT) lines (TriMet MAX service) within the Project limits, while the City of Portland, via Portland Streetcar Incorporated (PSI) provides Streetcar service on N/NE Broadway and N/NE Weidler Street.

LRT and TriMet and C-Tran Bus Design Criteria:

LRT track geometry, trackwork standards, and bus facility designs will conform to the current versions of TriMet Design Criteria, Directive Drawings, and Standard Specifications. Items not addressed in TriMet's standards will be developed with TriMet guidance.

In order of precedence, LRT and bus design will draw on the following sources:

- TriMet's Design Criteria, Rev 11.1 (July 2017)
- Manual for Railway Engineering and Portfolio of Trackwork Plans, AREMA, latest edition
- American Public Transportation Association (APTA) Guidelines for Design of Rapid Transit Facilities
- Transit Cooperative Research Program (TCRP) Report 155, Track Design Handbook for Light Rail Transit, latest edition

Streetcar Design Criteria:

PSI has not published an owner-approved design criteria manual, but standards developed for earlier Portland Streetcar projects are available. When otherwise lacking, Streetcar geometry

and trackwork standards will conform to locally-adopted best practices developed by the City and Portland Streetcar.

In order of precedence, Streetcar design will draw on the following sources:

- Portland Streetcar Typical Design Parameters, URS memo, July 2007
- TriMet's Design Criteria, Rev 11.1 (July 2017)
- Manual for Railway Engineering and Portfolio of Trackwork Plans, AREMA, latest edition
- TCRP Report 155, Track Design Handbook for Light Rail Transit, latest edition

For the 20% Design layout, the design criteria as listed in Table 2 was applied:

Table 2. Streetcar Base Design Criteria

Design Element	Standard
Minimum Radius of Curved Rail	20 meters (~66 feet) (with approval only)
Streetcar Length	64.93 feet (66.04 feet coupler to coupler)
Streetcar Width	8 feet
In Travel Lane Envelope (minimum)	10 feet
Grade	6% desirable (8% maximum for short distances)

2.3.3 Access Management

Due to the complexity of the Project, Project-specific guidance will be established to identify impacted driveways and design new access points in the Project area, as appropriate. This Project-specific guidance will blend ODOT, FHWA, City of Portland Bureau of Transportation (PBOT), and Bureau of Development Services (BDS) access management processes and criteria.

For driveways under ODOT jurisdiction, or driveways located within the interchange influence area, the following guidance will apply:

- ODOT manages access to the state highway system based on state law (Oregon Administrative Rules [OAR], Chapter 734, Division 51 Highway Approaches, Access Control, Spacing Standards and Medians), engineering principles, and objective standards (HDM Section 9.1.3 Access Control at Interchanges). These policies establish the main assumptions for the Project:
    - Driveway access to interchange ramps will not be permitted and none are planned at this time.
    - Existing and future driveways within the interchange influence area will need ODOT, in partnership with the City of Portland, review and concurrence.
    - Depending on type of access (for example: driveways accessing interchange ramps), ODOT may need to coordinate with and gain concurrence from FHWA.
    - Design Exceptions for driveways that do not meet City of Portland spacing standards may be needed.
- For interchange spacing and interchange ramp spacing, the Oregon Highway Plan (OHP) Table 18 and ODOT HDM Section 9.1.2 and Figure 9-8 operate as the Project's controlling criteria. Concurrence is required from the Region Access Management Engineer (RAME) for

existing ramp and interchange spacing that will be maintained or modified with this Project and does not meet the necessary minimum spacing. Interchange ramp spacing that does not meet the minimum spacing requirements in Figure 9-8 of the HDM will require a documented Design Exception.

- ODOT will coordinate with and gain concurrence from FHWA for interchange spacing and existing ramps for those that do not meet design criteria.

For driveways under City of Portland jurisdiction, and outside of the interchange influence area, the following policy will apply: 17.28.110 Driveways - Permits and Conditions, as well as City's adopted comprehensive plan and applicable zoning codes for this area. This policy establishes the main assumptions:

- No portion of a driveway (excluding ramps, if required) shall be located closer than 25 feet from the corner of a lot where two streets intersect.
- More than one driveway may be allowed for frontage up to 100 feet with the approval from the Director of the Bureau of Transportation and the City Traffic Engineer.
- Varying guidelines for residential and commercial driveway widths.
- City Traffic Engineer review and concurrence needed.

Driveways under both ODOT and City of Portland jurisdiction will be considered on a case-by-case basis. Assumptions for Access Management are summarized in Appendix O.

During the Final Design Phase, the Project will balance the following considerations when making decisions about existing and future access points: safety, operations in the interchange area, MOT operations and staging, business access to commercial properties (e.g., delivery access and accommodation for waste collection), existing and future development potential, active transportation needs, land use, parking use and future parking needs, vehicle type and size for turning templates, approach spacing, sight distance, channelization, weaving, queuing, and crash rates.

2.3.4 Traffic Signals and Interconnect

2.3.4.1 Ramp Meters

The ramp meter design for this Project will conform to the following standards:

- ODOT Oregon Standard Specifications for Construction (2021)
- ODOT Oregon Standard Drawings (Latest Version)
- ODOT Traffic Signal Policy and Guidelines (2017)
- ODOT Traffic Signal Design Manual (2020)

2.3.4.2 Traffic Signals and Interconnect

The traffic signal design for this Project will conform to following standards, as applicable:

- ODOT Oregon Standard Specifications for Construction (2021)
- ODOT Oregon Standard Drawings (Latest Version)
- ODOT Traffic Signal Policy and Guidelines (2017)
- ODOT Traffic Signal Design Manual (2020)
- PBOT Traffic Signal Design Guide, 2017
- FHWA Manual on Uniform Traffic Control Devices (2009)

Traffic signals and interconnect on local streets will be mostly owned, operated, and maintained by PBOT after the Project is constructed. Assumptions for ownership and operations of the impacted signalized intersection are summarized in Appendix N. The Project assumes that traffic signals will be designed to meet the maintaining agency's standards and that interconnect on local streets will be designed to meet PBOT's standards and preferences.

PBOT's traffic signal standards contained in their current Traffic Signal Design Guide and the standard specifications generally follow ODOT's standards with some modifications, such as for transit signal priority. PBOT's Standard Drawings, however, differ from ODOT's and they have different preferences for communications equipment to be used for interconnect. The design differences between ODOT and PBOT standards will continue to be explored and confirmed as the design progresses and will be incorporated into the 30% design milestone and Final Design Phase documents. A memorandum of understanding (MOU) or Intergovernmental Agreement (IGA) between ODOT and the City is recommended to document ODOT's future role in ownership, maintenance, and operation for the signalized intersections. Table 3 summarizes key differences in signal standards and the type of impact each has on early design development.

Table 3. Signal Design Standards Comparison

Design Element	ODOT	PBOT	Primary Impacts to Early Design Development
Signal pole standard	Standards include option of arms longer than 55'	Maximum arm length is 55' Open to the use of dual mast arms where practical	ROW Cost
Signal pole foundations	Drilled shaft foundations Depth based on geotechnical borings	Depth based on standard drawings unless the soil is disturbed	Geotechnical needs
Signal pole placement	Behind walk	Furniture zone	ROW Design Exceptions
Number of heads for three or more through lanes	One per lane	Typically, centered on lane lines, but it is subject to site-specific design for multi-lane approaches	ROW (pole placement) Cost (larger poles)
Signal phasing	ODOT allows permissive left turns where appropriate	Lead pedestrian intervals and no turn on red restrictions in areas with high potential for conflicts preferred	Operations
Bicycle Signal	Far-side displays	Prefers 4" diameter near-side bicycle signals as a supplement to the far-side displays	Cost
Service cabinet	Base mounted 10' from controller cabinet Metered	Base mounted or pole mounted Not metered	ROW Cost
Pushbutton placement	Pushbuttons only as last resort on mast arm poles Use separate pedestrian	Prefers pushbuttons separated by at least 10′ unless the two ramps	ROW

Table 3. Signal Design Standards Comparison

Design Element	ODOT	PBOT	Primary Impacts to Early Design Development
	poles	share a common landing Can mount pushbuttons on mast arm poles to minimize number of poles	
Detection	Radar	Radar for vehicles Loops for bikes	Cost

Bicycle signals are proposed for signals on N/NE Broadway and on NE Weidler Street. As of this writing, these signals must conform to the requirements of the FHWA Interim Approval for the Optional Use of Bicycle Signal Faces (IA-16). If active experiments lead to changes in FHWA guidance while the Project is in design, the new guidance will prevail. Listed below are a few key issues related to bike signal design that highlight what is and is not possible, as alternative designs are considered:

- Conflicting vehicle movements - A bicycle signal phase shall not be active with a conflicting vehicle phase. For example, if a bike lane with bike signal is to the right of a shared through right vehicle lane, the two may not run concurrently.
- "Turn on Red" restrictions - There are several cases for this Project that may result in left or right "turn on red" restrictions. Where there is a 'shall' condition in IA-16, the restriction was incorporated into the traffic analysis. Optional cases will continue to be evaluated.
- Bicycle turn prohibitions - Turn prohibitions cannot be accomplished using signing or striping, but rather requires arrow indications unless movement is not lawful and practical. For example, a left turn from a bike lane to the right of through lanes would not be lawful in Oregon; therefore, arrow indications would not be required.
- Bike signal indication visibility; placement of head nearside versus far side - these elements will be evaluated in more detail as the design progresses.
- Shared lanes - Bicycle signals shall not be used where bikes share a lane with vehicles.
- Scramble phases - Bicycle signals shall not be used for a scramble phase for bike movements only.

At locations subject to ODOT's approval, as listed in Appendix N, many aspects of traffic design will require approval by the State Traffic-Roadway Engineer and/or the Region Traffic Engineer. The majority of these items will be covered as part of traffic signal design approval requests. Below is a list of traffic design features anticipated to require ODOT approval (Note: City approvals will also be required; however, a comprehensive list is not known at this time). Details of approval requirements are provided in ODOT Traffic Manual: https://www.oregon.gov/odot/Engineering/Pages/Manuals.aspx

- State Traffic-Roadway Engineer
    - Colored pavement
    - Crosswalk closure
    - Dual turn lanes
    - Marked or enhanced crosswalk (e.g., rectangular rapid flashing beacon [RRFB])

  - Traffic signals installation, modification, or removal
  - Transit exceptions to turn lanes
  - Turn lanes
  - Turn prohibitions
  - Intelligent Transportation Systems
  - Bike signals (including 4 inch near-side signal heads)
  - Bike boxes
- Region Traffic Engineer
  - Advance stop lines (at marked crossings)
  - Bike lanes
  - Marking style for crosswalks
  - Ramp meters
  - Illumination
  - Turn lanes
  - Turn prohibitions
  - Wrong way treatments
  - Rumble strips
- State Traffic Signal Engineer
  - Plans
  - Project-specific special provisions

2.3.5 Intelligent Transportation Systems (ITS)

The Project presents an opportunity to install a fiber optic trunk line along I-5 through the Project area to provide additional redundancy to the regional Intelligent Transportation Systems (ITS) network and provide an easy connection point for ITS devices installed with the Project and future projects. Assumptions for ITS are summarized in Appendix F. ODOT currently has a fiber optic communications connection through the Rose Quarter and Albina area on a PBOT-owned aerial cable. Construction will need to be staged in such a way that limits downtime and disruptions for the multiple networks on the cable that are routed through the ODOT Region 1 Headquarters Building. Coordination between ODOT and PBOT will be necessary for allowed downtimes or need for temporary infrastructure installation.

Lane restriction and additional smaller variable-message signs (VMS) will be installed to facilitate FLS emergency notifications to motorists if an emergency should occur within the tunnel. This signing will use a combination of existing and new VMS signing along the I-5 Corridor.

Pan-Tilt-Zoom (PTZ) cameras will be placed at key locations to allow for monitoring of traffic leading up to the tunnels.

Radar detection will be replaced based on construction impacts to existing locations. New radar detection will be added to new guide sign structures between the I-84 WB to I-5 NB ramps for data collection for NB and SB I-5 traffic.

The ITS components will be designed to meet the following standards:

- ODOT’s Oregon Standard Specifications for Construction (2021)
- ODOT’s Oregon Standard Drawings (Latest Version)
- ODOT’s Traffic Signal Policy and Guidelines (2017)

- ODOT's Traffic Signal Design Manual (2020)
- FHWA's MUTCD (2009)
- National Electric Code (Latest Version)

2.3.6 Sign Design

The sign design for this Project is being developed in accordance with the ODOT Traffic Sign Design Manual 3rd Edition and the 2009 Edition of MUTCD. Appendix K includes Design Exceptions and deviations pertaining to the overhead sign design and Appendix E includes the signing roll map, which shows all existing and proposed overhead and major guide signs along the freeway and local streets. Local street signing will follow PBOT's Sign Code Book and MUTCD standards. The remainder of signing required for the Project roadways will be included during the Final Design Phase.

The widening of I-5 will result in mainline and ramp lane changes, thus requiring appropriate changes to the signing along the corridor. Major freeway updates on I-5 impact a short distance – a little over a mile between two major freeway-to-freeway interchanges – with three exits for both the NB and SB directions. This short distance with multiple exits and entrances poses a challenge for advance sign placement and sign spacing. More detail about key sign design assumptions within each zone are discussed later in this document.

Replacement of advance guide signs on I-5 SB upstream of the Project will begin approximately 500 feet south of the Greeley Avenue entrance ramp. Advance guide signs north of the Greeley Avenue entrance ramp will not be updated as they are not impacted by the Project. Advance guide signs upstream of the Project in the NB direction will be updated to provide the optimal advance signage and spacing along the freeway. Impacted signing on I-5 NB extends to MP 301.13, which is 3/4 mile south of the I-84 WB entrance ramp (south Project limit). Two new advance guide signs will be installed on an existing sign bridge at MP 301.13. A preliminary structural analysis has been made to determine there would be adequate loading capacity for the new guide signs. This structural analysis will be confirmed during the 30% Design Package. All other advance guide signs south of the I-84 WB entrance ramp will be structure mounted or mounted on new sign structures.

Signs within the Project limits will be designed for location and spacing in accordance with MUTCD standards. Due to the close proximity of major interchanges, design deviations for sign spacing are anticipated. Spacing becomes a particular challenge as signing approaches the freeway-to-freeway interchanges for both NB and SB I-5. The proposed highway cover pose additional spacing challenges, as it reduces available overhead sign space along the freeway as stated below. Currently, a sign is proposed to be mounted on the north end of the highway cover for approaching traffic on I-5 SB; this will be similar to a bridge structure mount. Detailed constraints are listed below:

- For I-5 NB, exits 302A and 302B have approximately 2/3 of a mile (3,500 feet) between them, allowing for advance signage at 1 mile and 1/2 mile for Exit 302A. Overhead arrow-per-lane signs between the I-84 WB entrance ramp and Exit 302A will be utilized as well. Exit 302B and 302C are spaced 810 feet apart. The signing challenges for the NB approach to these two interchanges include the closely-spaced exits, the use of an overhead arrow-per-lane sign at Exit 302B (which eliminates additional signage on the NB structure for Exit 302C), and the highway cover (which eliminates 1/3 mile of available freeway signing space).

- For I-5 SB, advance signage at 1/2 mile and 1/4 mile will be provided for Exit 302A, including overhead arrow-per-lane signs between the I-405 SB entrance ramp and Exit 302A. Exit 301 and 300B are spaced 1,100 feet apart. The signing challenges for the SB approach to these two interchanges include the closely-spaced exits and the highway cover (which eliminates 1/4 mile of available freeway signing space).
- Consideration was taken to reduce the amount of proposed sign structures, which resulted in consolidation of signs for the NB and SB directions on the same sign bridges. All new sign bridges will be designed to span the entire width of freeway, as opposed to spanning one direction.
- Current proposed sign design for Exit 302A complies with MUTCD Section 2E.20. This interchange is in advance of two additional closely-spaced interchanges in both the NB and SB directions. The overhead arrow-per-lane sign eliminates the ability to advance signage for these closely-spaced interchanges at a critical location. Additionally, the proposed highway cover further reduces the freeway space for these signs.

2.3.7 Illumination Design

2.3.7.1 Local Street Illumination

Illumination will be reinstalled on all City-owned facilities impacted by the Project, with design extending beyond Project limits as needed to tie into the existing systems. Several styles of existing local street luminaires will be impacted by the Project, which include:

- Ornamental poles (single and twin)
- Cobra heads on metal poles
- Cobra heads on Pacific Power-owned wood poles
- Cobra heads on signal poles
- Pedestrian-scale luminaires

Proposed Lighting System Options will be determined by the City of Portland's Guidelines for Lighting Options for New or Reconstructed Streets.[1] A portion of the proposed illumination falls within the Lloyd District, which requires Option C (owned and maintained by the City) Lighting. All other areas impacted will fall under either Option A (owned and maintained by the utility) or Option C; Option B (owned by the City and maintained by the utility) is not permitted. Additionally, lighting equipment and design in the Lloyd District will require direction from City of Portland staff, per the Design Guidelines for C.O.P. Street Lighting Systems.[2]

The power utility covering the entire Project area is Pacific Power. Coordination will be required at an early stage of design to determine power source locations and utility conflicts.

Local street illumination design will require coordination between PBOT and ODOT. This is to ensure that both agencies' standards are being met or that a mutual standard is agreed on. Inter-agency coordination is critical to ensure that the design meets local and federal standards and provides optimal, safe lighting for the new or reconstructed roadways as well as contracting requirements. Several design factors that need to be included in the coordination are listed in Table 4.

[1] City of Portland. March 2007.

[2] City of Portland, January 2004.

Table 4. Inter-Agency Illumination Coordination Items

Coordination Item	ODOT	PBOT
Illumination Analysis Methodology and Targets	RP-8-18	City of Portland – Recommended Light Levels and Guidelines for Roadway Lighting
Illumination Equipment	ODOT Special Provisions (requires a minimum of three manufacturers)	City of Portland – Electrical Equipment and Materials (several luminaire styles are not covered in ODOT's special provisions)
Specifications and Special Provisions	ODOT 2021 Standard Specifications	PBOT 2020 Standard Specifications
Luminaire placement	Back of walk	Front of walk (furnishing zone)

The illumination analysis coordination will precede other items, as the determined target light levels will inform many design components, such as fixture type, spacing, distribution, and power needs. Target levels for ODOT and the City are based on differing methodologies, resulting in different target levels for both roadways and intersections in the Project area. Comparison between targets was made using the illuminance method for both roadways and intersections, as this method is preferred for shorter block lengths and is widely used by both ODOT and PBOT. ODOT Target Levels were determined using the RP-8-00[3] (roads) and RP-8-14[4] (intersections) manual and PBOT Target Levels were determined using the City of Portland – Recommended Light Levels and Guidelines for Roadway Lighting[5]. Table 5 below shows the comparison of target levels for the majority of roadways in the Project. Table 6 shows the comparison of target levels for the majority of intersections. This comparison is a preliminary look at the target levels and serves to show the key differences in functional classification and target levels between agencies. These comparisons will be used to determine an agreed-on target for each roadway classification that can be applied to impacted roadways for the design of the Project. The ODOT and PBOT methodology tables used to determine the target levels can be found in the PBOT Illumination supporting documents.

Table 5. Illumination Analysis – Agency Target Levels for Roadways

Roadway Segment	PBOT Lighting Target Levels			ODOT Lighting Target Levels		
	Functional Classification	Illuminance (fc)	Uniformity (E_{avg}/E_{min})	Functional Classification - Ped Level	Illuminance (fc)	Uniformity (E_{avg}/E_{min})
NE Broadway	Major Traffic	1.2	3	Major - High	1.7	3
NE Weidler St	Major Traffic	1.2	3	Major - High	1.7	3
NE Hancock St	Local Service	0.6	4	N/A	N/A	N/A
NE Multnomah St	Neighborhood Collector - Major	1.2	3	N/A	N/A	N/A

[3] Illuminating Engineering Society (IES), 2000.

[4] Illumination Engineering Society (IES), 2014.

[5] City of Portland, May 2019.

Table 5. Illumination Analysis – Agency Target Levels for Roadways

Roadway Segment	PBOT Lighting Target Levels			ODOT Lighting Target Levels		
	Functional Classification	Illuminance (fc)	Uniformity (E_{avg}/E_{min})	Functional Classification - Ped Level	Illuminance (fc)	Uniformity (E_{avg}/E_{min})
	Transit					
NE Holladay St	Local Service	1.2	3	N/A	N/A	N/A
N Ramsay Way	Local Service	0.9	4	N/A	N/A	N/A
N Vancouver Ave	Neighborhood Collector - Major Transit	0.9	4	N/A	N/A	N/A
N Williams Ave	Neighborhood Collector - Major Transit	1.2	3	N/A	N/A	N/A
N Wheeler Ave	Neighborhood Collector - Major Transit	0.7	4	N/A	N/A	N/A
NE Victoria Ave	Local Service	0.4	4	N/A	N/A	N/A
NE 1st Ave	Local Service	0.9	4	N/A	N/A	N/A
N Tillamook St	Local Service	0.9	4	N/A	N/A	N/A
N Ross Ave	Local Service	0.6	4	N/A	N/A	N/A

Table 6. Illumination Analysis - Agency Target Levels for Intersections

Intersection		PBOT Lighting Target Levels		ODOT Lighting Target Levels	
Roadway 1	Roadway 2	Intersection Illuminance (fc)	Intersection Uniformity (Eavg/Emin)	Intersection Illuminance (fc)	Intersection Uniformity (Eavg/Emin)
NE Broadway	NE 1st Ave	1.2	3	2.6	3
NE Broadway	NE Victoria Ave	1.2	3	2.6	3
NE Broadway	N Williams Ave	1.8	3	3.4	3
NE Broadway	**N Vancouver Ave**	1.8	3	3.4	3
NE Broadway	N Wheeler Ave	1.8	3	2.9	3
NE Broadway	N Ross Ave	1.2	3	2.6	3
NE Weidler St	NE 1st Ave	1.2	3	2.6	3
NE Weidler St	NE Victoria Ave	1.2	3	2.6	3
NE Weidler St	N Williams Ave	1.8	3	3.4	3
NE Weidler St	N Vancouver Ave	1.8	3	3.4	3
NE Weidler St	N Wheeler Ave	1.8	3	2.9	3
N Ramsay Way	N Wheeler Ave	0.7	4	2.4	4
N Williams Ave	N Wheeler Ave	1.8	3	2.9	3
NE Multnomah St	NE 1st Ave	1.2	3	2.1	4
NE Multnomah St	N Wheeler Ave	1.8	3	2.4	4

Table 6. Illumination Analysis - Agency Target Levels for Intersections

Intersection		PBOT Lighting Target Levels		ODOT Lighting Target Levels	
Roadway 1	Roadway 2	Intersection Illuminance (fc)	Intersection Uniformity (Eavg/Emin)	Intersection Illuminance (fc)	Intersection Uniformity (Eavg/Emin)
NE Holladay St	NE 1st Ave	1.2	4	2.1	4
NE Holladay St	N Wheeler Ave	0.7	4	2.4	4
N Williams Ave	NE Hancock St	1.2	3	2.1	4
N Vancouver Ave	NE Hancock St	0.9	4	2.1	4
N Vancouver Ave	N Ramsay Way	0.9	4	2.1	4

Text in **bold** indicates the intersection is partly owned by ODOT.
PBOT requires vertical illuminance calculations at unsignalized marked crossings.

2.3.7.2 Freeway Illumination

This Project will replace the existing freeway and ramp illumination system within the Project limits. See Chapter 4.4.3.5 for freeway illumination systems, including highway cover illumination, to be modified or installed as part of this Project.

A detailed lighting analysis will be performed using the AGi32 lighting software to evaluate light levels for the interchange areas and freeway mainline. Light level values will be based on those published in the ODOT lighting design manual and the Illuminating Engineering Society of America National Standard Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (RP-8-18).

Table 7 summarizes the recommended illuminance values to be used in this analysis. Glare and veiling luminance at critical points will be checked to verify a 30 to 40 percent maximum veiling luminance ratio. The reflectance characteristics of the pavement will impact the amount of light required to achieve the recommend light levels. Both Portland Cement Concrete (PCC) and black asphalt pavement surfaces will be considered in the lighting analysis.

Table 7. Freeway Recommended Light Levels

Location	Min. Average Maintained (fc)	Max. Uniformity (Avg/Min)
On/Off Ramps	1.0 to 1.5	3:1
Gore Areas	1.0 to 1.5	3:1
Weaving Lanes	0.8 to 1.0	3:1
Mainline	0.9	3:1

The new illumination system will include base mounted service cabinet with illumination (BMCL) service cabinets, conduit, wiring, cobra head style luminaires, street light poles, and foundations. All equipment, including foundations, will be located within ODOT or City ROW or permanent easements. The lighting design approach assumes the following:

- Energy efficient light-emitting diode (LED) luminaires.
- Typical “cobra head” steel light poles. Fixed base poles will be installed outside of the clear zone per AASHTO design guidelines, or behind a protected barrier. Slip base poles will be installed if the proposed pole needs to be placed inside the clear zone.
- Poles will be located 30 feet from the edge of the travel lane or 5 feet behind the face of a barrier.
- A luminaire mounting height of 40 feet, unless a 50-foot mounting height is required to meet light levels.
- Fifteen-foot luminaire arms on the freeway mainline.
- Six- to 15-foot luminaire arms on on-ramp and off-ramp locations.

The illumination design for this Project will conform to the following standards:

- ODOT Lighting Policy and Guidelines, 2017
- ODOT Traffic Lighting Design Manual, 2018
- ODOT’s Oregon Standard Specifications for Construction, 2021
- ODOT’s Oregon Standard Drawings, Latest Version
- Illumination Engineering Society of American National Standard Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (RP-8-18)
- AASHTO Green Book, 11th Edition

Coordination with the utility company will be required at an early stage of design to determine power source locations and utility conflicts. Freeway illumination design will require coordination and approval from ODOT. Proposed LED luminaires (minimum three manufacturers), lighting analysis methodology, and recommended target values will be coordinated with ODOT as part of the 30% Design Package.

2.3.7.3 Temporary Freeway Illumination

Temporary lighting will be installed as needed to provide adequate freeway and ramp lighting during the construction of the Project. A lighting analysis will be performed using the AGi32 lighting software to evaluate light levels for the interchange areas and freeway mainline. Light level values will be based on those published in the ODOT Traffic Lighting Design Manual. Table 8 summarizes the recommended illuminance values to be used in this analysis.

Table 8. Temporary Illumination – Freeway Recommended Light Levels

Location	Min. Average Maintained (fc)	Max. Uniformity (Avg/Min)	Maximum to Minimum
On/Off Ramps	1.2	4:1 to 6:1	15:1 or less
Gore Areas	1.2	4:1 to 6:1	15:1 or less
Mainline	0.8	4:1 to 6:1	15:1 or less

The temporary lighting will be coordinated to determine pole locations during all construction stages as part of the Project’s Final Design Phase. The lighting design will assume the following:

- Wood poles
- Fifteen-foot minimum luminaire arms

- Energy efficient LED luminaires
- Poles will be located 30 feet from the edge of the travel lane or 5 feet behind barrier
- Aerial power distribution, unless the existing underground illumination system can be used

The illumination design for this Project will conform to the following standards:

- ODOT Lighting Policy and Guidelines, 2017
- ODOT Traffic Lighting Design Manual, 2021
- ODOT's Oregon Standard Drawings, Latest Version
- Illumination Engineering Society of American National Standard Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (RP-8-18)
- AASHTO Green Book, 11th Edition

Temporary illumination design will require coordination and approval from ODOT. Proposed luminaires, poles, lighting analysis methodology, and recommended target values will be coordinated with ODOT as part of the 30% Design Package.

2.3.8 Traffic Control and Temporary Maintenance of Traffic

Temporary traffic control design criteria will conform to the following standards:

- ODOT Traffic Control Plans Design Manual
- Oregon Temporary Traffic Control Handbook for Operations of 3 Days or Less
- ODOT Sign Policy and Guidelines
- ODOT PCMS Handbook
- ODOT Work Zone Traffic Control Standard Drawings
- ODOT/APWA Standard Specifications for Construction
- PBOT Traffic Design Manual, Volume 2 - Temporary Traffic Control
- PBOT Temporary Traffic Control Standard Drawings and Details.

2.4 Bridges and Structures

2.4.1 Auxiliary Lane Bridge Widenings

The Project includes the following I-5 bridge widenings:

- Br. No 08583, Hwy 1 over NE Hassalo St and NE Holladay St, MP 301.99
- Br. No. 08782A, Eliot School Viaduct, Hwy 1, MP 302.65
- Br. No. N8958A, Fremont Viaduct, Hwy 1 NB , MP 302.99
- Br. No. 08958E, Hwy 1 NB to Hwy 61 SB over Conn (E Fremont Intchg), MP 303.06
- Br. No. 16358, NB Hwy 1 Conn to N Greely Ave over City Street, MP 303.04
- Br. No S8588E, Hwy 1 SB over UPRR, MP 301.70 (I-5)
- Br. No. 08588C, Hwy 1 SB to Hwy 2 EB over Hwy 1 and Conn (Banfield Interchange), MP 0.23 (I-84)

The Project includes the following I-84 bridge widenings:

- 08588A, Hwy 2 WB to Hwy 1 NB over UPRR (Banfield Interchange), MP 0.24

Designs for new elements supporting bridge widenings will satisfy the requirements in the ODOT Bridge Design Manual (BDM) and ODOT Geotechnical Design Manual (GDM), as well as relevant AASHTO manuals referenced within them. Widening designs do not include

maintenance items, AASHTO Green Book, 11th Edition etc., that are not directly affected by the Project improvements.

Inspection reports for bridges in this corridor identify several recommended maintenance items for each bridge, such as deck rehabilitation, joint repairs, girder painting. Bridge widenings in this Project address existing maintenance items only in the following circumstances:

- Bridge widenings where the physical limits of the widening encompass the area of the maintenance item.
- Scenarios where the location of the maintenance item in the bridge creates potential for it to negatively impact the structural performance of the bridge widening.

Maintenance items beyond these circumstances will not be addressed in this Project.

As specified by the ODOT BDM, existing members that will be affected by widening need to be strengthened for permit vehicles OR-STP-4D, OR-STP-5BW, OR-STP-4E in the LRFD Strength II Limit State, but not for HL93 in Strength I (see ODOT BDM 1.3.2[4]). It is also understood that if strengthening to meet that requirement is too costly, ODOT will consider approving Bridge Design Deviations for a lesser amount of strengthening, as long as all Load and Resistance Factor Ratings (LRFR) exceed 1.0. Existing load ratings indicate that some existing bridge members have deficiencies for permit vehicles. Strengthening of these deficient members will only be incorporated in this Project if widening of the bridge increases the amount of the deficiency. Application of this approach to the existing deficient members results in the following:

- Strengthening of deficient interior steel girders (Bridge #08588C) will not be addressed in this Project as bridge widenings are unlikely to increase deficiencies in such members.
- Strengthening of deficient reinforced concrete crossbeams (Bridges #08588C, #08782A, and #N8958A) may be included depending on the location of the deficiency within the member. Crossbeam deficiencies in exterior bent spans adjacent to the bridge widening will likely be strengthened; deficiencies within interior bent spans will not be addressed in this Project.

The conclusions above are based on existing load rating results and do not include impacts of the improvements made by the Project. These impacts will not be known until future design phases. It should be assumed, however, that the deficient crossbeams identified above will be strengthened with crossbeam enlargements utilizing reinforced concrete for those locations connecting to the bridge widenings.

See Chapter 2.4.4 for the seismic design approach.

See Appendix G and Appendix H for specific bridge assumptions.

2.4.2 New Structures

The Project consists of the following new I-5 structures:

- Br. No. TBD, Highway Cover (N Vancouver, NE Hancock, N Williams, NE Broadway, and NE Weidler over Hwy 1), MP C302.40
- Br. No. TBD, Clackamas Pedestrian and Bicycle Bridge over Hwy 1, MP 302.20

Designs for new bridge structures will satisfy the requirements in the ODOT BDM and ODOT GDM, as well as relevant AASHTO manuals referenced within them.

See Appendix G and Appendix H for specific bridge assumptions.

2.4.3 Retaining Walls

A number of retaining walls are planned within the Project corridor along the proposed I-5 widening and local streets (Appendix G). The following wall types were selected to address needs for both cut and fill walls within the corridor based on the cost effectiveness, site conditions, constructability, and functional application. These five wall types include: mechanically stabilized earth (MSE) walls, cast-in-place walls, cantilever soldier pile walls, solider pile walls with concrete anchor blocks or tiebacks, and secant/tangent walls. Wall types with descriptions of applications and restrictions for their use within the corridor are as follows:

- MSE Wall
    - No restrictions on height.
    - Limited use because of required construction easement. Horizontal limits = 0.7H Bench + 1:1 Slope.
    - Not allowed in City of Portland ROW.
- Cast-in-Place Walls
    - Generally used when the height of the wall is less than or equal to 8 feet and there are no property impacts during construction.
- Soldier Pile Walls
    - Used without tiebacks (cantilevered) for wall height less than or equal to 15 feet.
    - Used with tiebacks or anchor blocks for wall heights greater than 15 feet.
        - Tiebacks are allowed within State and City property and when ROW is already being acquired.
        - No tiebacks under private property not being acquired.
        - Tiebacks and timber lagging are not allowed in City of Portland ROW.
- Secant or Tangent Walls
    - Used when wall height is greater than 15 feet and tiebacks and site restrictions prevent use of tiebacks, or when buildings and structures are behind the wall and very limited ground deformation is required.
    - Drilled shafts can be stacked to develop a pseudo counterfort wall.

A full list of anticipated retaining walls and types is located in Appendix G. Note that five retaining walls (2b, 3, 4, 14, and 15) are unique due to special site conditions and the potential impact of the wall construction on adjacent existing buildings and facilities. Below is a summary of the five walls:

- Wall 2b is located along NB I-5 at the Eliot Viaduct widening area. The proposed wall is a cut retaining wall. The wall is proposed to be up to approximately 26 feet high. Existing buildings and facilities are approximately 20 feet away from the proposed Wall 2b. Due to the potential wall construction impact on the existing building, the wall should be designed as a non-yielding wall to minimize the risk of the potential impact, such as settlement of the school building. A tangent pile wall design was selected to minimize settlement.
- Wall 3 is located along NB I-5 between north of N Flint Avenue and N Vancouver Avenue. The proposed wall is a cut retaining wall and consists of double cantilevered soldier pile walls (Walls 3T & 3B), and lightweight fill is incorporated with Wall 3T. The height of Wall 3T

varies, but the maximum height is less than 15 feet; the height of Wall 3B varies, but the maximum height is less than 12 feet. The double cantilevered wall system was selected to achieve the required wall height while avoiding tiebacks in this area of the Project and the expense of a secant pile wall.

- Wall 4 is located along the NB I-5 on-ramp at NE Broadway. The proposed wall is a cut retaining wall. The wall height varies between approximately 8 to 19 feet. The wall alignment is approximately 10 feet away from the existing building and parking area. Due to the potential impact of the wall construction on the existing properties, the portion of the wall closest to the existing structures should be designed as a non-yielding wall to minimize the risk of potential impacts, such as settlement of adjacent buildings. Portions of the wall away from the building could potentially be designed as a yielding wall. However, given the wall height and inability to use tiebacks at this location, a secant pile wall design was selected for the entire length of Wall 4. A design progression will continue to investigate opportunities to use yielding wall types in portions of this wall that are not adjacent to existing structures.
- Wall 14 is located along the WB I-84 on-ramp to I-5. The proposed wall height varies between approximately 5 to 25 feet. The proposed wall alignment is approximately 20 feet away from the existing lower retaining wall, which currently retains the on-ramp along NE 1st Avenue. The existing retaining wall along NE 1st Avenue is an old retaining wall and was not designed under current seismic conditions. If this wall collapses during a seismic event, it will significantly influence the global stability of Wall 14. Therefore, to avoid this risk, a solider pile tieback wall with concrete anchor blocks and lightweight fill was selected for Wall 14.
- Wall 15 is located along SB I-5 between NE Oregon Street and NE Holladay Street. The proposed wall height varies between approximately 20 to 30 feet. The wall is a cut and fill wall. Therefore, typical types of walls such as solider pile wall with tiebacks, soil nail, MSE, or cast-in-place, are not preferred types due to potential impact on I-5 or risk of wall global stability. A soldier pile tieback wall with concrete anchor blocks and lightweight fill was selected for this wall.

Details of the unique walls are provided in Appendix I. Designs for new retaining wall structures will satisfy requirements in the ODOT GDM with the following exception:

> Non-yielding tangent and secant walls will be designed for at-rest earth pressure for static conditions and seismic active earth pressure for seismic conditions. This design approach and retaining wall types will be further evaluated after geotechnical explorations, testing, and analysis are complete.

Appendix G also contains Wall NCW that is a steel pile-supported cantilevered concrete wall, which is different than other wall types that have been described. This wall is a transition between the highway cover abutment and Wall 3B as shown in Appendix G and will be accomplished as an extension of the highway cover abutment.

Based on preliminary noise analyses, two reasonable and feasible noise walls are anticipated in the Project. A public process to garner a decision for these walls, as is ODOT practice, will be conducted during the Final Design Phase. It is assumed that these walls conform to ODOT standard drawings.

2.4.4 Seismic Design Approach

Seismic design for bridge widenings will satisfy the requirements in the ODOT BDM and other AASHTO manuals referenced within it unless design deviations are issued in the Project. Following the process outlined in Figure 1.17.2-1A of the ODOT BDM, BR08583 is the only bridge that will require seismic structural model incorporating existing and new elements. This is the only bridge widening in the Project with new columns on both sides of the structure. Other widened bridge designs will include seismic detailing but will not require development of full seismic models.

The design process outlined in Figure 1.17.2-1A also requires a practical assessment for a Phase 2 retrofit for each structure. In addition, if a Phase 2 retrofit is not performed, a Phase 1 retrofit is required. A design deviation will be required if a Phase 1 retrofit is not constructed as part of this Project.

New bridges will be designed according to the ODOT BDM, and deviations from it will require design deviations. Design criteria for partial replacement of structures has not been developed or been incorporated into the 20% Design.

The 20% Design does not include any seismic considerations for retrofitting of existing modified structures, but typical reinforcement ratios for proper seismic detailing were incorporated into the quantities that have been developed.

2.4.5 Fire and Life Safety Design Approach

Preliminary analyses were completed, per the requirements of National Fire Protection Association, Standard 502 (NFPA 502), for appropriate design fires resulting from emergency events. These results demonstrated that FLS systems are required for the highway cover structures to satisfy code requirements for safe egress of people (tenability) for facility occupants and structural protection during events. The Project design fire has been defined as the 300 megawatt fire with a “hydrocarbon” growth rate based on a flammable liquid tanker fire spill. Additional details for FLS analyses are discussed in Study Zones 4n and 4s (Chapter 4.4.3.3) of this 20% Design Memorandum. FLS assumptions are shown in Appendix J.

2.4.6 Traffic Structures

Future traffic movements differ from the existing conditions and require new and modified signage on I-5 from MP 301.13 to MP 303.09 including select local streets and intersecting highways to adequately direct drivers to the appropriate lanes carrying their intended movement. Signage will be mounted in a variety of methods including individual overhead galvanized steel sign structures meeting ODOT standard designs, when possible, as noted below, or attached to existing or new vehicular bridges when possible. Existing sign structures that will remain in place but will have new static signing will be evaluated and three options are possible: the structure has sufficient capacity to carry the proposed new signs, the signage must be reduced for the structure to be sufficient and for economic viability of the Project or the signage location and arrangement must be redesigned.

Due to varying site constraints, the Project team anticipates the use of both spread footings and drilled shaft foundations, but primarily drilled shaft foundations because of the tight property boundaries. When drilled shafts are required, they are generally deep; therefore, it is recommended to use Cross Sonic Log Tubes and subsequent testing on each deep shaft in order to verify the integrity of the concrete in the shaft. Additional geotechnical investigations

and recommendations will be required to finalize the design because the existing boring log information is not near the sites and the nearby historical geotechnical reports do not address all proposed sites and structures. Based on experience, the existing soil types are generally acceptable for both drilled shaft and spread footing foundations, but economics and constructability should be considered as part of the foundation selection. The adjacent slopes, groundwater, slope stability, traffic impacts, and constructability will be considerations in the foundation type, size, and depth. In addition, if the majority of the foundations tend to be one type, consideration about making them all the same type will be discussed.

The sign structures will be designed in accordance with the following specifications, as applicable to the structure type:

- AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 1st Edition, with all current interim revisions, will govern the structural design of the new sign structures.
- ODOT Geotechnical Design Manual
- ODOT Traffic Structures Manual
- ODOT Bridge Design and Drafting Manual
- PBOT structural design requirements for City-owned facilities

2.4.7 New Truss Sign Bridges & Cantilever Structures

It is anticipated that some of the sign structures will exceed the ODOT standard drawings for appurtenances; for example, one sign bridge is proposed to host several large signs in addition to multiple ITS items. A custom design, but with similar detailing as the ODOT standard, will be required. Generally, the anticipated spans are within the ODOT standard maximums, but due to retaining walls and steep embankment slopes, the heights may also exceed the standards. Because of the steep embankment slopes on each end and tight property boundaries, drilled shafts are expected for foundations.

2.4.8 New Structure Mounts to Existing Bridges

Signage will be mounted on steel frames mounted to the existing concrete decks on the existing bridges with resin-bonded or through anchors.

Existing mounts will be used when feasible, but it is anticipated that most guide signs will require many new frames on existing bridges. The sign support frames will generally be mounted to the edge and underside of the concrete deck overhangs.

2.4.9 New Sign Mounts on Existing Sign Bridge

It is anticipated that all the steel vertical supports attaching any guide signs to sign structures will be replaced along with proposed new signs. The existing sign bridge will be evaluated for the proposed sign configuration and that it has sufficient capacity without structural retrofit or replacement.

2.5 Geotechnical

Geotechnical considerations in this Project will satisfy the requirements in the ODOT GDM, geotechnical design considerations included in the structural design standards listed in Chapter 2.4, as well as the referenced AASHTO and other manuals referenced within ODOT

manuals. Walls and features outside of ODOT ROW will utilize the equivalent City manuals, standards, and specifications. The requirements in these manuals will be implemented according to the local geology and subsurface conditions within the corridor. Subsurface conditions are described in Chapter 4 within each study zone, as well as in the Geotechnical Engineering Reports (GERs) and Geotechnical Data Report (GDR) that have been developed; however, a general description of the history and local geology of the Rose Quarter corridor is included in this chapter for background and understanding.

The Project lies within the Portland Basin, where Beeson and others[6] have mapped the underlying sediments as Sandy River Mudstone (SRM), overlain by Troutdale Formation. The Troutdale Formation is overlain by a sequence of catastrophic flood deposits laid by a series of floods, referred to as the Missoula Floods. During each episode, the floodwaters washed across eastern Washington and down the Columbia River gorge. In the Portland Basin, the floodwaters spread out depositing sediment consisting of boulders, cobbles, and gravel nearest the mouth of the gorge and along the main channel of the Columbia River. Cobble-gravel bars stretched west across the basin, grading to thick deposits of micaceous sand and silt.

The Missoula Flood Deposits (MFD) are divided into three facies: fine-grained facies, coarse-grained facies, and channel facies. The fine-grained facies consists of coarse sand to silt. The coarse-grained facies consist of gravel, cobbles, and boulders in a sand and silt matrix. The channel facies consist of complexly interlayered fine- and coarse-grained material formed by the channeling of flood deposits into earlier or contemporaneous deposits. In the time since the catastrophic floods, local rivers, creeks, and streams have eroded and reworked the landscape, depositing varying thicknesses of alluvial sediment in the region. Also, in the vicinity of the Project site, variable thicknesses of fill material were placed before development of the I-5 corridor.

Geological summaries of subsurface investigations by study zone are included within Chapter 4 of this 20% Design Memorandum.

2.6 Stormwater/Hydraulics

The stormwater management basis of design is detailed in the Final Water Resources Impact Assessment, dated August 22, 2019 and submitted under separate cover. The Project's stormwater management design will adhere to the rules of the Oregon Department of Environmental Quality (DEQ) and the U.S. Environmental Protection Agency (EPA) as well as the Oregon Department of State Lands, U.S. Army Corps of Engineers, ODOT, and City of Portland, as they pertain to the Project.

The City of Portland and ODOT each hold a National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Permit issued by Oregon DEQ to manage their respective storm sewer systems.

The stormwater design standards are based on the current versions of the ODOT Hydraulics Manual, the Portland Sewer and Drainage Facilities Design Manual, and the Portland

[6] Beeson, M.H., Tolan, T.L., and Madin, I.P., 1991, Geologic Map of the Portland Quadrangle, Multnomah and Washington Counties, Oregon, and Clark County, Washington: Oregon Department of Geology and Mineral Industries, Geological Map Series GMS-75, scale 1:24,000

Stormwater Management Manual, effective October 2020. The ODOT and City standards meet or exceed the standards required by the Federal-Aid Highway Program (FAHP), the National Marine Fisheries Service, and the requirements provided in their respective NPDES permits. Stormwater assumptions are shown in Appendix P.

3 Other Project Drivers

3.1 Equity by Design

The Project is located within the historic Albina community. As the Project advances into subsequent design phases, there will be a defined process to listen, inform, engage, and empower historically impacted African American communities and communities of color. This Equity by Design process will lead to the inclusion of community-driven design decisions and elements into the Project. The Project public engagement plan identifies a number of stakeholders and engagement strategies to seek design input. The 20% Design Memorandum serves in support of those discussions.

3.2 Design Exceptions and Design Deviations

Due to the existing Project constraints and a range of competing needs and objectives, multiple Roadway Design Exceptions and design deviations are anticipated. As part of the NEPA Phase, anticipated Design Exceptions on ODOT facilities were preliminarily coordinated with ODOT Technical Services. Many of these Design Exception elements have been carried forward into the 20% Design layout, while others have been modified or identified. Appendix K includes a preliminary summary of anticipated Design Exceptions, Design Deviations, or non-standard approvals listed by discipline and approving agency.

As the Project will impact, modify, or construct a range of facilities with different jurisdictions and authorities, many Project elements will involve a range of review and approval processes to seek concurrence for the Project design. The Project will follow adopted agency design approval processes for any element inconsistent with prevailing policies or standards. Coordination will occur with the applicable agencies to identify these policies and processes as part of the 30% Design Package.

3.3 Corridor Mobility Approach

I-5 is a key N/S regional connection running through multiple west-coast states and connecting international borders. Specifically as it applies to freight, I-5 is designated as an “Orange Route” on ODOT’s Motor Carrier Transportation Division’s (MCTD) facility designation. This designation indicates a generally unrestricted freight and oversized/overweight route. I-5 is also a designated high route. Based on these designations, I-5 has a minimum vertical clearance requirement of 17 feet 4 inches and minimum horizontal clearance requirement of 28 feet for two lanes of travel. In addition, the existing I-84 WB to I-5 NB horizontal clearance is limited within the one-lane NB entrance ramp from I-84, which requires a minimum horizontal clearance of 19 feet. I-5 is designated as an Oregon Revised Statute (ORS) 366.215 Reduction-in-Capacity review route that requires any permanent or temporary reduction in carrying capacity to be reviewed by ODOT MTCD and the State Mobility Advisory Committee (MAC).

The Project has reviewed the existing horizontal and vertical clearances within both the Project limits and adjacent freeway section. The existing N Williams Avenue structure, as well as N Vancouver Avenue and N Flint Avenue overcrossings, create local Project area restrictions to the vertical and horizontal clearance on I-5. All of these structures are proposed to be replaced with this Project. As a result, this Project includes an opportunity to eliminate existing clearance limitations that do not meet minimal clearance requirements for this type of facility. Based on input received by the MAC in August 2019, and input from the subteam meetings, the Project is designing to meet vertical clearance targets of 18-foot minimum for at least one travel lane and 17 feet 4 inches for the remaining I-5 mainline travel lanes. Reduced vertical clearance for the mainline shoulders and reduced vertical clearance for the Broadway/Weidler ramps is being proposed. The design clearance assumptions are listed in Appendix L. Existing over-height freight movements are currently served via I-205 and US 30 within N/NE Portland; however, with major freeway improvement projects such as this one, pinch points may be eliminated, improving safety and efficient movement of over-dimensional freight.

3.4 Urban Design

In the context of this 20% Design Memorandum, urban design is inclusive of the architecture and landscape architecture disciplines. The Project's urban design is intended to extend into all elements of Project design. The focus of design development in the 20% Design Memorandum is focused on the highway cover configuration and uses. The 20% Design remains consistent with the original NEPA design assumption, but with modified shape variations and structural capacities to enable urban design treatments adjacent to the local road alignments. The 20% Design reflects a single highway cover designed to accommodate open cover uses. The "open cover" concept includes public open-spaces at key locations within the urban context and within the Project footprint. The goal of the 20% Design's "open cover" concept is to blend the landscape and uses within the Project area, both on and off structure, with the adjacent urban area in its current and possible future development form. Neither the shape nor use are considered to be final decisions at this point. Both the shape and use of the highway cover are anticipated to be further evaluated, progressed, and coordinated with the public and Project stakeholders as part of the design progression towards the 30% design milestone.

3.5 Corridor Aesthetics Approach

To allow for additional discussion and input related to key Project elements, including the highway cover, corridor aesthetics recommendations have not been included within this memorandum. The design and consideration of corridor aesthetics and architectural treatment strategies will be further investigated as part of the 30% Design Package.

3.6 Environmental

The 20% Design's environmental constraints are derived from the NEPA FONSI / Revised EA and the supporting technical reports used to develop the NEPA EA. The Project footprint conforms to the Project area included in the FONSI / Revised EA. Design refinements since the EA have resulted in minor design deviations, but impacts to any given resource are generally consistent with the level of impacts analyzed and disclosed in the FONSI / Revised EA.

Air Quality/Climate Change. Any modifications to traffic patterns or design as evaluated in the EA will not increase or modify the impacts disclosed in the EA or deviate from the assumptions.

Design refinement resulting in minor deviations from the assumed traffic patterns evaluated in the EA may be the preferred solution. If those deviations do not result in reduced roadway or intersection level of service, or result in increased air quality impacts, minor deviations may occur.

Noise. Minor design changes will not modify the traffic patterns to the extent that additional noise analysis will be required. The Project will not deviate from the assumptions used in the EA to determine noise impacts to sensitive receptors and will not result in additional noise mitigation requirements.

Water Resources. The EA analysis includes "conceptual stormwater analysis" and "potential locations for stormwater treatment facilities" with a commitment to meet ODOT and City of Portland stormwater management requirements. Design refinements will result in stormwater treatment locations and facility types that differ from the conceptual stormwater plan; however, the ODOT and City of Portland treatment requirements will be met within the EA Project area and there will be no change to the findings presented in the EA with respect to water resources impacts as they relate to stormwater.

The 20% Design includes placement of new piers above the ordinary high water (OHW) but within the regulated floodplain of the Willamette River within the Open Space River General design overlay zone. These assumptions are consistent with the design solution identified within the FONSI / Revised EA. The proposed piers will likely required compliance with City of Portland Title 33 and Title 24.

Hazardous Materials. Initial evaluation of geotechnical borings has determined contamination consistent with the assumptions of the EA. There are no proposed design modifications or additional information that modifies the hazmat impacts assumed in the EA. Additional Phase I and Phase II Environmental Site Assessments will be required on ROW acquisition areas as well as in the vicinity of suspected subsurface hazardous materials to determine the extent and intensity of hazardous materials likely to be encountered during construction.

Utility. Impacts to utilities throughout the Project corridor were disclosed in the EA. While impacts to some utilities may differ from impacts envisioned in the EA, the deviations will be minor in nature and all major critical utility services will remain functional for the duration of the Project.

ROW. The EA assumes "3.5 to 4.0 acres in fee simple (permanent acquisition); 0.5 to 1.5 acres of permanent easement for surface and/or subsurface uses…; and approximately 1.5 to 2.5 acres of temporary easement…" resulting in the "displacements of person and property (Businesses 4; Landlord-Only Business 3; Outdoor Advertising Signs 4; Personal Property-Only 8; Residential 0". All ROW refinements within the 20% Design are believed to be consistent with the analysis and assumptions of the EA.

Transit – Streetcar. The EA states that streetcar operations would be accommodated during construction. Two options for accommodating streetcar service through the Project area during construction were considered. These two options were 1) including streetcar tracks in temporary structures that would be constructed to carry the east/west bicycle, pedestrian, and motor vehicle trips through the Broadway/Weidler corridor, or 2) by operating a temporary "bus bridge"[7] that would maintain transit connectivity to the east side streetcar stations and could

[7] A bus bridge is a temporary system of shuttle buses bypassing an interrupted segment of transit.

include construction of a new turnback. Due to the long term duration and potential to negatively impact streetcar ridership, the design will assume maintaining temporary streetcar operations with temporary tracks through the majority of construction with only limited bus bridging during changes to track alignments. The modified approach would generate less impact than assumed in the EA and is consistent with the EA Project area.

Transit – MAX Line. The EA anticipated impacts to MAX operations in the vicinity of Rose Quarter Transit Center during construction, up to and including complete closures of light rail beneath I-5 as well as a TriMet "bus bridge" to maintain service. The Project will use accelerated construction methods with only short duration "bus bridges." The modified approach would generate less impact than assumed in the EA and is consistent with the EA Project area.

Traffic. Minor deviations from any change in traffic patterns (i.e., NE Lloyd Boulevard) should be evaluated to determine if user's exposure is modified.

Active Transportation. The EA found that bicyclists would encounter generally favorable conditions, as determined by the bicycle level of traffic stress (LTS) scores at the study intersections through which the routes would pass. Overall conditions for pedestrians would also be similar to the No-Build Alternative, with the exception of slightly improved intersection quality in some locations. The Project design will maintain or improve bicycle and pedestrian LTS scores disclosed in the EA.

Parks/Section 4(f). Temporary impacts to the Eastbank Esplanade, a Section 4(f) resource, are not anticipated. There are no other impacts to Section 4(f) resources.

Land Use. Direct land use impacts (change to transportation use) total "approximately 2.54 acres." Acquisitions will not cause any instances of nonconforming development. Design refinement will result in minor deviations in temporary and permanent ROW acquisition; however, there are no proposed modifications that will change the impacts finding included in the EA.

Historic Resources. The avoidance and effect minimization measures contained within the Project area will be implemented to maintain a Section 106 Finding of "No Adverse Effects." The Project will be consistent with the Project area and not deviate from the assumptions and analysis presented in the EA.

4 Project Study Zones

4.1 Study Zone 1

4.1.1 20% Design Description

Figure 2. Study Zone 1

Study Zone 1 is the northern most Project area, which includes several existing viaduct structures that comprise the I-5/I-405 interchange area, as shown in Figure 2. As part of this Project, several modifications to the existing interchange area include:

- An addition of a NB auxiliary lane and safety recovery taper at the I-5 NB to Greeley Avenue exit ramp.
- Widening of the I-5 NB to I-405 SB exit ramp.
- Modifications to N Russell Street to accommodate structure widening.

There are no proposed modifications to I-5 SB within Study Zone 1 beyond potential restriping, due to temporary traffic control impacts, and signing or ITS modifications, as required. These Project elements will be considered and documented in greater detail as part of the 30% Design Package.

4.1.2 Concepts Discussion

The following design concepts were investigated within Study Zone 1:

- Widening strategies at Bent 27 of Bridge #08958E due to its close proximity to N Russell Street. Strategies include widening in line with the existing bent centerline and widening with a deflected bent to minimize impacts to N Russell Street.
- Additional bridge widening beyond the NB I-405 exit ramp to accommodate future BOS operations.
- Alternative stormwater treatment strategies for contributing impervious area.

4.1.3 Key Issues and Assumptions

4.1.3.1 Roadway

The Project would retain the existing roadway cross section and highway geometries in the SB direction. In the NB direction, the Project would transition from the proposed widened median shoulder (12 feet) and right shoulder (12 feet) back to existing conditions within the I-405

interchange area. Existing vertical clearance within the I-405 interchange area would be maintained. Maintaining existing conditions for shoulder width within the Project transition areas is expected to require Design Exceptions for the existing nonstandard features.

Future potential application of BOS operations were considered within the NB improvement area. The transition into Study Zone 1 limits would include construction of a full width left (median) and right shoulders, which would be compatible with BOS operations. However, due to the existing geometric constraints and narrow shoulders through the I-405 interchange, full width left and right shoulders cannot be maintained without major widening and reconstruction of the existing structures which is well beyond the current Project scope. In particular, the structures for the NB exit to I-405 and NB exit to Greely Avenue significantly constrain the additional widening required to achieve full width shoulders in this transition area of the Project. As such, no additional bridge widening to the structures located beyond the NB exit ramp to I-405 are proposed.

To accommodate the proposed I-5 NB auxiliary lane, the existing viaduct over N Russell Street would be widened toward the east. Due to the existing freeway cross slope and ascending grade on N Russell Street, the widening would result in a net reduction to roadway vertical clearance on N Russell Street. The design would result in an estimated minimum vertical clearance of 16 feet. The City's standard is 18 feet desirable and 16 feet minimum. The Project would request a Design Exception for the clearance given that N Russell Street is designated only as a Truck Access Street in City's TSP. Truck Access Streets are "intended to serve as access and circulation routes for delivery of goods and services to neighborhood-serving commercial and employment uses" (Portland 2035 Transportation System Plan). Non-local truck trips are discouraged.

As part of the structure widening over N Russell Street, the installation of a new bridge column adjacent to the EB travel lane on N Russell Street is proposed. At the intersection of N Russell Street and N Kerby Avenue, approximately 150 feet of the southern curbline and sidewalk would be shifted to the north to accommodate the new I-5 bridge column. While the overall curb-to-curb width for this small length of N Russell would be reduced, the intersection can still accommodate a WB-40 and a City of Portland T_1 Fire Truck turning left from N Kerby to EB N Russell Street. Additional coordinates would be required with the City as the design progresses.

Active Transportation

Due to the new I-5 bridge column, approximately 150 feet of the EB curb and sidewalk would be relocated and reconstructed to provide additional sidewalk clearance around the new bridge column. Within this area, N Russell Street has curb-to-curb width of approximately 43 feet with an EB travel lane width of approximately 15 feet. It is proposed that the EB travel lane be restriped at a width of 12 feet while maintaining an EB striped bike lane.

No additional modifications or impacts to Active Transportation are anticipated within Study Zone 1.

Transit

There are no modifications or impacts to transit within Study Zone 1.

4.1.3.2 Pavement

All I-5 NB improvements within Study Zone 1 are on existing viaducts and would not require pavement reconstruction.

Where required, due to the realignment of the N Russell Street curb line, the existing shoulder bike lane would be reconstructed. No additional paving is anticipated on local streets within Study Zone 1.

4.1.3.3 Structures/Geotechnical

Widenings in Study Zone 1 impact three bridges: Bridge #N8958A, #08958E, and #16358. See Appendix G, Appendix H, and Appendix I for details of structures and retaining walls within Study Zone 1. In general, variable width widening is accomplished in the following areas:

- Gore area at the I-5 NB exit ramp to Greeley Avenue (Bridge #N8958A / #16358)
- Gore area at the I-5 NB exit ramp to I-405 (Bridge #N8958A / #08958E)
- I-5 NB right side continuing into the exit ramp to I-405 (Bridge #N8958A)

Widenings to Bridge #N8958A would be accomplished with additional girder lines to support a deck extension and Type F barrier. Additional girder lines in this bridge are proposed to be prestressed girders and steel girders. The existing structure mostly utilizes AASHTO Type III girders, and the ability to utilize those exact girder types in the widening would depend on availability of formwork at local precast manufacturers. If AASHTO girders are not available, the new girders supporting the deck extension would be precast, prestressed members that approximately match the depth of the existing AASHTO girders, such as Modified DBT45 and standard BI51 prestressed girders. The Modified DBT45 are expected to require alterations to the flange width, which can likely be accomplished without modifying the standard forms used by precast manufacturers for these girders.

Widenings to Bridge #08958E would be accomplished with cast-in-place reinforced concrete box girder (RCBG) spans that approximately match those of the existing bridge. Precast girders were also investigated as an alternative girder type to support the widening in this bridge, but an in-span superstructure hinge exists 15'-0" back station of Pier 9. Maintaining the superstructure hinge with prestressed girders is not a conventional application of prestressed girders and would require a detailed investigation to determine if such a concept is feasible. Therefore, cast-in-place box girder spans remain the proposed widening solution for Bridge #08958E at this stage of the Project.

Substructures and foundations supporting the widened superstructures would primarily utilize single-column bent extensions supported by micropile foundations with partial length permanent casings and reinforced concrete pile caps. Crossbeams in the widened regions would likely be structurally connected to the existing crossbeams of the structure to help improve the lateral response of the bridge during seismic events. Columns in Bridge #N8958A would have 3'-6" or 4'-0" diameters depending on the bent location within the structure. Columns in Bridge #08958E are expected to have 5'-0" diameters. New columns are centered under the widened portions of the bridge when possible to primarily support the additional loadings from the bridge widening within the new substructures and foundations. However, widenings at Bents 11, 12, 18, and 19 in Bridge #N8958A require columns that are not centered within the widened portion of the bridge. At these locations, new loadings could be introduced into the existing bridge foundations. The detailed analysis required to determine the magnitude of increased loadings on these existing foundations, as well as the structural and geotechnical resistance of the

existing structure to support increased loadings, have not been completed. However, locations of such existing foundations have been labeled “potential foundation improvements” within the JA & JB drawings in Appendix H to call awareness to this risk item. If foundation improvements are required at these locations, potential concepts would likely consist of micropiles with a reinforced concrete cap connected to the existing foundation. Some existing foundations in this area of the Project have battered piles, and new micropile foundations have been positioned to avoid conflicts with existing battered piles. However, field work should be considered to verify the as-constructed positions of the battered piles and adjust micropile positions if necessary.

Estimated preliminary foundation data have been included in the foundation sheets within the JA & JB drawings in Appendix H. This information has been included in the drawings to illustrate assumptions supporting quantity development and to assist with constructability conversations with the CM/GC. For additional discussion pertaining to foundation selection and geotechnical considerations in this area of the Project, see the Draft GERs for bridges #N8958A, #08958E, and #16358; also see the Draft GDR. Note that micropile capacities are dependent on contractor’s design and construction methods (per ODOT Standard Special Provision 00515) and will require a conversation with the CM/GC in design progression.

For details of retaining walls in this study zone, see Chapter 2.4.3 and Appendix I.

Geological Conditions

See the Draft GERs for bridges #N8958A, #08958E, and #16358, and the Draft GDR for geotechnical and geological considerations and discussions in this area of the Project. These documents will be updated after all geological exploration and testing is complete, and also as designs are progressed.

4.1.3.4 Stormwater

ODOT Stormwater Summary

Within ODOT ROW (Study Zones 1-3 and 5-7), the contributing impervious area (CIA) is approximately 22.3 acres, as shown in the Stormwater Roll Plot (Full Corridor) included in Appendix P. The Project is required to provide water quality treatment for this area, either directly or by treating an equivalent offsite impervious area. The conceptual stormwater management plan proposes providing three water quality facilities along the highway and within ODOT ROW. This would maximize the available area for stormwater management, meeting the Project stormwater management requirements and providing a mitigation bank for future roadway improvements within the freeway corridor. The conceptual design could treat approximately 33.48 acres of I-5 impervious area, 11.2 acres more than the CIA. Two of the conceptual stormwater management facilities are located within Study Zone 1.

The first ODOT stormwater management facility located in Study Zone 1 is located north of I-405 between I-5 and N Mississippi Avenue. The facility would treat the stormwater runoff from 16.84 acres of I-5 impervious area extending north of the Project limits. This entire treated basin area is outside of the Project area. This facility is currently proposed as two biofiltration swales, with stormwater low flows diverted from the existing freeway storm system into the swale and back into the existing ODOT storm system.

The second ODOT stormwater management facility located in Study Zone 1 is located under and next to the freeway adjacent to N Knott Street. The facility would treat the stormwater runoff from 5.06 acres of I-5 impervious area, consisting of 1.66 acres of Project CIA and 3.40 acres of

offsite area. This facility is currently proposed as a biofiltration swale, with stormwater low flows diverted from the freeway storm system into the swale and back into the existing ODOT storm system.

This facility would require rerouting of the existing ODOT storm system by adding approximately 1,000 feet of conveyance pipe onto the I-5 Bridge, beginning just north of the I-405 interchange and ending at N Graham Street. The proposed conveyance pipe would connect the existing deck drains and convey the stormwater south, where a pipe would run down the existing bent and would continue to the facility through the parking area under the bridge and cross N Borthwick Avenue and N Knott Street. While feasible, this option may be costly due to new pipes being attached to an existing bridge structure.

A second option for stormwater treatment includes rerouting existing flows into a proprietary modular wetland treatment system similar to the one proposed for Study Zone 3. Instead of rerouting the existing stormwater conveyance system, stormwater treatment could be provided by simply diverting the stormwater quality flows from the existing conveyance system to a proprietary treatment system located under the freeway near N Mississippi Avenue. This approach would result in significantly less excavation and reconstruction of stormwater pipe as compared to option 1. The area under the freeway is a parking lot owned by ODOT and leased to other public agencies. Construction and long-term maintenance access would be via surface streets into the parking lot.

A third option would not provide stormwater quality treatment of this basin area. Without this treated area, the Project would still exceed the stormwater management requirements with approximately 4.43 acres of impervious area treated in excess of the CIA. Discussions are needed with ODOT to develop a stormwater management plan that meets the Project requirements while maximizing the mitigation bank potential within the Project limits.

A summary of the conceptual stormwater management plan is included in Appendix P. Because this section of the Project is entirely raised freeway, the existing conveyance system consists of bridge deck drains that connect to a storm pipe that runs parallel to and directly underneath the raised freeway. The area beneath the freeway is parking lots that are owned by ODOT and currently leased to other public agencies. Access to the conveyance system is via manholes in the parking lots. The ODOT conveyance system extends west from the freeway along N Mississippi Avenue and weaves its way through city streets to an outfall into the Willamette River.

Proposed improvements to this system will depend on what is decided for stormwater management, but will most likely involve relocation of the bridge deck drains to accommodate the roadway widening. It is not anticipated that the existing main conveyance system under the raised freeway will be replaced.

4.1.3.5 Traffic Operations and Design

Operations and Analysis

The Project will consist of extending the existing NB auxiliary lane on I-5 from the I-84 WB entrance ramp to the Greeley Avenue exit ramp. With the extension of the NB auxiliary lane, traffic operations at the I-405 and Greeley exit ramps in Study Zone 1 would improve as the auxiliary lane would facilitate access for traffic from I-84 WB to either the I-405 or Greeley exit ramp without having to make a lane change.

There is no new SB auxiliary lane in Study Zone 1.

Signing

Spacing limitations pose a challenge to properly sign for Exit 302C Greeley Avenue, as Exit 302B is only 800 feet in advance and has the proposed overhead arrow-per-lane sign to indicate the option lane. Exit 302C has an exit only lane, which requires an advance exit direction sign. An option to provide warning for drivers of this exit is to split the overhead arrow-per-lane sign and provide guidance that the option right lane would become an exit only lane.

Study Zone 1 signing would have a new sign bridge and cantilever sign structure to support proposed signage. Space is limited between Exits 302B and 302C, which would impact the advance signage for Exit 302C. Advanced signage would be included on a modified overhead arrow-per-lane sign at Exit 302B.

All existing signs would be replaced; new signs and their supports would meet the latest versions of the ODOT Traffic Sign Design Manual and MUTCD.

Signals

There are no signalized intersections within Study Zone 1.

Local Street Illumination

Local street illumination design in Study Zone 1 is contingent on potential changes to the roadway grade on NE Russell Street. Freeway widening could result in a lower grade on NE Russell Street, thus resulting in a redesign of the local street lighting to avoid “shading” along NE Russell Street. Poles impacted are PBOT-owned decorative post-top luminaires.

Freeway Illumination

The Project would include replacing impacted freeway lighting within Study Zone 1. Lighting analysis and design standards will follow criteria presented in Chapter 2.3.7.

ITS

The Project would impact a new radar device that would be installed on the existing sign bridge at the approximate mile point 302.8, with ODOT’s K20430: I-5 Marine Drive to Fremont Bridge Sec. Project. The existing sign bridge would be removed and replaced due to freeway widening and the radar unit would be removed, salvaged, and reinstalled on a replacement sign bridge or a new pole. The Project would provide an opportunity to connect this radar unit, which would communicate to the ODOT ITS Network via broadband radio, to the new fiber optic trunk line.

The Project is anticipated to disrupt the existing PBOT fiber optic cable at N Kerby Avenue. The existing fiber optic cable would need to be rerouted and reconnected at N Kerby Avenue; construction would need to be staged such that the multiple networks on this cable can be maintained with minimal downtime during construction. The Project would also disrupt the existing fiber optic cable under the I-405/I-5 interchange during roadway construction and connection to the new ODOT fiber optic trunk line.

The Project is not anticipated to impact the variable speed signs (VSS) located on the N Kerby Avenue to SB Fremont Bridge overcrossing that would be installed with the I-5 Marine Drive to

Fremont Bridge Sec. Project. Additionally, the Project is not expected to impact the VSS signs or associated power and communications connections.

Small VMS and lane restriction signs associated with the FLS system are discussed in Zones 4n and 4s.

Access Management

There are no impacts to existing driveways within Study Zone 1. One driveway along Russell Street, near I-5 over Russel Street, is adjacent to possible construction, but impacts to driveways are not expected.

4.1.3.6 Utilities

There is existing overhead 69-115kV transmission power running parallel to N Russell Street that crosses over I-5. Large diameter sewers are also located on N Russell Street, and include one main that varies in size from 48 inches to 36 inches, and a second main that varies in size from 21 inches to 18 inches. There are several other existing utilities running parallel to each of the local streets and abandoned ROW under the interchange, under the ramps, and under I-5 within the limits of the proposed bridge improvements.

City of Portland TRN-10.19 Utility Permits in the Right-of-Way (TRN-10.19), amended January 6, 2020, requires new infrastructure to provide 5-foot horizontal clearance and 18 inches vertical clearance from the City of Portland's water and sewer utilities. Proposed bridge foundations for highway widening at N Russell Street are anticipated to meet this minimum skin-to-skin clearance criterion. Additional protection measures for the large diameter sewers, if any, have not been provided by City of Portland's Bureau of Environmental Services (BES).

Utility conflicts will be identified as part of the utility coordination after utility mapping is available. Subsurface Utility Engineering (SUE) utility exploration and mapping activities are in progress. Utility conflict assessments will be completed as part of the 30% Design Package.

4.1.3.7 ROW Considerations

It is not currently anticipated that temporary construction easements or permanent easements within Study Zone 1 will be required. There are several existing areas within the I-405 interchange area under ODOT ownership that are under consideration for stormwater treatment facilities, construction access, and contractor staging. Some of these areas are currently under lease and construction access will need to be coordinated with those parties. ROW assumptions and Project needs will be refined as part of the 30% Design Package.

4.1.4 Findings and Conclusions

The findings and conclusions are working assumptions and do not reflect final Project design/scope decisions. The assumptions herein may be modified based on stakeholder and community input and additional technical information gathered as a natural part of the design progression process.

It is proposed that advance design be based on the assumptions for horizontal and vertical geometry as shown herein. Some additional consideration of the proposed structure widening at the NB exit ramp to I-405, as it relates to the potential section for future BOS operations, will be coordinated as part of the 30% Design Package. Additional design approvals and concurrences are anticipated for the modifications of N Russell Street to finalize bridge foundation and

widening strategies over N Russell Street. If stormwater overtreatment is considered, a second modular wetland is recommended as the solution over the originally proposed second water quality site in Study Zone 1.

4.2 Study Zone 2

4.2.1 20% Design Description

Figure 3. Study Zone 2

Study Zone 2 begins at the south end of the I-5/I-405 interchange viaduct, as shown in Figure 3. This zone includes approximately 550 linear feet of on-grade interstate mainline and 430 linear feet of viaduct widening. Project elements include:

- I-5 NB pavement reconstruction and widening, and construction of a retaining wall to accommodate a new NB auxiliary lane.
- Widening of the existing I-5 NB Eliot viaduct.
- Reconstruction of the existing Eliot viaduct retaining wall.

There are no proposed modifications to I-5 SB within Study Zone 2 beyond potential restriping, due to temporary traffic control impacts, and signing or ITS modifications, as required. These Project elements will be considered and documented in greater detail as part of the 30% Design Package.

4.2.2 Concepts Discussion

The following Eliot viaduct and retaining wall reconstruction concepts were investigated within Study Zone 2:

- Widening the NB freeway segment on-grade with a pile-supported retaining wall versus widening on the structure.
- Alternative retaining wall types.

4.2.3 Key Issues and Assumptions

4.2.3.1 Roadway

Study Zone 2 includes a standard 12-foot median and right side shoulders in the NB direction. This zone also includes a fourth lane, which acts as an auxiliary lane for approximately 1,000 feet between the single lane NB entrance ramp from N/NE Broadway to the two-lane exit

ramp to I-405 SB. SB within Study Zone 2, the existing lane configuration and shoulder width is proposed to be maintained. The current design assumes a new noise wall along the east side of I-5 paralleling the freeway ROW. The Project team is continuing to investigate the preferred wall placement in coordination with Project stakeholders.

Active Transportation

There are no modifications or impacts to active transportation within Study Zone 2.

Transit

There are no modifications or impacts to transit within Study Zone 2.

4.2.3.2 Pavement

The Project would consist of widening and reconstructing the existing section of I-5 NB within Study Zone 2 with a new section of CRCP. A preliminary pavement report will be provided by ODOT Pavement Services outside of this 20% Design Memorandum. There is no proposed pavement reconstruction in the SB direction within Study Zone 2. Quantities assume a 2-inch grind and inlay to re-establish permanent striping that could be affected by temporary lane shifts.

4.2.3.3 Structures/Geotechnical

Bridge #08782A (Eliot viaduct) within Study Zone 2 requires widening on its east side, and a unique retaining wall structure is required to accompany the required widening. A minimal gap is included between the bridge and face of retaining wall to prevent structural interaction between the two structures. Noise Wall 24 is also located within this area of the Project; details of this noise wall will be determined as the Project progresses. See Appendix G, Appendix H, and Appendix I for details of structures and retaining walls within Study Zone 2.

Widening of Bridge #08782A would be accomplished with additional girder lines to support a deck extension and Type F barrier. The new girder lines would consist of precast girder lines to match the girder span types of the existing structure. The existing structure utilizes AASHTO Type III in some spans, and the ability to utilize those exact girder types in the widening would depend on availability of formwork at local precast manufacturers. If AASHTO girders are not available, the new girders supporting the deck extension would be precast, prestressed members that approximately match the depth of the existing AASHTO girders, such as Modified DBT45 prestressed girders. As previously mentioned, the Modified DBT45 are expected to require alterations to the flange width, which can likely be accomplished without modifying the standard forms used by precast manufacturers for these girders.

Substructures and foundations supporting the widened structures at all bents would be single-column reinforced concrete bents supported by drilled shaft foundations; columns would be 4 feet in diameter, and drilled shafts would be 6'-6" in diameter to satisfy requirements of ODOT BDM Table 1.10.5.5. Crossbeams in the widened regions would likely be structurally connected to the existing crossbeams of the structure to help improve the lateral response of the bridge during seismic events.

Estimated preliminary foundation data for new foundations for Bridge #08782A have been included in the footing plan within the JC drawings in Appendix H. This information has been included in the drawings to illustrate assumptions supporting quantity development and to assist with constructability conversations with the CM/GC. For additional discussion pertaining to

foundation selection and geotechnical considerations in this area of the Project, see the Draft GER for Bridge #08782A and the Draft GDR.

The total length of Wall 2b is composed in segments of a soldier pile wall, counterfort tangent wall, and a secant wall. Tiebacks would not be utilized within Wall 2b. The wall is estimated to be approximately 26 feet high at its highest point within the counterfort tangent wall. Soldier pile walls and a secant wall are positioned to the north and south, respectively, to address retaining wall needs in those segments of the wall alignment.

Multiple drilled shaft sizes have been investigated and considered for the tangent and secant walls. Wall solutions utilizing smaller drilled shafts and larger drilled shafts are both considered to be viable options that can achieve the design intent of no damage to nearby buildings and facilities. However, mobilizing large drilling equipment to the site to construct drilled shafts larger than 5 feet in diameter was considered to be improbable given the limited construction space and required temporary access that is needed to construct the walls. As a result, drilled shaft sizes 5 feet in diameter, sometimes with multiple rows to form a counterfort wall, have been utilized within the tangent and secant walls. The size of drilled shafts will continue to be investigated as designs are progressed and as construction means and methods are discussed with the CM/GC in future phases of the Project.

For details of other retaining walls in Study Zone 2, see Chapter 2.4.3, Appendix G, Appendix H, and Appendix I.

Geological Conditions

See the Draft GER for Bridge 08782A and the Draft GDR for geotechnical and geological considerations and discussions in this area of the Project. These documents will be updated after all geological exploration and testing is complete, and also as designs progress.

4.2.3.4 Stormwater

There are no proposed stormwater treatment facilities within Study Zone 2.

The existing conveyance system in this section of the Project begins approximately 250 feet north of the Eliot viaduct and continues south along the freeway. This system crosses the freeway twice in this study zone and with the proposed roadway improvements the inlets would be located within the travel lanes. It is anticipated that the existing storm system in this study zone will be replaced.

4.2.3.5 Traffic Operations and Design

Operations and Analysis

The NB weave section between the N/NE Broadway entrance ramp and the I-405 exit ramp is expected to operate slightly over the ODOT HDM mobility standard in the Design Year 2045 morning rush hour. A Design Exception will be required.

The SB weave section between the I-405 entrance ramp and then N Broadway exit ramp is expected to operate just over the ODOT HDM mobility standard in the Design Year 2045 morning rush hour. A Design Exception will be required.

Signing

Study Zone 2 signing would have a new sign bridge structure to support proposed signage as well as supplementary ground-mounted signing. All existing signs would be replaced; new signs and their supports will meet the latest versions of the ODOT Traffic Sign Design Manual and MUTCD.

Signals

There are no signalized intersections in this study zone.

Local Street Illumination

Project improvements within Study Zone 2 are not anticipated to impact local street lighting. N Commercial Avenue does not include separate local street lighting, but is partially illuminated by the existing freeway lighting. City of Portland reports it has street lighting attached to the utility poles on N Commercial Avenue. If any utility poles to which the street lighting is attached require relocation, then the street lighting would also need to be addressed.

Freeway Illumination

Freeway lighting is anticipated to be replaced in the NB direction.

ITS

Within Study Zone 2, the fiber optic conduit would be installed along the shoulder in areas where the freeway is at-grade. On bridge structures, the fiber optic conduit may be attached to the underside of the structure or embedded within the bridge rail. The new fiber optic cable installation would be designed to ODOT and NEC (National Electrical Code) standards.

Small VMS and lane restriction signs associated with the FLS system are discussed in Zones 4n and 4s.

No impacts to existing ITS infrastructure are anticipated within Study Zone 2.

Access Management

There are no impacts to existing driveways within Study Zone 2.

4.2.3.6 Utilities

There is existing overhead power, gas, and sewer along N Commercial Avenue, which may be in conflict with the retaining wall or noise wall improvements. Utility poles on N Commercial Avenue include attachments for street lighting. The existing overhead PacifiCorp power distribution that crosses I-5 may be in conflict with the Project improvements. The powerline crosses from N Commercial Avenue on the eastern side of I-5 to an assumed private easement on the western side of the freeway.

Additional utility conflict assessments would be completed as part of the 30% Design Package.

4.2.3.7 ROW Considerations

Temporary construction easements and permanent easements are anticipated for maintenance and access of proposed freeway improvements along N Commercial Avenue, and partially

within the existing parking lot of the Harriet Tubman Middle School. ROW assumptions and Project needs will be refined as part of the 30% Design Package.

4.2.4 Findings and Conclusions

The findings and conclusions are working assumptions and do not reflect final Project design/scope decisions. The assumptions herein may be modified based on stakeholder and community input and additional technical information gathered as a natural part of the design progression process.

The design will be advanced based on widening the existing Eliot viaduct structure rather than constructing an at-grade fill with a second retaining wall, which is consistent with the assumptions within the 15% BOD memo. The proposed noise wall placement will continue to be coordinated with the Project team as well as the Portland Public School District.

4.3 Study Zone 3

4.3.1 20% Design Description

Figure 4. Study Zone 3

Study Zone 3 includes approximately 3,000 linear feet of existing freeway, as shown in Figure 4. The Project consists of reconstructing the existing roadway section with new CRCP. To balance achieving the proposed vertical clearance while minimizing impacts to the surrounding built environment, the existing freeway profile would be lowered through the highway cover area. The existing freeway centerline would be maintained and the existing N/NE Broadway and Weidler Street interchange ramps would be reconstructed. Extensive use of retaining walls are included within this zone to minimize additional impacts associated with the construction of a new auxiliary lane in each direction.

Within Study Zone 3, the five existing freeway overcrossing structures would be demolished: N Flint Avenue, N Vancouver Avenue, N/NE Broadway, N Williams Avenue, and N/NE Weidler Street. One new highway cover would be constructed to accommodate local street connections for a new east/west NE Hancock-Dixon Street, SB N Vancouver Avenue, N/NE Broadway, N Williams Avenue, and N/NE Weidler Street across I-5. In addition, a new pedestrian and bicycle overcrossing structure would be provided across I-5 near NE Clackamas Street. See Study Zone 4n/4s for details of the highway cover. See Study Zone 5 for details of the new pedestrian and bicycle overcrossing structure.

4.3.2 Concepts Discussion

A range of design concepts aimed at addressing the Project parameters include:

- Maintaining the existing freeway grade while raising the proposed cross streets to achieve freeway vertical clearance requirements.
- Additional freeway lowering throughout the entirety of Study Zone 3.
- Increasing the interior (median) shoulders within the highway cover structures for accommodation of 12-foot continuous lanes to accommodate future potential BOS operations.
- Increasing the separation between the proposed median barrier and proposed median highway cover column to allow for a barrier-protected pedestrian egress route that could be used in the event of a potential fire beneath the highway cover.

4.3.3 Key Issues and Assumptions

4.3.3.1 Roadway

The proposed freeway profile grade assumes lowering I-5 mainline up to approximately 3 feet through a portion of the southern end of the highway cover through a modification of the existing sag vertical curve within this zone. Doing so provides the opportunity to reduce the proposed change to profile grade at the south end of the cover, mainly N/NE Weidler Street, which was proposed in the NEPA design profile to be raised nearly 5 feet near the east end of the new highway cover. This grade differential would result in a more complex construction staging and an expanded Project footprint as compared to the proposed solution. Because the existing mainline CRCP is proposed to be reconstructed with the Project, the freeway lowering can be completed with minimal costs or added staging impacts, as compared to reconstructing at existing grade.

To further reduce grading impacts on local streets, the Project design has proposed Design Exceptions for vertical clearance within the NB mainline right safety shoulder and several interchange ramps. Because of an existing horizontal curve, I-5 is super-elevated within the South Cover, significantly effecting vertical clearance. In addition to the proposed Design Exception for vertical clearance, the Project design utilizes a reduced superelevation for NB I-5 in the highway cover area. By pursuing a Design Exception for the NB freeway shoulder the cross street profile can be reduced by approximately 0.5 feet. Additionally, it is proposed that Design Exceptions be requested for vertical clearance for the I-5 SB exit ramp to NE Broadway, I-5 NB exit ramp to NE Weidler Street, and I-5 SB entrance ramp from NE Broadway. These exceptions would improve multimodal access to the proposed NE Hancock-Dixon road crossing and new Clackamas Pedestrian and Bicycle Bridge. Additional information related to these and other Design Exceptions can be found in Appendix C and Appendix K.

To accommodate the potential for future BOS operations, it is assumed a minimum 12-foot median shoulder is maintained throughout the length of Study Zone 3. This revision resulted in additional total paved width and required a horizontal taper transition leading into and out of the highway cover to accommodate the additional median width. Due to existing and future corridor constraints, some of these horizontal taper transitions are below the minimum standard rate.

A second modification to the median width through the highway cover is proposed to allow for a 4- to 6-foot wide barrier-protected pedestrian egress route on both sides of the highway cover median abutment wall. This area is envisioned to facilitate pedestrian egress in the event of a large fire beneath the highway cover. The barrier-divided route would provide additional

separation between pedestrians from the egressing side of the highway cover and vehicular traffic that may be proceeding in the opposing barrel of the highway cover. Additional discussion of FLS is included in Study Zone 4.

Active Transportation

There are no existing or proposed active transportation facilities on I-5. Features associated with active transportation crossing I-5 within this zone are included in the discussion for Study Zones 4n, 4s, and 5, which are located in Chapters 4.4 and 4.5.

Transit

There are no modifications or impacts to transit within Study Zone 3.

4.3.3.2 Pavement

The existing CRCP roadway section would be reconstructed with a new CRCP section. ODOT pavement services is in the process of completing a preliminary Life Cycle Cost Analysis to evaluate and confirm the preliminary pavement type selection and final pavement section.

4.3.3.3 Structures/Geotechnical

No bridge widenings are required in Study Zone 3. See Appendix H and Appendix I for details of structures and retaining walls within Study Zone 3.

Geological Conditions

The development of the GER for this Project zone for the retaining walls is not yet available and will be developed after the completion of the geotechnical exploration and testing in the Project. Review of GERs for Bridges #08782A and the highway cover can provide geological details to the north and south of this zone, respectively, to provide some insight about the geological conditions that may exist within this zone.

4.3.3.4 Stormwater

The third ODOT water quality facility is located adjacent to the freeway at the I-5 SB Weidler Street entrance ramp. The facility would treat the stormwater runoff from 11.58 acres of I-5 impervious area, 10.46 acres of Project CIA, and 1.12 acres of offsite area. This facility is currently proposed as a proprietary treatment system. Any proposed proprietary treatment is required to be on ODOT's Qualified Products List (QPL) and to be approved for enhanced treatment with a General Use Level Designation (GULD) by the Washington Department of Ecology's Emerging Stormwater Treatment Technologies Evaluation Technology Assessment Protocol – Ecology (TAPE) program. This facility location was not identified during the NEPA phase, but is proposed due to its accessibility for maintenance.

A subteam meeting with the stormwater team and ODOT Maintenance was held on July 30, 2020 to discuss these proprietary treatment systems. The primary maintenance concerns were placement of the facility and the cost to maintain it. To address the concerns of ODOT maintenance, the system would be located as far south as possible for visibility and safety; the vaults would be constructed parallel and adjacent to the roadway barrier, eliminating the need for an access road as the facilities can be maintained from the shoulder.

Stormwater from the 11.87 acres of CIA south of the third water quality facility would not be treated, as 21.36 acres of offsite impervious area is proposed to be treated in lieu of Project

CIA. The conceptual stormwater management plan for the ODOT section of the Project would treat the stormwater runoff from 33.48 acres, 9.49 acres more than the ODOT CIA.

The existing conveyance system in this section of the Project is an extension of the conveyance system in Study Zone 2 and begins with an 18-inch-diameter pipe, increasing in size to a 36-inch-diameter pipe. The mainline runs along the west side of the freeway but crosses to the center of the freeway under the NE Weidler Street crossing and then crosses back to the west side. Due to the proposed roadway improvements, the existing manholes would be located in the center shoulder and the far right lane of the SB traffic. As such, it is anticipated that the entire storm system in this study zone would be replaced.

4.3.3.5 Traffic Operations and Design

Operations and Analysis

I-5 mainline is anticipated to operate below a maximum v/c of 0.75 for a basic freeway segment.

Signing

Study Zone 3 signing would have two new sign bridge structures to support proposed signage as well as supplementary ground-mounted signing. Study Zone 3 also contains the highway cover, the front of which would be used for structure-mounted overhead signs. All existing signs would be replaced; new signs and their supports will meet the latest versions of the ODOT Traffic Sign Design Manual and MUTCD.

Spacing becomes a key issue on the approaches to the freeway-to-freeway interchanges for both NB and SB I-5. The proposed highway cover poses another spacing issue, as it reduces approximately 1/4 mile of available sign space along the freeway. Detailed constraints are listed below:

- I-5 NB: Exits 302A and 302B have approximately 2/3 of a mile (3,500 feet) between them, allowing for advance signage at 1 mile and 1/2 mile for Exit 302A. Overhead arrow-per-lane signs between the I-84 WB entrance ramp and Exit 302A would be utilized as well. Exit 302B and 302C are spaced 810 feet apart. The signing challenges for the NB approach to these two interchanges include the closely-spaced exits, the use of an overhead arrow-per-lane sign at Exit 302B (which eliminates additional signage on the NB structure for Exit 302C), and the highway cover (which eliminates 1/3 mile of available freeway signing space).
- I-5 SB: Advance signage at 1/2 mile and 1/4 mile would be provided for Exit 302A, including overhead arrow-per-lane signs between the I-405 SB entrance ramp and Exit 302A. Exit 301 and 300B are spaced 1,100 feet apart. The signing challenges for the SB approach to these two interchanges include the closely-spaced exits and the highway cover (which eliminates 1/4 mile of available freeway signing space).
- Consideration was taken to reduce the amount of proposed sign structures, which resulted in consolidation of signs for the NB and SB directions on the same sign bridges. All new sign bridges would be designed to span the entire width of freeway, as opposed to spanning one direction.

Current proposed sign design for Exit 302A complies with MUTCD Section 2E.20. This interchange is in advance of two additional closely-spaced interchanges in both the NB and SB directions. The overhead arrow-per-lane sign eliminates the ability to advance signage for these

closely-spaced interchanges at a critical location. Additionally, the proposed highway cover further reduces the freeway space for these signs.

Signals

This Project consists of replacing the existing I-5 NB entrance ramp from NE Broadway and I-5 SB entrance ramp from NE Weidler Street, which would require replacement of both ramp meters. The location of the ramp meter stop line will be determined based on the criteria described in the ODOT Traffic Signal Design Manual, coordination with the roadway designer, and approval of the ODOT Region Traffic Engineer.

Local Street Illumination

There are no impacts to local streets within Study Zone 3. Local street illumination for cross streets are addressed in Chapter 4.4.3.5.

Freeway Illumination

This Project consists of replacing the existing freeway illumination system within Study Zone 3. This includes a new freeway illumination system along the proposed highway cover. The new lighting system would include energy efficient LED luminaires, service cabinets, cable gutters, and quick electrical disconnects. A detailed lighting analysis would be performed using the AGi32 lighting software to evaluate light levels. Temporary freeway lighting is assumed due to the multiple stages of construction activity and the inability to reinstall lighting in the final configuration to support construction.

The reflectance of the freeway pavement would impact the amount of light required to achieve recommended light levels beneath the highway cover. Both PCC and black asphalt pavement surfaces would be considered in this lighting analysis. PCC walls and ceiling surfaces would also be considered.

Light level values would be based on those published in the Illuminating Engineering Society of America National Standard Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (RP-8-18), Chapter 14. Based on the lighting criteria included in the RP-8-18, the highway cover characteristics were determined and are shown in Table 9.

Table 9. Highway Cover Illumination

Location	Approx. Cover Length (ft.)	Exit Visible from One SSD	Assumed Daylight Penetration	Traffic Volumes (ADT) a	Cover Wall Reflectance	Presence of Cyclists
Cover – NB Direction	1,160	Yes	Poor	61,700	<30%	No
Cover – SB Direction	1,065	Yes	Poor	58,000	<30%	No
Hancock-Dixon – NB Ramp	260	Yes	Poor	11,500	<30%	No
Hancock-Dixon – SB Ramp	145	Yes	Poor	11,300	<30%	No

Notes: SSD = Stopping Sight Distance

[a] ODOT Interstate Traffic Volume Diagram, Exit 302A, 2017.

The following sections summarize the methodology used to determine daytime and nighttime light levels.

DAYTIME LIGHT LEVELS

Daytime light level recommendations are more complex due to the way the human eye adjusts from light to dark ambient light levels. Daytime recommended light levels for the highway cover are broken into four zones: Threshold Zone (Lth), Transition Zone, Interior Zone, and Exit Zone.[8]

The step-down methodology included in the RP-8-18[9] would be used to determine recommended daytime highway cover light levels. Based on the highway cover characteristics shown in Table 9 and the RP-8-18 lighting criteria, the recommended daytime highway cover light levels were determined and are shown in Table 10. While highway cover light levels are typically evaluated using the luminance method, in some circumstances the curvature of the roadway requires use of the illuminance method. Light level values would be converted to illuminance foot candles where appropriate.

NIGHTTIME LIGHT LEVELS

During nighttime the motorist's eyes are adapted to a low exterior luminance; therefore, a low luminance value is recommended for the entire length of the cover. The recommended nighttime cover light levels to be used in this analysis are shown in Table 10.

Table 10. Highway Cover Recommended Light Levels[a]

Time of Day	Luminance Values (cd/m^2)	Average to Minimum Uniformity	Maximum to Minimum Uniformity
Daytime	NB Direction		
Threshold Zone 1	280	2:1	3.5:1
Threshold Zone 2	196 (70% L_{th})	2:1	3.5:1
Transition Zone 1	114 (40.7% L_{th})	2:1	3.5:1
Transition Zone 2	38 (13.57% L_{th})	2:1	3.5:1
Transition Zone 3	15 (5.4 % L_{th})	2:1	3.5:1
Interior Zone	8	2:1	3.5:1
Daytime	SB Direction		
Threshold Zone 1	270	2:1	3.5:1
Threshold Zone 2	189 (70% L_{th})	2:1	3.5:1
Transition Zone 1	110 (40.7% L_{th})	2:1	3.5:1
Transition Zone 2	37 (13.57% L_{th})	2:1	3.5:1
Transition Zone 3	15 (5.4 % L_{th})	2:1	3.5:1
Interior Zone	8	2:1	3.5:1
Daytime	Broadway – NB On-Ramp		
Threshold Zone 1	140 [b]	2:1	3.5:1
Daytime	Broadway – SB On-Ramp		
Threshold Zone 1	135 [b]	2:1	3.5:1

[8] National Standard Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (RP-8-18), Chapter 14, Section 14.1.

[9] National Standard Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (RP-8-18), Chapter 14, Section 14.6.2.2.

Table 10. Highway Cover Recommended Light Levels[a]

Time of Day	Luminance Values (cd/m^2)	Average to Minimum Uniformity	Maximum to Minimum Uniformity
Nighttime – Entire cover			
All Zones	2.5	3.5	–

[a] No threshold lighting is required when cover length is less than 15 meters (50 ft.), RP-8-18, Table 14-2, Page 14-10.
[b] Based on the RP-8-18, a 50% reduction in Lth is allowed. The cover exit is within the threshold zone, so transition zone/interior light levels are never reached.

Highway cover recommended light levels and design will require coordination and approval from ODOT. Proposed LED luminaires, lighting analysis methodology, and recommended target values will be coordinated with ODOT as part of the 30% Design Package.

ITS

New fiber optic branch cables would be installed for communications to the two new ramp meters. These ramp meters would be located at the N Williams Avenue/N Weidler Street SB Entrance Ramp and N Williams Avenue/N Broadway NB Entrance Ramp.

The Project provides an opportunity to install new PTZ traffic cameras within the Project area. New PTZ cameras would be installed at the new SB VMS site and NB guide sign structure located just south of the NB NE Weidler Street exit ramp. Locating PTZ cameras at these locations allow shared power and communications connections with other ITS components. It may also be advantageous to install new PTZ cameras within the cover to monitor traffic conditions and identify incidents not easily visible from outside the covered area. Camera installations would be designed to ODOT and NEC standards.

There are two existing character matrix VMS within Study Zone 3, one SB near the N Flint Avenue overcrossing and one NB on the NE Weidler Street exit ramp. Each VMS would be replaced with a new full matrix VMS near the same location. Each new VMS would be connected to the proposed fiber optic trunk line. The VMS installations would be designed to ODOT and NEC standards. The VMS installations would be designed to ODOT and NEC standards. The new VMS would need to be coordinated with planned sound walls at each of the ramp locations.

Small VMS and lane restriction signing associated with the FLS is discussed in Zones 4n and 4s.

A new radar for traffic count data would be installed for NB I-5 traffic on the new guide sign structure, near the NB NE Weidler Street exit ramp.

Access Management

Key access management considerations in Study Zone 3 include the closely spaced interchanges and entrance and exit ramps along I-5. The I-5 interchange connections with I-405 and I-84 are each located within 1 mile of the NE Broadway/NE Weidler Street Interchange. As the Project will reconstruct the NE Broadway/NE Weidler Street Interchange, concurrence of interchange crossroads and interchange ramps from the ODOT RAME will be required. The revised ramp spacing and the relocation of the existing I-5 SB exit ramp from Wheeler Ave will also require coordination and approval with FHWA. This coordination and concurrence will be completed as part of the 30% Design Package.

4.3.3.6 Utilities

Within the area of the proposed highway cover there are a number of existing utilities crossing both above and below I-5 that will influence the Project design and constructability of this area. Those utilities that cross I-5 as part of the existing local street system are discussed in Zones 4n and 4s. Utility crossings of the freeway that are not on the local street system are discussed below.

Along NE/N Hancock Street there is an existing 56-inch BES combined sewer pipe that crosses beneath I-5. The portion of pipe located within the I-5 ROW is a 56-inch inner diameter (72-inch outer diameter) reinforced concrete pipe with an exterior liner. This section of combined sewer pipe was relocated as part of the original interstate construction project. BES reports that there is a diversion structure and a permanent monitoring station located at the downstream end of the pipe, which is located in N Hancock St, west of N Flint Ave, in BES Structure No. ABC559. Any relocation of the existing sewer would interfere with the monitoring activity at this downstream location.

To accommodate a standard vertical clearance for Broadway's I-5 NB entrance ramp from the underside of the North Cover, it is currently anticipated that lowering the existing 56-inch BES combined sewer pipe would be required. The working assumption is the conflicting portion of the existing combined sewer pipe could be addressed by replacing the pipe between the I-5 median and existing combined sewer system in NE Hancock Street on the upstream end. This assumption will require further discussion with BES after determining the final sewer profile and maintenance access needs. BES reports that complex bypass flow considerations would be required for constructing the pipe replacement.

The SUE mapping, protection requirements for the existing 56-inch pipeline, and design decisions for the North Cover are all required to determine feasibility of protecting the sewer in place. The sewer will be protected, if determined feasible, to avoid disruptions in operation and monitoring.

The existing overhead PacifiCorp power distribution that crosses I-5 may be in conflict with Project improvements. The powerline crosses from N Tillamook Street on the eastern side of I-5 to an assumed private easement on the western side of the freeway.

Additional utility conflict assessments will be completed as part of the 30% Design Package.

4.3.3.7 ROW Considerations

The existing I-5 corridor is a highly developed, urbanized area, with extensive development and limited existing freeway ROW. Within Study Zone 3 there are a number of parcels adjacent to I-5 that will be affected by Project improvements. The Project extensively utilizes retaining walls in areas of roadway widening to minimize potential ROW acquisition. In areas where retaining walls abut existing private property, wall type selection would avoid the use of soil tie-back systems that would require permanent easements. The Project also incorporates wall types consistent with top-down construction methods that limit temporary ROW impacts.

Construction of retaining walls within Study Zone 3 are primarily assumed to be performed from the freeway side; however, temporary construction easements will be required in some areas. As documented in the NEPA phase, there are several parcels within Study Zone 3 that will require partial ROW acquisition, primarily in the area adjacent to the proposed I-5 NB exit ramp to N Weidler Street. Additional definition of ROW needs will be included as part of the 30% Design Package.

4.3.4 Findings and Conclusions

The findings and conclusions are working assumptions and do not reflect final Project design/scope decisions. The assumptions herein may be modified based on stakeholder and community input and additional technical information gathered as a natural part of the design progression process.

- Lowering of the I-5 mainline profile to reduce cross road profile grades and impacts.
- Utilize temporary single-span structures for N/NE Broadway and N Weidler Street to maintain local traffic, improve construction access, and increase temporary horizontal clearance for the majority of the South Cover construction.
- Pursue Design Exceptions for I-5 mainline vertical clearance exceptions for portions of the highway shoulders, the I-5 SB exit ramp to NE Broadway, the I-5 NB exit ramp to N Weidler Street, and the I-5 NB entrance ramp from NE Broadway.
- Include full width 12-foot median safety shoulders to accommodate future potential BOS operations and a barrier-protected median pedestrian egress route with median doors.

4.4 Study Zone 4n and 4s

4.4.1 20% Design Description

Figure 5. Study Zone 4n and 4s

Study Zones 4n and 4s are composed of the City's local street network within the Broadway / Weidler Street interchange area, as shown in Figure 5. They are generally bordered by NE Hancock Street/N Dixon Street on the north, NE Weidler Street on the south, N Wheeler Avenue on the west, and NE 1st Avenue on the east. They include Streetcar (City of Portland) on NE Broadway and NE Weidler Street, as well as several north-south and east-west bus lines (TriMet) and one express bus service between the Lloyd District and Vancouver, WA (C-Tran). They exclude I-5 or the entrance and exit ramps, which are included in other study zones. As part of this Project, the following elements to the local street system are included:

- Removal of the existing overcrossing structures at N/NE Weidler Street, N/NE Broadway, N Williams Avenue, and N Vancouver Avenue and replacement with a single highway cover structure over I-5, including a new roadway crossing at N Hancock Street and N Dixon Streets.
- Removal of the existing overcrossing structure at N Flint Avenue.
- Construction of a new east-west road connection on NE Hancock Street/N Dixon Street.

- Adding a new access pathway between NE Flint Avenue and NE Vancouver Avenue, which may serve as a future multiuse path as identified in the 2012 Facility Plan.
- Upgrades to existing pedestrian and bicycle facilities, including a new center median pedestrian and NB bicycle path on N Williams Avenue between N/NE Weidler Street and N/NE Broadway.
- Reconstruction of N/NE Weidler and N/NE Broadway with upgraded pedestrian and bicycle facilities and matching into the City's planned road reorganization project cross section the east and west end of the Project.

4.4.2 Concepts Discussion

The following design concepts were or are being investigated within Study Zone 4n and 4s:

- Modifying the horizontal alignment and cross section of N Vancouver Avenue between NE Hancock Street and N/NE Broadway to properly align travel lanes and minimize lane offsets through the Broadway intersection and to add a sidewalk along the west side.
- Modifying the intersection of N/NE Weidler Street and N Vancouver Avenue to include a crosswalk on east leg with a right turn channelization island.
- Modifying the directional north-south bicycle couplet between NE Hancock Street and NE Weidler Street by designing SB bike lanes on N Vancouver Avenue/NE Wheeler Avenue and NB bikeways on N Williams Avenue from NE Hancock Street to N Ramsay Road (outside of Zone 4s).
- Refining the pedestrian and bicycle storage space on the SW corner of the N Weidler Street/N Williams Avenue intersection to increase safety.
- Providing a bicycle connection on the south side of NE Hancock Street between N Vancouver Avenue and the N Flint Avenue cul-de-sac to provide a more direct route for SB bikes on N Vancouver Avenue heading to the Broadway Bridge that avoids the N Broadway/N Vancouver Avenue intersection.
- Maintaining streetcar service during construction by constructing temporary single-track shoofly alignments adjacent to N/NE Broadway and N/NE Weidler Street.
- Investigating multiple design alternative layouts within Study Zone 4n and 4s. A detailed discussion is included in subsection 4.4.3.8.

4.4.3 Key Issues and Assumptions

4.4.3.1 Roadway

N Hancock Street-N Dixon Street

A new roadway crossing will be constructed to extend N/NE Hancock Street west across and over I-5, connecting it to N Dixon Street. The steep vertical profile grade of the new road is driven by the large grade difference between the west and east sides of I-5 and by the need to maintain acceptable vertical clearance of the northern highway cover over I-5. Mitigation to lower grade includes lowering I-5 and interchange ramps, reducing the structural depth of the highway cover, and requesting Design Exceptions from ODOT for vertical clearances on the interchange ramps.

The proposed street grade of N Hancock Street/N Dixon Street is 7 percent. The design team is investigating with the City to determine if the sidewalks directly adjacent to the street and

following the profile grade of the street fulfills the City's expectation for ADA compliance. The layout for this facility will be reassessed as input is gathered during future design phases.

At the 15% milestone, the City provided their standard minimum widths of travel lanes, sidewalks, and bicycle facilities. This information is documented in Appendix L Roadway Design Criteria Sheets.

Traffic calming measures to be incorporated during future design phases will discourage use of NE Hancock Street by through motor vehicle traffic.

N Flint Avenue

The existing N Flint Avenue structure over I-5 would be removed, and N Flint Avenue south of N Russell Street would terminate at and connect directly to N Tillamook Street. The portion of Flint between the existing I-5 overcrossing and N/NE Broadway would be closed as a through street for all roadway users. Driveway access would be maintained on this portion of N Flint Avenue to maintain local access.

N/NE Broadway and N/NE Weidler Street

The existing horizontal geometries would be maintained. The vertical geometries would be maintained as close to existing as possible, with minor modification over the highway cover to account for vertical clearances over I-5.

The number of lanes and lane assignments have been generally resolved by ongoing traffic operations and analysis and work with the Project agency partners. However, final consensus is needed at N Broadway and N Williams intersection. The typical width of travel lanes, sidewalks, and bicycle facilities are resolved based on direction from the City at the 15% milestone review. Modified widths may be required in specific locations based on vehicle turning movements at intersections or ROW constraints. For these specific locations, it is anticipated that additional coordination with the agency partners will be required after the 20% milestone. Any widths less than the minimums provided by the City will require a Design Exception with the City and are noted in Appendix K.

The cross sections would tie into the planned cross section for the City's road reorganization project at either end of the Project, which is assumed to be completed prior to the start of construction of the Project.

N Vancouver Avenue, N Williams Avenue, and NE Victoria Avenue

The existing horizontal geometries would be maintained. The vertical geometries would be maintained as close to existing as possible, with modification over the highway cover to account for clearances over I-5.

The number of lanes and lane assignments have been generally resolved by ongoing traffic operations and analysis and work with the City. However, final consensus is needed at N Broadway and N Williams intersection. The typical widths of travel lanes, sidewalks, and bicycle facilities are resolved based on direction from the City at the 15% milestone review. Modified widths may be required in specific locations based on vehicle turning movements or ROW constraints. For these specific locations, it is anticipated that additional coordination with the agency partners will be required after the 20% milestone.

Typical sections are included in Appendix D. Plan and profile maps are included in Appendix A through Appendix G.

Active Transportation

The N/NE Broadway/N/NE Weidler Street area is a critical location for pedestrian and bicycle circulation and has especially high volumes during weekday AM and PM peak, as well as before and after events at the Moda Center and Veterans Memorial Coliseum. Any design refinements in this area need to accommodate both daily and event access.

The following streets within the Project area are identified as Major City Walkways in the City of Portland's recently adopted Ped PDX Plan and as Major City Bikeways in the City's Bicycle Plan for 2030:

- NE Broadway
- NE Weidler Street
- N Vancouver Avenue
- N Williams Avenue

Major city walkways are intended to provide safe, convenient, and attractive pedestrian access, with regularly spaced marked crossings, wide sidewalks, and a pedestrian realm that can accommodate high volumes of pedestrian activity. As part of central city, much of the Project area is within a pedestrian district where all streets are important in serving pedestrian trips and should have sidewalks on both sides or meet alternative design criteria.

Typical weekday pedestrian AM peak volumes exceed 60 and typical weekday PM peak volumes exceed 90 at key intersections in the Broadway/Weidler interchange area, as seen below in Table 11.

Table 11. Existing Pedestrian Volumes in Broadway/Weidler Interchange Area, 2018

Intersection	AM Peak (7:00 AM – 8:45 AM)	PM Peak (4:00 PM – 5:45 PM)
N Broadway & N Vancouver	28	76
N Weidler & N Vancouver	64	94
N Broadway & N Williams	45	87
N Weidler & N Williams	31	96

Source: Portland Bureau of Transportation Traffic Counts. Data was collected between 5/2018 – 8/2018 depending on the intersection or road segment.

Major City Bikeways are intended to provide safe, direct, seamless, and efficient bike travel through and across districts. They are designed to accommodate large volumes of bicyclists and minimize delays by emphasizing the movement of bicycles.

Typical weekday bicycle AM peak (7:00 AM-8:45 AM) volumes exceed 700 and typical weekday PM peak (4:00 PM-5:45 PM) volumes exceed 1,100 within the Project area, as seen below in Table 12.

Table 12. Existing Bicycle Volumes on Local Roads, Broadway/Weidler Interchange Area, 2018

Direction	AM Peak (7:00 AM-8:45 AM) Largest Bicycle Traffic Volume, (Typical Weekday)	PM Peak (4:00 PM-5:45 PM) Highest Bicycle Traffic Volume, (Typical Weekday)
Northbound (N Williams Ave)	90	1,114
Southbound (N Vancouver Ave)	426	89
Eastbound (N/NE Weidler St)	51	583
Westbound (N/NE Broadway St)	862	114
Bidirectional (Flint at N Tillamook)	634	141
Bidirectional (NE Multnomah at Wheeler)	—	700

Source: Portland Bureau of Transportation Traffic Counts. Data was collected between 5/2018 – 8/2018 depending on the intersection or road segment. AM peak is between 7:00 AM-8:45 AM on a normal weekday. PM peak is between 4:00 PM - 5:45 PM on a normal weekday.

The proposed active transportation network improvements emphasize safety and direct connections to destinations whenever possible. They are intended to provide the shortest and safest path for people walking and bicycling through the district and are also intended to minimize multimodal conflicts. Further investigation and design are needed to resolve remaining multimodal conflicts.

The 20% Design improvements include:

- Protected bicycle lanes on Broadway and Weidler from N Wheeler Avenue to N 1st Avenue, creating a safer bicycling environment for east-west travel through the Project area.
- Safer connections for north-south bicycle by providing a direct, seamless, and efficient bicycle route between Williams/Hancock and destination to the south, including the Steel Bridge. This includes a continuous, dedicated right-side running protected bike lane on N Vancouver Avenue from NE Hancock Street to NE Weidler Street to accommodate the removal of N Flint Avenue overcrossing. Currently, buses and bikes share a lane between NE Broadway Street and NE Weidler Street.
- Sidewalks on both sides of N Vancouver Avenue from NE Hancock Street to NE Broadway Street.
- A bicycle connection on the south side of N Hancock Street between N Vancouver Avenue and N Flint Avenue to facilitate bike movements from SB Vancouver to the Broadway Bridge. This connection would allow bicycles destined to EB Broadway to avoid the Broadway/Vancouver intersection.
- Retained existing on-street bicycle circulation with enhanced treatments and refined intersection solutions.
- A lowered NE Hancock/N Dixon overcrossing, when compared to the NEPA concept, to facilitate accessibility between N Broadway and NE Hancock/N Dixon

For the 20% design, Table 13 outlines the assumed pedestrian and bicycle facilities within the Project limits.

Table 13. Pedestrian and Bicycle Facilities

Street	Pedestrian Facilities	Bicycle Facilities
Hancock/N Dixon St	Sidewalk on both sides matching street profile of 7% with flat pedestrian rest landings at the back of the south sidewalk.	Directional street level bike lanes on both sides matching street profile of 7% and a sidewalk level SB bicycle side path on the south side between N Vancouver Ave and N Flint Ave.
N/NE Broadway	Sidewalk on both sides.	Directional sidewalk level protected bike lane between NE 2nd Ave and N Wheeler Ave on north side. Matches into City's planned "road reorganization" cross section at either end.
N/NE Weidler St	Sidewalk on both sides.	Directional sidewalk level protected bike lane between N Benton Ave and NE 1st Ave on south side. Matches into City's planned "road reorganization" cross section at either end.
N Vancouver Ave	Sidewalk on both sides.	Southbound directional sidewalk level protected bike lane on west side.
N Williams Ave	Sidewalks on both sides.	Northbound directional sidewalk level protected bike lane on east side.
NE Victoria Ave	Sidewalks on both sides.	Directional bike lane on east side.

Lane configuration, furnishing zones, frontage zones, buffers, pedestrian and bicycle widths as well as pedestrian and bicycle mixing zones at intersection crosswalks and transit stop has been advanced since the 15% milestone in coordination with the Project's agency partners. However, additional coordination will be required as the design progresses to develop the final recommendations.

Transit

EXISTING BUS AND STREETCAR SERVICE

Study Zone 4n/4s includes operation of the Portland streetcar on N/NE Broadway and N/NE Weidler Street. In its final configuration, it is assumed the streetcar would operate in the same alignment and lane configuration (with streetcar on the inside lane) as currently exists on N/NE Broadway and N/NE Weidler Street. Temporarily, the streetcar would be relocated on shoofly alignments through the work zone to allow for the construction of the cover and maintain streetcar operations through the duration of the Project.

Other key assumptions for the streetcar service include:

- Streetcar stations would not be temporarily or permanently relocated with the Project.
- Continued coordination with Portland Streetcar, Inc. and the City is necessary. Any temporary transit operation through the construction limits would need to maintain equal capacity to existing conditions.
- Multiple short-duration shutdowns and bus bridges would be required to construct the tie-ins for the temporary alignments of the streetcar, as well as construction of the final configuration. See Section 5, Maintenance of Traffic Approach During Construction.

Study Zone 4n/4s also includes bus lines # 17, 4, 44, and 157 operating on the following routes:

- Bus #4 and #44 operate north-south on N Vancouver Avenue and N Williams Avenue
- Bus #17 operates east-west on N/NE Broadway and N/NE Weidler Street

- Bus #157 (C-Tran) is an express line carrying passengers between the C-Tran facility in Vancouver, WA and the Lloyd District. The line operates north-south on N Vancouver Avenue and N Williams Avenue, circulating on 11th, 13th, and NE Multnomah Street

Impacted bus stops would be replaced at or near their existing locations. Coordination of design details with C-Tran and TriMet would continue through design.

EXISTING STREETCAR TRACK SECTION

The existing streetcar track section is similar on both N/NE Broadway and N/NE Weidler Street. It includes an embedded track with Ri 52 rail installed at a gauge of 4' – 8¼", with a rail boot provided to limit stray current. The depth of the track slab is 12 inches, with 6 inches of aggregate base underneath. The slab includes both longitudinal and transverse rebar and was constructed using an insulated support tie every 10 feet (reduced to 5 feet in curves). The rails within the curve on N/NE Broadway between N Vancouver and N Flint and within the curve on N/NE Weidler between N Ross and N Wheeler were precurved. Restraining rail was not included in these curves because of the formed flangeway provided with the Ri52 girder rail section. No vibration mitigation besides the rail boot was installed. The details on the existing track section come from the record drawings of the Portland Streetcar Loop Project, May 2012, but would need to be confirmed with the City and Portland Streetcar Inc.

TEMPORARY STREETCAR TRACK SECTION

It is recommended that the section details for the temporary shoofly tracks on both N/NE Broadway and N/NE Weidler be the same; this would provide efficiencies in construction and lower cost for material purchase. The overall depth of the temporary streetcar section to be installed would depend on several considerations, including rail type, track type (embedded or ballasted with concrete infill), vibration mitigation, track rail precurving, and materials lead time.

It is recommended to construct a track section that uses either the 115RE or the 85ASCE rail shape, both of which are commonly available and can be purchased used (recommended, since this is a temporary installation).

The least expensive section would be tie and ballast with asphalt pavement inlay. This type of section would need to be stabilized laterally and made to work with the temporary shoofly roadway sections. If a tie and ballast section would not work, an embedded section with a rail boot, restraining rail, and non-head hardened, relay rail is recommended.

PERMANENT STREETCAR TRACK SECTION

Installing a permanent track section on both N/NE Broadway and N/NE Weidler that matches the existing track would provide several benefits to the system. A matching section would be able to use the existing supply of spare parts as well as take advantage of the existing bank of maintenance knowledge and experience. Matching rail types would reduce potential unknowns with respect to noise and vibration and would eliminate differences in the wheel-to-rail interface between the existing and proposed track.

The proposed permanent alignments would match the existing. Noise and vibration analysis for the permanent streetcar alignment has not been undertaken. However, because the alignments would match existing, it is not anticipated further measures for mitigation beyond what the current track section provides would be necessary.

4.4.3.2 Pavement

For the purpose of the 20% Design, it is assumed that the existing, full depth pavement would be removed and reconstructed in areas having horizontal or vertical alignment modifications. A pavement design for local streets has not yet been conducted. In reviewing historical projects in the area, the assumed preliminary pavement section is assumed to be 9 inches of asphalt concrete above 12 inches of aggregate base rock for all street sections. For portions of the existing roadway that are immediately adjacent to or paralleling local streets or have no change in horizontal or vertical alignment, existing travel lanes would include a grind and inlay vs full depth pavement reconstruction. A detailed pavement design, including field explorations and traffic analysis, will be conducted for the 30% Design Package.

4.4.3.3 Structures/Geotechnical

A highway cover structure is being constructed within Zone 4 that extends from the north region (Study Zone 4n) to the south region (Study Zone 4s). Several new retaining walls are also being implemented in this study zone. See Appendix G, Appendix H, and Appendix I for details of the highway cover and retaining walls within Study Zone 4. An open layout concept is assumed for the highway cover in this phase of the Project, and future urban design efforts will determine the urban design concept that will advance to future phases of the Project.

Four primary regions compose the highway cover with the following girder types:

- Region 1: North area of highway cover consisting of a two-span structure spanning over I-5 SB and exit ramp, as well as I-5 NB and entrance ramp. Girders consist of flared, two-span variable depth, cast-in-place post-tensioned box girders with a minimum depth of 5 feet.
- Region 2: Area of highway cover adjacent to Region 1 spanning over I-5 SB and exit ramp, as well as I-5 NB and entrance ramp. Girders in areas of the highway cover spanning over the exit and entrance ramps consist of 30-inch-deep voided slab girders with a 5-inch topping slab. Girders in areas of the highway cover spanning over I-5 NB and I-5 SB consist of flared precast, prestressed BT60 girders.
- Region 3: Area of the highway cover south of Region 2 consisting of a two-span structure over I-5 NB and I-5 SB. Girders in this area of the highway cover consist of parallel precast, prestressed BT60 girders with centerlines spaced a 4'-1".
- Region 4: Area of the highway cover spanning between the abutment and end of the Region 3 bridge that supports local streets exiting/entering the highway cover. Girders in this area of the highway cover consist of a cast-in-place edge girder supporting cast-in-place rib girders and a concrete deck.

Girders in Regions 1-4 are supported by the following bents and abutments throughout the highway cover:

- Semi-integral abutments: Cast-in-place abutment walls supported on pile caps and 30-inch-diameter driven pipe piles. Design is used in locations where retaining fill is required.
- Median bent wall: Cast-in-place bent wall supported on a shaft cap and 6'-0" diameter drilled shafts. Wall has intermittent FLS egress doors. Design is used throughout the length of the highway cover between I-5 NB and I-5 SB.
- Multi-column bents: Cast-in-place, reinforced concrete bent caps and 4'-0" diameter columns supported on pile caps and 30-inch-diameter driven pipe piles. Design is used in locations that are not median bent walls or abutments retaining fill.

Foundation positions within the highway cover have been positioned to minimize conflicts with the abandoned foundations of the bridges being demolished within this area of the Project. Some known likely conflict areas between abandoned foundations and proposed foundations exist within the Bent 2 alignment where drilled shaft spacing has been shown to vary near existing foundations to avoid direct conflict. Other potential areas of conflict with abandoned foundations exist within the limits of the 1960 timber trestle detour bridges that were used during the original construction of the existing bridges. The approximate limits of these bridges have been presented in the JD drawings of Appendix H, and it is likely that foundations from these detour bridges were abandoned and still exist as potential subsurface conflicts in those areas of the Project. Additional discussion will be required with the CM/GC to coordinate design and construction methods to deal with these likely foundation conflicts, and any others that may be identified throughout design progression. Additionally, foundation design of the eastern side of the highway cover will be coordinated with the relocation of the BES 56-inch combined sewer pipe discussed previously under Chapter 4.3.3.6. Utility attachments and maintenance access will be considered as design progresses.

Estimated preliminary foundation data for new foundations have been included in the footing plan sheets within the JD drawings in Appendix H. This information has been included in the drawings to illustrate assumptions supporting quantity development and to assist with constructability conversations with the CM/GC. For additional discussion pertaining to foundation selection and geotechnical considerations in this area of the Project, see the Draft GERs for the highway cover; also see the Draft GDR.

Fire and Life Safety

Preliminary analyses for FLS were conducted to confirm that FLS systems were required for each highway cover that was considered in earlier phases of the Project, and to compare alternative types of FLS systems and estimate the necessary system components capable of achieving requirements for tenability and structural protection. From those analyses, an FLS system for the highway cover with the following components are recommended for further consideration:

- Early detection
- Early notification
- Median wall exits
- Egress pathway protected by physical barriers
- Fire-resistant cover board
- Jet fans
- Water-based fixed fire-fighting system (FFFS)
- Other required components (regardless of selected FLS system)
    - Standpipes
    - Emergency Response Plan

Additional FLS analyses will be completed as the design for the highway cover progress. All preliminary FLS features and systems are working assumptions until an Authority Having Jurisdiction (AHJ) is appointed and provides authoritative FLS direction for the Project.

Utilizing fire-resistant cover board for structural protection during fire events introduces challenges to bridge inspections that utilize traditional inspection methods. To overcome this challenge, a track-mounted remotely operated vehicle (ROV) with video capabilities is proposed

to obtain visual inspection of the underside of the bridge and girder soffits. It is likely that an 8-inch gap between the cover board and girder soffit will be required to utilize this ROV inspection concept. Discussions regarding the use of ROV inspection will continue in project progression. See Appendix J for additional details.

Geological Conditions for Study Zone 4n and Study Zone 4s

See the Draft GERs for the highway cover and the Draft GDR for geotechnical and geological considerations and discussions in this area of the Project. These documents will be updated after all geological exploration and testing is complete, and also as designs are progressed.

4.4.3.4 Stormwater

Within City of Portland ROW, the CIA is 18.40 acres, as shown in the Stormwater Roll Plot (Local Streets) included in Appendix B.

Water quality treatment if required for this area, either directly or by treating an equivalent offsite impervious area. Approximately 16.88 acres of the CIA are within the City's combined sewer area (CSA) and 1.52 acres of the CIA are within the City's storm-only system.

The City's combined sewer system drains to the Columbia Boulevard Wastewater Treatment Plant where it is treated prior to discharging into the Columbia River. The City does not require additional water quality treatment of the stormwater within the Project site; however, the City will require infiltration of the stormwater within vegetated facilities to the maximum extent feasible prior to connection to the combined sewer system and will require that the Project meets the flow control requirements of the Stormwater Management Manual current at the time of final engineering. The City may also require additional retention of the stormwater depending on the capacity of the existing combined sewer system.

Per the City, portions of the combined sewer system within the Project area are capacity limited. Post 20%, a figure will be developed showing existing and proposed basin areas and their respective connection points to the combined sewer system. This figure will be shared with the City's BES for their use in updating their hydrologic and hydraulic models to evaluate and refine capacity risk and develop measures to mitigate that risk.

The conceptual stormwater plan, within the City's CSA, is to infiltrate the stormwater to the maximum extent feasible within stormwater planters, located within the furnishing/landscape zone and adjacent to the roadway.

The conceptual stormwater plan, within the City's storm-only system, is to provide water quality treatment within stormwater planters or basins located within the furnishing/landscaping zone and adjacent to the roadway. Other opportunities within the Project basin area may exist outside of the street landscape buffer zone and those opportunities will be analyzed as the Project progresses and discussions with the City's BES are conducted.

A summary of the conceptual stormwater management plan is included in Appendix P. Proposed stormwater conveyance improvements would be limited to new catch basins where needed, with new laterals connecting to the combined sewer or storm mainline. It is anticipated that stormwater infrastructure will most likely be needed on the freeway cover. The structural design team does not anticipate any issues with accommodating this proposed infrastructure.

4.4.3.5 Traffic Operations and Design

Operations and Analysis

The 20% Design traffic operations analysis and lane configuration is based on the NEPA 2045 Build Alternative configuration with the exception of the intersections of NE Broadway at NE Victoria Avenue, NE Broadway at N Williams Avenue, N Broadway at N Vancouver Avenue, and N Vancouver Ave at N Weidler Street. It is assumed that the City's planned Broadway/Weidler road reorganization will be constructed prior to the construction of the Project, and as such, are reflected in the lane configuration and operations analysis for this Project.

Intersection signal phasing and timing within Study Zone 4s is predominately driven by the following guiding strategies:

- Provide adequate green time for interchange ramp terminal to avoid traffic queuing onto I-5.
- Provide protected pedestrian and bicycle signal phases at signalized intersections as directed by the City.
- Eliminate turn on red throughout the study area to reduce conflicts between turning vehicles and pedestrians.
- Consider leading pedestrian intervals at all signalized intersections with conflicting pedestrian and shared vehicular movements.
- Consider the necessary green time allocation to accommodate the large existing and future bicycle movements within the Project limits at signalized intersections.
- Minimize queuing impacts that would have a negative effect on transit movements.
- Minimize the number of dual vehicle turn lanes to the greatest extent possible.

Study Zone 4n includes the following four intersections on N/NE Hancock Street:

- N/NE Hancock Street at N Williams Avenue
- N Hancock Street at N Vancouver Avenue
- N Hancock Street at N Flint Avenue
- N Hancock Street/N Dixon Street at N Wheeler Avenue

The intersection of NE Hancock Street at N Williams Avenue would have a traffic signal for motor vehicles, along with a bike signal for bicyclists traveling diagonally across NE Hancock Street from the east side of N Williams Avenue to the west side through the intersection as the bike lane north of NE Hancock Street would stay along the west side of N Williams Avenue. The intersection of NE Hancock Street at N Vancouver Ave was also assumed to be under signal control in the 15% design; however, a signal is no longer needed with the 20% Design as there would be no diagonal crossing of SB bicyclists across NE Hancock. The east and west approaches are assumed to be under stop control. The north and south approaches to the intersections of N Hancock Street at N Flint Avenue and N Hancock Street at N Wheeler Avenue are also assumed to be under stop control.

Study Zone 4s includes the following six key intersections on the N/NE Broadway/ N/NE Weidler Street couplet.

NE BROADWAY AT NE VICTORIA AVENUE

The number of lanes for the east approach is primarily driven by the intersection operations at the NE Broadway intersection with N Williams Avenue and the I-5 NB and SB ramp terminals.

The east approach consists of a 5-lane cross section. The right lane is a shared right turn/through lane, which is consistent with existing conditions. The south approach has two dedicated left turn lanes and a dedicated through lane. The north approach has a dedicated right turn lane. Figure 6 shows the proposed lane configuration and signal phasing concept.

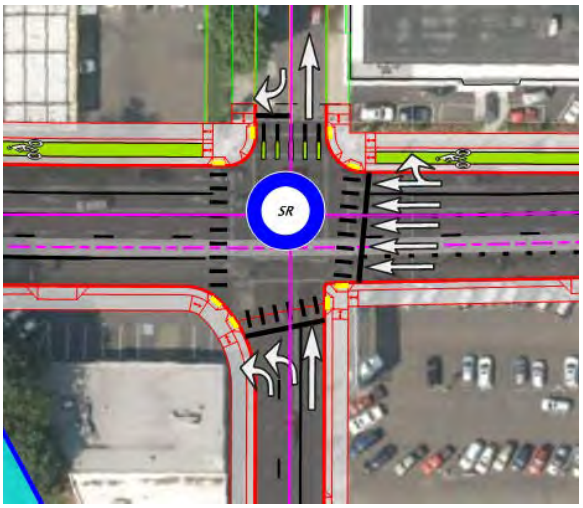
There is an existing bike signal for the WB bike movements along the north side of Broadway; however, this bike signal does not comply with the FHWA MUTCD Interim Approval (IA-016)[10] because the bike movement operates with the conflicting WB right-turning vehicles from the shared through right turn lane. To meet the requirements of the interim approval for the WB bike signal, one of the following options would be required for this Project:

- Option 1 – Prohibit the WB right turn movement. The 2045 AM and PM peak hour volumes for the WB right turn movement are very low, 10 vehicles per hour and 15 vehicles per hour, respectively. Access to NE Victoria Avenue would be served from adjacent blocks.
- Option 2 – Operate the bike phase as an exclusive phase such that vehicles on all approaches except for the NB dual left turn movement on the south approach would be required to stop. This would impact the operational efficiency of the intersection, resulting in additional delay to vehicles and transit within the intersection.

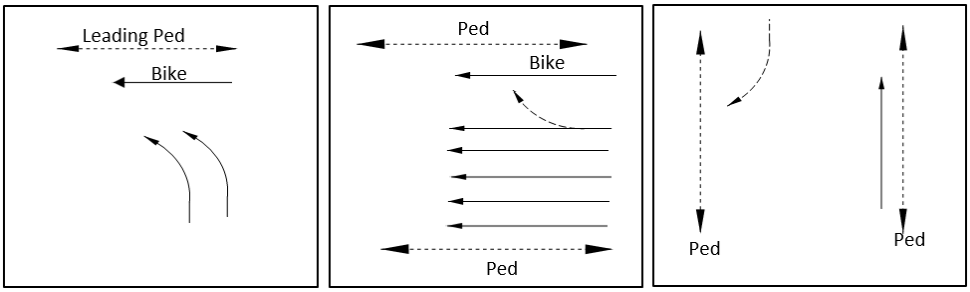
These options will be coordinated with the Project agency partners and resolved after the 20% Design milestone.

[10] https://mutcd.fhwa.dot.gov/res-interim_approvals.htm and https://mutcd.fhwa.dot.gov/resources/interpretations/pdf/9_09_47.pdf

Figure 6. NE Broadway at NE Victoria Avenue (see* Appendix B*) – Proposed Signal Phasing



Broadway at Victoria - Proposed Signal Phasing



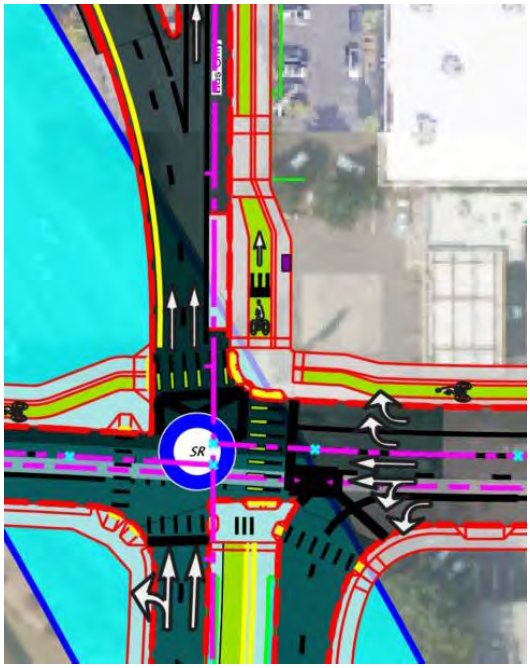
N/NE BROADWAY AT N WILLIAMS AVENUE

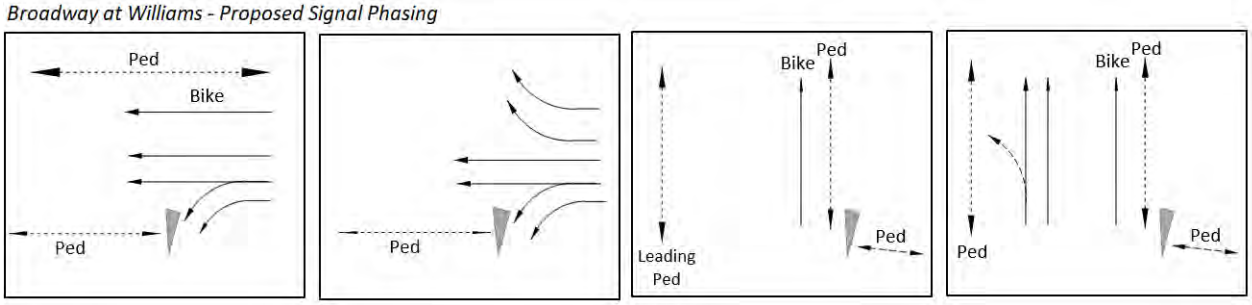
The intersection of NE Broadway at N Williams Avenue functions as both a local street connection with NB N Williams Avenue as well as an access to the I-5 NB and I-5 SB entrance ramps. The intersection utilizes a series of displaced left turn movements to accommodate traffic movements from WB Broadway to SB I-5 and from EB NE Weidler Avenue to NB I-5. The east approach would have two dedicated right turn lanes, a dedicated through lane, a shared through/left turn lane, and a dedicated left turn lane. The left turn lanes form a two-lane SB counter-flow ramp connection along the east side of N Williams Avenue between N/NE Broadway and N/NE Weidler Street, facilitating traffic movements from N/NE Broadway to access the I-5 SB entrance ramp. NB N Williams Avenue south of NE Broadway consists of a shared left turn/through lane and a dedicated through lane, which would be separated from the two-lane SB counter-flow ramp connection by a new sidewalk level protected NB bike lane and a sidewalk median between NB and SB N Williams Avenue. Figure 7 shows the proposed lane configuration and signal phasing concept. An alternative to this layout, showing a NB bus-only lane on NB N Williams Avenue south of N/NE Broadway, is included as an alternative layout discussed in subsection 4.4.3.8 and shown in Appendix R.

There would be a two-stage pedestrian crossing on the south side of Broadway. The eastern portion of the south crosswalk would operate exclusively with the NB traffic movement and the western portion of the south crosswalk would operate with the WB traffic movement. A bike signal would be provided for the sidewalk level protected bike lane along the east side of

N Williams Avenue and another bike signal would be provided for WB bikes along the north side of Broadway, which would operate only concurrently with the WB through vehicular movement. The WB to NB right turn vehicles would be required to stop with a red signal indication during the protected pedestrian crossing phase and protected bike phase for WB bikes.

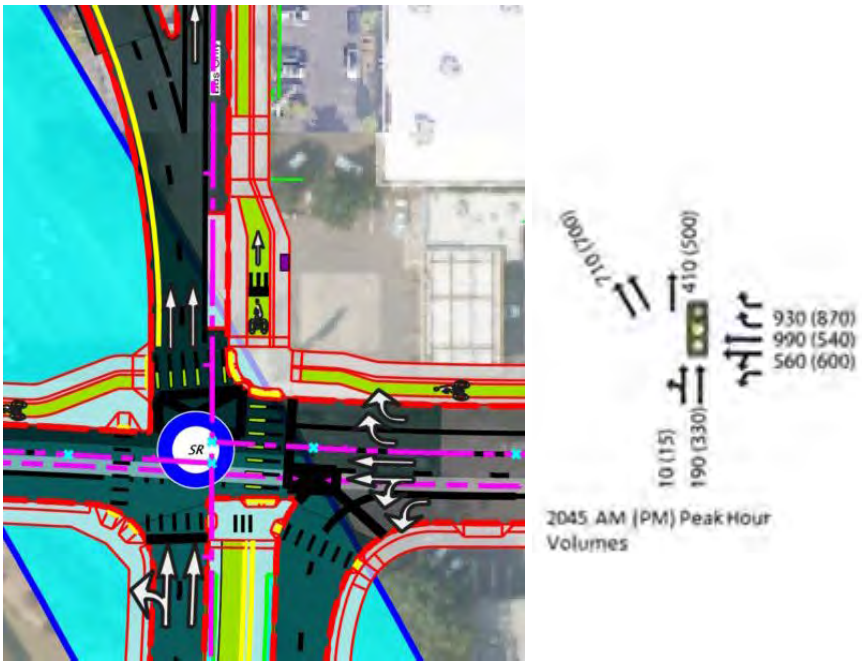
Figure 7. N/NE Broadway at N Williams Avenue (see* Appendix B*) – Proposed Signal Phasing





As a refinement from the NEPA lane configuration, the 20% Design lane assignments for WB Broadway utilize a dedicated left turn lane plus shared through left turn lane to access the I-5 SB entrance ramp via N Williams Avenue. This design refinement is proposed to mitigate extensive queuing in the WB left turn lane that was anticipated in the build condition. The two primary vehicular movements within this intersection include WB to NB right turns (to I-5 NB) and WB to SB left turns (to I-5 SB). Another design refinement from the 15% Basis of Design is the two NB lanes with a shoulder for bus movements on Williams Avenue north of NE Broadway. The right lane functions as an option lane for traffic to access either I-5 NB entrance ramp or continue to travel on Williams Avenue. The main benefit of providing two NB lanes is to reduce the crosswalk distance, minimizing the exposure of pedestrians to vehicular traffic.

Figure 8. NE Broadway at N Williams Avenue Lane Configuration and 2045 Peak Hour Volumes.



The NEPA configuration assumed a single WB to SB left turn lane; however, the resulting queue for this movement was reported to extend several hundred feet beyond N Victoria Avenue, NE 1st Avenue, and occasionally backing beyond the NE 2nd Avenue signalized intersection. This condition would result in several potential negative operational and safety affects as a result of the left turn queue. The left turn queued traffic could extend back into the shared vehicle and streetcar travel lane beyond the left turn storage lane. Also, due to the length of the queue there is a potential safety and operations concern for late merging vehicles to approach the Williams Avenue intersection in the through lane and perform last second merging maneuvers to access the WB left turn lane near Williams Avenue. This potential late merge also creates a potential safety concern with vehicles potentially failing to yield to the pedestrian crosswalk as sight distance to pedestrians may be obstructed by vehicles in the dedicated left turn lane. Based on these considerations, a dedicated WB left turn plus a shared through/left turn lane is proposed.

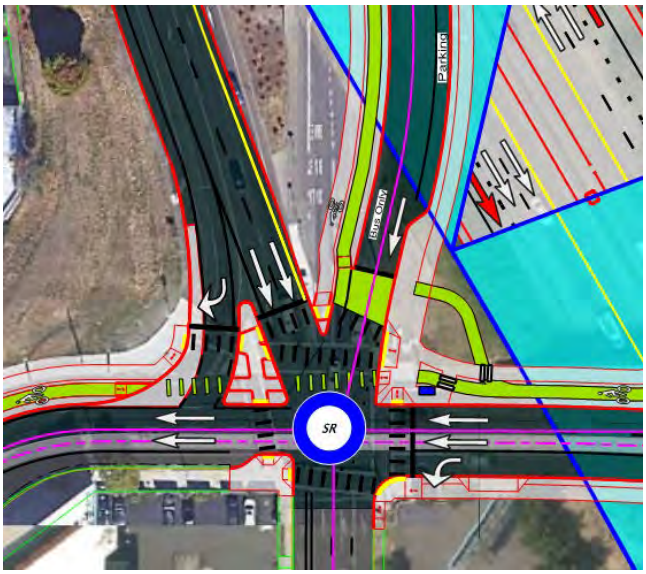
Signal phasing details and the bike signal operation have been coordinated with the City and will be reaffirmed after the 20% Design milestone.

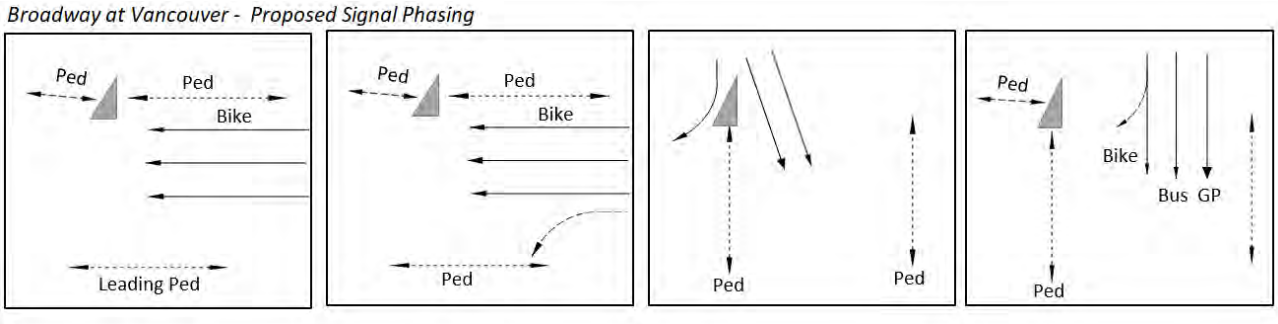
N BROADWAY AT I-5 SB EXIT RAMP/N VANCOUVER AVENUE

The I-5 SB entrance ramp relocation from N Wheeler Avenue to N Williams Avenue would result in a significant reduction in WB to SB left turning vehicles. Additionally, WB vehicles on N/NE Broadway are anticipated to be reduced, as compared to the existing conditions, as a result of the planned City's road reorganization project. The existing north approach from N Vancouver Avenue has three SB through lanes with the existing right lane currently functioning as a queue jump lane for buses and bikes. The 20% Design concept would maintain the bus lane and provide only one general purpose lane. Traffic data shows that a vast majority (75 percent) of SB N Vancouver Avenue traffic are destined to either I-5 SB entrance ramp or N Wheeler Avenue south of N Ramsay Way. As such, if a second GP lane was to be

maintained on Vancouver, the majority of traffic would occupy the middle lane of N Vancouver Avenue between N Broadway and N Weidler Avenue, making the right lane on N Vancouver Avenue not well utilized and diminishing the value and benefit of having a second GP lane on N Vancouver Avenue. Consequently, the current design concept includes only a single GP lane on N Vancouver Avenue. Figure 9 shows the proposed lane configuration and signal phasing concept. However, because consensus with the City could not be reached prior to the 20% milestone, the second GP lane is included as an alternative layout discussed in subsection 4.4.3.8 and shown in Appendix R.

Figure 9. N Broadway at N Vancouver Avenue (see Appendix B) – Proposed Signal Phasing





The existing bike lane along the west side (right-hand side) of N Vancouver Avenue would be maintained. A bike box is proposed on the north approach to enhance safety for bikes either crossing N Broadway or turning right onto WB Broadway toward the Broadway Bridge. A bike signal[11] with a straight through green arrow display and a right-turn green arrow display for bikes crossing N Broadway and turning onto N Broadway should be considered.

[11] https://mutcd.fhwa.dot.gov/resources/interim_approval/ia16/ia16attachment.pdf

Installation of a bike signal and the lane assignments on N Vancouver Avenue have been coordinated with ODOT, in partnership with the City, and will be reaffirmed after the 20% design milestone.

N WEIDLER STREET AT N VANCOUVER AVENUE/N WHEELER AVENUE

As part of the NEPA concept, the north approach was assumed to have a dedicated left turn lane, a shared left turn/through lane, a dedicated through lane, and a shared bus/bicycle shoulder. N Wheeler Avenue south of N Weidler Street was assumed to have three SB lanes (one-way operations). As part of the 20% Design refinement, the Project team identified a design alternative for a two-way N Wheeler Avenue and modified Moda Center access (e.g., the "Green Triangle"). Under the current design concept, the north approach would have dedicated dual left turn lanes, a SB through lane (bus and general purpose), and a dedicated bicycle lane. N Wheeler Avenue south of N Weidler Street would be converted from one way SB to two-way operations to allow for NB dual right turn lanes to facilitate Moda Center event egress traffic.

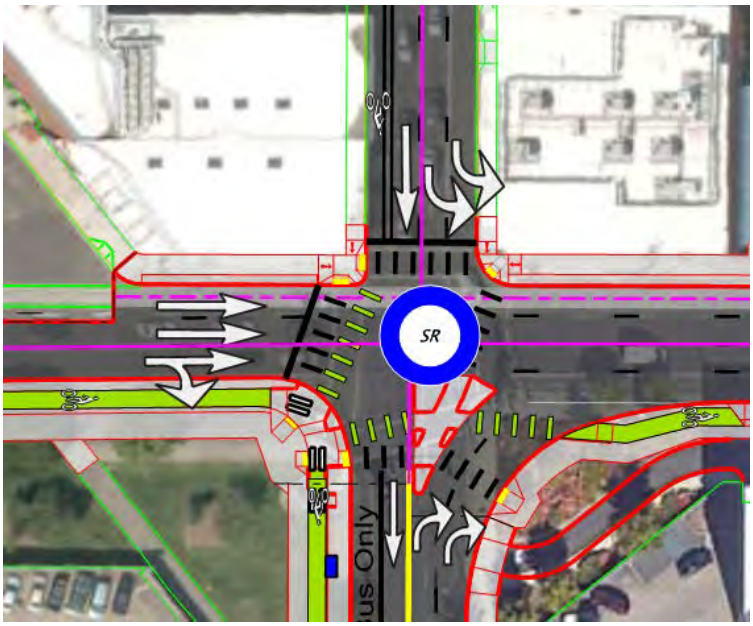
The 15% design concept included a dedicated EB right turn lane on N Weidler Street, whereas the current design concept removes the dedicated EB right turn lane and includes a three-lane western approach with a shared through/right lane on N Weidler Street. The EB right turn demand is expected to be very low and traffic analysis has revealed that there would not be any discernible operational impact associated with removing the dedicated EB right turn lane and the overall intersection operations would be similar to that with a dedicated EB right turn lane. The removal of the EB right turn lane would eliminate the EB bike signal as it would not comply with the requirements of the current FHWA interim approval of bike signals. However, because consensus with the City could not be reached prior to the 20% milestone, the inclusion of a dedicated EB right turn lane on the western approach is included as an alternative layout discussed in subsection 4.4.3.8 and shown in Appendix R.

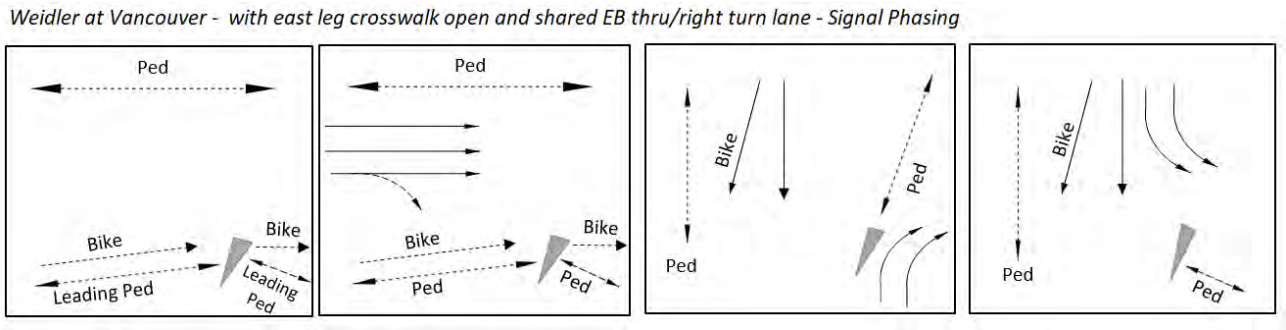
The east crosswalk at the intersection of N Weidler Street and N Vancouver Avenue would remain open to provide additional accessibility to pedestrians. Right turn channelization with a pedestrian island is proposed to facilitate the use of the east crosswalk and to allow the dual NB right turn movements to occur during the east crosswalk phase.

The lane assignment on the west approach has been coordinated with ODOT, in partnership with the City, and will be reaffirmed after the 20% Design milestone.

Figure 10 shows the proposed lane configuration and signal phasing concept.

Figure 10. N Weidler Street at N Vancouver Avenue (see Appendix B) – Proposed Signal Phasing





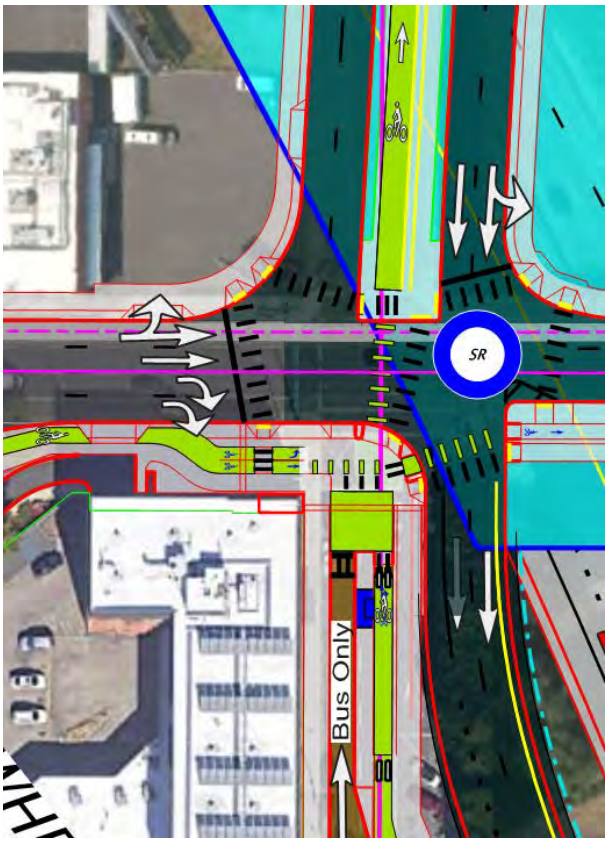
N/NE WEIDLER STREET AT N WILLIAMS AVENUE/I-5 SB ENTRANCE RAMP

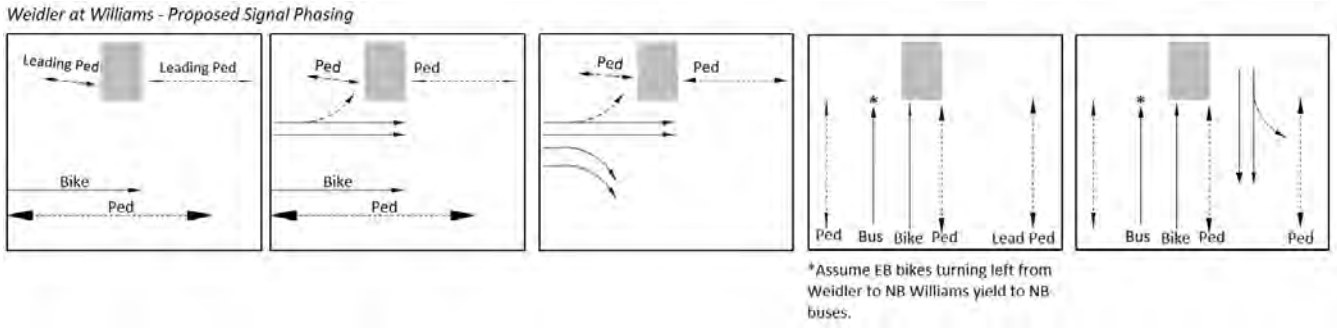
The west approach would have two dedicated right turn lanes to facilitate traffic movements to access the I-5 SB entrance ramp. A two-lane SB counter-flow ramp connection between N/NE Broadway and N/NE Weidler Street would be provided to facilitate traffic movements from N/NE Broadway to access the I-5 SB entrance ramp. The south approach would be restricted to NB buses and a new NB bike facility only. A traffic signal would be provided for the NB buses while a bike signal would be provided for the bicycle facility. A bike signal would also be provided for EB bikes along the south side of N/NE Weidler Street.

A crosswalk at each approach would be provided. The current design concept calls for a crosswalk for N/S pedestrians into the proposed median along the east side of the north/south bike crossing.

Figure 11 shows the proposed lane configuration and signal phasing concept.

Figure 11. N/NE Weidler Street at N Williams Avenue (see Appendix B) – Proposed Signal Phasing



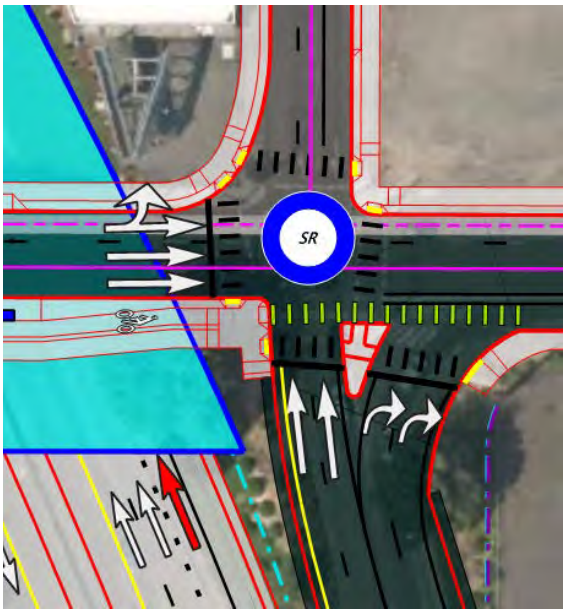


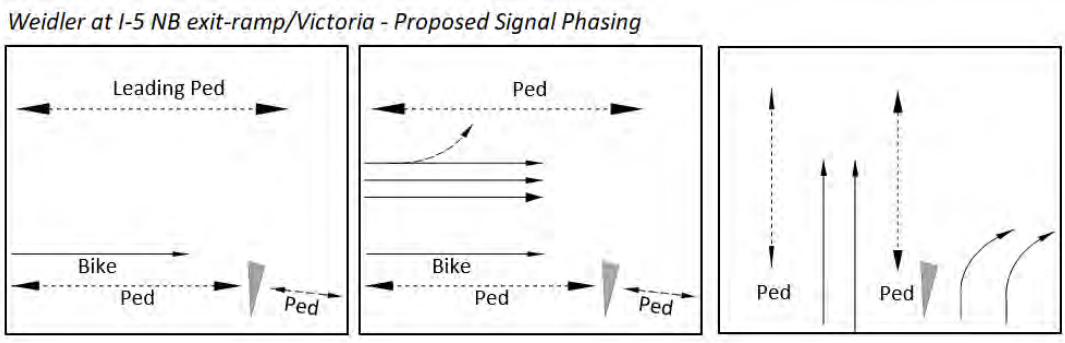
NE WEIDLER STREET AT I-5 NB EXIT RAMP/NE VICTORIA AVENUE

The I-5 NB exit ramp would be widened to provide two through lanes and two dedicated right turn lanes. A bike signal is proposed on the south side of NE Weidler Street to enhance bike safety. All crosswalks would be maintained.

Figure 12 shows the proposed lane configuration and signal phasing concept.

Figure 12. NE Weidler Street at I-5 NB exit ramp/NE Victoria Avenue (see Appendix B) – Proposed Signal Phasing





Signing

Study Zone 4 signing consists of local street signs in the N/NE Broadway/ N/NE Weidler Street area, overhead and ground-mounted. Several overhead guide signs directing traffic to the freeway would be replaced, as the roadway configurations are changing. Part of Study Zone 4 is built on the highway cover, so unique structural support designs would be produced for overhead sign structures. All existing signs would be replaced; new signs and sign supports would meet the latest versions of ODOT Traffic Sign Design Manual, MUTCD, City Sign Code Book, and City Specifications. “No turn on red” regulatory signs would be installed at the six key signalized intersections within the interchange areas. This includes both right turns as well as no turn on red for several left turns on one-way streets.

Signals

Study Zones 4n and 4s include the signalized intersections listed in Table 14 below. More discussion is provided on the operation of these signals under the operations discussion.

Table 14. Traffic Signals for Study Zones 4n and 4s

Intersection	New Signal	Signal Replacement	Signal Modification	Foundation Type	Bike Signal	Span Wire Temporary Signal
Hancock & N Williams Ave	●			Drilled Shaft	NB	
N Broadway & N Vancouver Ave		●		Drilled Shaft	SB, WB	●
N/NE Broadway & N Williams Ave		●		Structure Mounted	NB, WB	●
NE Broadway & NE Victoria Ave		●		Drilled Shaft	WB	●
N Weidler St & N Vancouver Ave		●		Drilled Shaft	—	●
N/NE Weidler St & N Williams Ave		●		Drilled Shaft, Structure Mounted	NB, EB	●
NE Weidler St & NE Victoria Ave		●		Drilled Shaft	—	●

Local Street Illumination

The majority of the local street illumination design on the Project will take place in Study Zones 4n and 4s. Many of the luminaires would be installed at-grade, but a portion of the luminaires would be installed on the highway cover. This would require unique structural foundations and detailed pole designs.

Illumination would be reinstalled on all City-owned facilities impacted by the Project, with design extending beyond Project limits as needed to tie into the existing systems. Several styles of existing local street luminaires would be impacted by the Project, which include:

- Ornamental poles (single and twin)
- Cobra heads on metal poles
- Cobra heads on Pacific Power-owned wood poles
- Cobra heads on signal poles
- Pedestrian-scale luminaires

Proposed Lighting System Options would be determined by the City of Portland's Guidelines for Lighting Options for New or Reconstructed Streets.[12] A portion of the proposed illumination falls within the Lloyd District, which requires Option C (owned and maintained by the City) lighting. All other areas impacted would fall under either Option A (owned and maintained by the utility) or Option C; Option B (owned by the City and maintained by the utility) is not permitted. Additionally, lighting equipment and design in the Lloyd District will require direction from City of Portland staff, per the Design Guidelines for C.O.P. Street Lighting Systems.[13]

[12] City of Portland. March 2007.

[13] City of Portland, January 2004.

The power utility covering the entire Project area, including Study Zone 4, is Pacific Power. Coordination will be required at an early stage of design to determine power source locations and utility conflicts.

Freeway Illumination

No freeway lighting is required in Study Zone 4.

ITS

Within the highway cover structures, the fiber optic conduit may be installed within the cover walls with access panels at least every 500 feet. The new fiber optic cable installation would be designed to ODOT and NEC standards.

The Project will impact the existing PBOT aerial fiber optic cable throughout the Project area, requiring sections of the cable to be relocated or replaced. Construction should be staged in such a way that downtime is limited for the multiple users of the cables throughout the duration of the Project. It is assumed that construction would include new underground fiber with communication devices in every signal controller cabinet. The quantity assumes fiber would run on one side of the street for all streets being reconstructed. It is also assumed that temporary fiber during construction would be one third of the proposed fiber quantity, no other ITS elements would be added on local streets, and that no work would be required beyond Project limits.

Emergency services such as police, fire, and 9-1-1, are likely to share or have their own existing fiber optic cables running underground or overhead in Study Zones 4n and 4s. Information from PBOT on these and other third-party communications will be needed to determine impacts and temporary connections during construction. It is assumed that the cost for restoring other services would be addressed by the new and temporary communications described above.

VARIABLE MESSAGE AND LANE MANAGEMENT SIGNS

As one of the FLS enhancement strategies for the cover, the ITS signs would be installed at the following locations to actively manage traffic demand and facilitate incident response operations through the I-5 NE Broadway/NE Weidler Street Interchange:

I-5 SB Direction

- Install a small VMS on the Kerby Street overcrossing adjacent to the three existing lane management signs. ODOT would need to consider programming upgrades to utilize the existing lane management signs for FLS purposes.
- Install three lane management signs and a small VMS on I-5 SB in advance of the cover at the I-405 to I-5 SB entrance ramp.
- Install a lane management sign over each lane and a small VMS on I-5 SB at the portal of the cover.

I-5 NB Direction

- Install two lane management signs and a small VMS on a cantilever structure just south of the I-84 WB to I-5 SB entrance ramp overcrossing of I-5.
- Install three lane management signs and a small VMS on I-5 in advance of the cover at the I-84 WB to I-5 NB entrance ramp.

- Install a lane management sign over each lane and a small VMS on I-5 NB at the portal of the cover. These signs would display symbols directing drivers to change lanes when a lane is closed or blocked.

These signs would display symbols directing drivers to change lanes when a lane is closed or blocked and provide emergency information. The VMS and lane management sign locations have been included on the ITS Roll Plot included in Appendix F. Further information on the FLS assumptions and layout are included in Appendix J. It should be noted that prior to implementing these signs for FLS purposes, a proof of concept per FHWA guidelines would need to be developed and approved through ODOT. It is anticipated that additional coordination, including software updates and back-end programming, would be required to implement the ITS infrastructure strategy outlined for dynamic lane assignment and FLS mitigation. This work will be closely coordinated with ODOT Statewide ITS, region TMOC, and other agency design staff during the proof of concept phase.

Preliminary evaluation of sign visibility and spacing with other overhead signing has been completed. Additional evaluation will be made after the 20% Design is complete. The quantities of the ITS devices have been accounted for in an FLS evaluation of the highway cover, under the general ITS installation item.

Access Management

Key access management considerations in Zones 4s and 4n include:

- Two existing driveways on NE Hancock Street east of the cover may be impacted by the new Hancock-Dixon road crossing. Driveways would be maintained using PBOT design criteria.
- Three existing driveways on N Flint Avenue west of the cover would be modified as a result of the new Hancock-Dixon road crossing improvements and pedestrian routing. New revised driveway access will be provided using PBOT design criteria.
- One existing driveway on N Wheeler Avenue would be relocated to N Flint Avenue. PBOT design criteria applies.
- Two driveways on N Williams Avenue may be impacted. Due to the proximity with the interchange, both ODOT and PBOT criteria apply.
- One driveway on Broadway may be impacted by street redesign and relocated. Due to the proximity with the interchange, both ODOT and PBOT criteria apply.
- Multiple driveways on Broadway would be impacted due to full property acquisitions.
- One driveway on NE Weidler Street would be impacted due to full property acquisition.
- One driveway on N Williams Avenue would be impacted due to reconfiguration of intersection.
- Multiple driveways on NE Victoria Avenue would be impacted due to full property acquisitions.
- All other driveways are proposed to be maintained within the Project.

Final design assumptions related to access management will be coordinated between ODOT and PBOT as part of the 30% Design Package.

4.4.3.6 Utilities

The existing N Flint Avenue, N/NE Broadway, N Williams Avenue, and NE Weidler Street overcrossing structures carry a range of utilities, including gas, water, overhead and

underground power, and overhead communications. The local street system accommodates utility infrastructure for sewers, water, gas, communications, and power.

The existing gas line on the N Flint Avenue overcrossing structure would be removed and does not require replacement.

There is an existing city water line running on each of the existing N Williams Avenue and N/NE Weidler Street structures. Based on coordination during the NEPA process, it was determined that at least one of these two waterline facilities must remain operational during construction at all times.

There is also an existing fiber optic communication ductbank of eight 4-inch PVC and twelve 4-inch steel conduits that crosses beneath I-5 at N/NE Broadway, within the limits of the cover. It is assumed this fiber optic ductbank would be relocated due to construction conflicts.

Bordering the eastern side of the north half of the cover, existing water and sewer mains are located in a utility easement bordering I-5. The easement allows utility infrastructure to connect between the existing cul-de-sac of NE Hancock Street and N Vancouver Avenue, north of the existing bridge abutment. It is assumed that, if these utilities are found to be in conflict, relocation would require a continued connection of service between N Hancock Street and N Vancouver Avenue, particularly for the sewer that flows to the existing 56-inch combined sewer pipeline in NE Hancock Street.

Bordering the eastern side of the south half of the cover, existing utilities on N Williams Avenue are connected to utility mains along N Broadway. All utilities located within or crossing through the intersection will be in conflict, including those that are not attached to the current overcrossing structure. It is assumed that relocation of utility connections between N/NE Broadway and N Williams Avenue would occur outside of the cover. It is also assumed that staging of the utility relocations in and around the cover would have to be closely coordinated with the cover construction phasing.

Utility protection necessity and feasibility for temporary streetcar alignments will be investigated as the design advances. These will focus on the connections to the temporary streetcar alignments along N/NE Broadway and N/NE Weidler, and NE 1st Avenue. If allowed by both PBOT and BES, utility protection would be considered on NE 1st Ave for the 24 inch combined gravity sewer main under the SB lane, as it has an approximate depth of 17 feet per BES mapping.

Utility conflicts will continue to be identified and coordinated as part of the 30% Design Package.

4.4.3.7 ROW Considerations

ROW considerations within the 20% Design Memorandum are generally consistent with the NEPA phase for this zone. It is assumed there will be extensive use of retaining walls to avoid or minimize potential ROW impacts. As part of the 30% Design Package, additional investigations related to permanent parking impact, property access, and temporary construction impacts will be evaluated to develop the final recommended ROW needs. Further analysis is necessary for property impacts on NE 1st Avenue between NE Broadway and NE Weidler Street based on maintenance of traffic needs.

4.4.3.8 Alternative Design Layouts

The 20% Design includes design alternative layouts related to the City street network included in Appendix B (referred to as “Base Design”). These alternatives were anticipated to be

discussed and resolved in subteam meetings leading up to the 20% milestone. However, with the Portland City Council direction for City staff to suspend all work on the I-5 Rose Quarter Project, consensus could not be reached on preferred alternatives for several topics. The alternatives still being considered are shown in Appendix R and are described below.

N Vancouver Avenue Cross Section Alternative (Hancock to Broadway)

The alternative design to N Vancouver Avenue between NE Hancock Street and N/NE Broadway maintains the same horizontal geometry as the base design; however, the number of general purposes lanes varies. The base design includes one 12.5-foot general purpose lane with an 8-foot on-street parking lane. The alternative design includes two 12.5-foot general purpose lanes with no on-street parking. All other cross section elements are the same between the base design and the alternative. Both designs include a bus only lane, a directional sidewalk level protected bike lane, and sidewalks on both sides of the street.

Two general purpose lanes were originally thought to be needed to address queue spillback past NE Hancock Street. However, signal design progression and adjusted signal timing has now made the SB movements a coordinated phase with the signal at the Vancouver/Weidler intersection, which significantly reduced the queue and delay for SB N Vancouver Avenue.

The Project's Traffic Operations subteam has determined that providing two general purpose lanes provides no benefit to traffic operations and recommends providing only one general purpose lane between NE Hancock Street and N/NE Broadway. The majority of SB N Vancouver Avenue traffic is destined to either the I-5 SB entrance ramp or N Wheeler Avenue south of N Ramsay Way. As such, most traffic on N Vancouver Avenue is expected to queue into the single lane that feeds into the middle lane of N Vancouver Avenue between N/NE Broadway and N Weidler Street. However, City staff were not able to provide input on this updated analysis; therefore, a full consensus on layouts has not been reached.

Future coordination after the 20% milestone includes:

- The Project's agency partners' concurrence with traffic operations analysis for number of general purpose lanes.
- The Project's agency partners' input on providing on-street parking lane and allocation of curb zone space in the context of the ongoing Urban Design of the freeway cover.
- The Project's agency partners' input on lane width to accommodate buses and design vehicles.

N Vancouver Avenue/N Weidler Street Intersection Alternative

The alternative design to N Vancouver Avenue/N Weidler Street intersection maintains the existing dedicated right turn pocket on the west approach of the intersection for EB to SB turn movements. The base design eliminates the turn pocket, replacing it with the through-right turn lane on the west approach of the intersection. Both the base design and alternative designs include a crosswalk on the east leg of the intersection at the right turn channelization island.

The dedicated turn pocket lane alternative provides some benefit to traffic operations for eastbound N Weidler Street; however, it increases the length of the pedestrian crossing across N Weidler Street's west leg. The alternative also includes an EB bike signal; however, it provides less bike green time as there is an additional signal phase needed for the dedicated right turn movement.

The Project's Traffic Operations subteam recommends eliminating the dedicated right turn pocket. However, the subteam needs to perform additional traffic analysis for ingress event conditions at the Moda Center and the agency partners need to provide final consensus on the analysis before the turn lane can be eliminated.

Future coordination after the 20% milestone includes:

- The Project's agency partners' and Rip City Management concurrence with traffic operations analysis for ingress events without dedicated right turn pocket

N Williams Avenue Bus Only Lane Alternative (Broadway to Weidler)

The alternative design to N Williams Avenue between N/NE Broadway and N/NE Weidler Street adds a NB bus only transit lane to separate out buses from the general purpose lane. All other lane configurations are the same between the base design and the alternative. This alternative would complete a continuous bus only lane on N Williams Avenue from N Interstate Avenue to the I-5 NB entrance ramp. The lane widths shown in the base design and the alternative are subject to further discussion, however, adding the bus only lane is anticipated to widen the total cross section of N Williams Avenue.

The maximum peak hour queue anticipated on N Williams Avenue at the N/NE Broadway intersection is 150 feet. The approximate available storage on N Williams Avenue between N/NE Broadway and N Weidler Street is 175 feet. Therefore there is a benefit to providing a bus only lane; however, this will need to be balanced with the increased cross section width.

Future coordination after the 20% milestone includes:

- The Project's agency partners' input on preference for bus only transit lane.
- The Project's agency partners' input on lane width

N Williams Avenue Cross Section and Bus Stop Location Alternatives (Hancock to Broadway)

There are three alternative designs to the base design cross section for N Williams Avenue between NE Hancock Street and N/NE Broadway. The base design includes the N Williams and N/NE Broadway bus stop shifted south to be closer to the corner of N/NE Broadway. This allows extra width for active transportation through the bus stop area. The base design also includes a directional parking protected bike lane north of the I-5 entrance ramp gore. This maintains parking on both sides of N Williams Avenue and provides future flexibility with the cross section (e.g., bus only lane or bus queue jump).

The first alternative maintains the existing location of the N Williams and N/NE Broadway bus stop mid-block between N/NE Broadway and NE Hancock Street (approximately 200 feet north of N/NE Broadway). This provides further separation between intersection traffic and where buses stop for passengers. However, due to ROW constraints, the active transportation width is pinched down through the bus stop. A directional parking protected bike lane is provided north of the I-5 entrance ramp gore.

The second alternative includes the N Williams and N/NE Broadway bus stop closer to the N/NE Broadway intersection; however, it provides a directional sidewalk level protected bike lane the entire length between N/NE Broadway and NE Hancock Street. This alternative would require reconstruction of the east curb, narrowing the curb to curb width to 20 feet. On-street parking would be eliminated from one side of the street.

The third alternative includes the N Williams and N/NE Broadway bus stop closer to the N/NE Broadway intersection, but removes the on-street parking along the east side to provide a wide directional street-level bike lane (16 feet including a 4-foot buffer) north of the I-5 entrance ramp gore. This alternative retains the future flexibility of the cross section similar to the base design.

At N/NE Broadway intersection, the north leg of N Williams Avenue for the base design and all alternatives include two general purpose lanes and a bus only shoulder lane to access the bus stop. North of the I-5 entrance ramp gore, the bus merges back into the one general purpose lane that continues north on N Williams Avenue.

Future coordination after the 20% milestone includes:

- The Project's agency partners' input on bus stop location.
- The Project's agency partners' and Emergency Services' input on cross sections and lane widths.

4.4.4 Findings and Conclusions

The findings and conclusions are working assumptions and do not reflect final Project design/scope decisions. The assumptions herein may be modified based on stakeholder and community input and additional technical information gathered as a natural part of the design progression process.

- Through meetings with the City, N Hancock Street/N Dixon Street is not classified as a Major Bikeway and N Vancouver Avenue should assume a right side running bike facility.
- The profile grade for Hancock Street was reduced from 10 percent in the NEPA to 7 percent based on the use of a 4-span cast-in-place, post-tensioned concrete box girder bridge type.
- Passive and active FLS improvements have been incorporated into the Project design to achieve tenability and structural protection due to the extent of the highway cover.
- The highway cover would contain amenities based on an "open" cover concept without fixed, multi-story buildings. Ongoing community and partner conversations will be conducted to assess this assumption as the Project design advances.
- NE Broadway and NE Weidler Street would have directional sidewalk level protected bicycle facilities.
- Based on revised Moda Center circulation and update operations assessment, N Vancouver Avenue only requires one SB lane to N Wheeler Avenue (shared bus and general purpose). The existing SB bus stop at N Weidler Street would be relocated to a far side stop.
- The 15% eliminated crosswalk on the east leg of the N Vancouver Avenue/N Weidler Street intersection has been added back into the Project.
- SB bicycle movements on N Vancouver Avenue to WB Broadway and to the Steel Bridge are important routes to be maintained/enhanced.
- The City will require the use of the recently updated AASHTO Guide for the Development of Bicycle Facilities (2012) as a standard. This guide has been updated since the NEPA phase was completed.
- Design refinements that contradict the policy guidance within any of the City's adopted planning documents may require amendments to maintain consistency and predictability of future land development.
- The current design assumes an open cover concept. There is a design risk that a change in the assumed use of the highway cover (e.g., buildings on the cover) would result in a

change in design criteria, design loads, approvals, or other potential items that could affect Project schedule and cost. This item will need to be monitored as the Project moves toward 30% design.

4.5 Study Zone 5

4.5.1 20% Design Description

Figure 13. Study Zone 5

Study Zone 5 is composed of the City's local street network around the Moda Center, as shown in Figure 13. The study zone is south of N Weidler Street, north of NE Multnomah Street, and excludes I-5 and the entrance and exit ramps, which are included in other zones. It includes several bus lines (TriMet and C-Tran) circulating around the Moda Center. As a part of this Project, the following elements to the local street system are included:

- Modifications to the Moda Center access, including a reconfiguration of the N Wheeler Avenue/N Williams Avenue/N Ramsay Way intersection.
- Upgrades to existing pedestrian and bicycle facilities, including a new SB bike lane and addition of a sidewalk on the E side of N Williams Avenue between N Ramsay Way and NE Multnomah Street.
- Construction of the Clackamas Pedestrian and Bicycle Bridge, and a new crossing over I-5 connecting N Ramsay Way on the west and NE Clackamas Street on the east.

4.5.2 Concepts Discussion

The following design concepts were investigated within Study Zone 5:

- Modifying the N Ramsay Way alignment to intersect N Wheeler Avenue at less of a skewed angle.
- The NEPA concept for Moda Center operations, including temporary reverse lanes on N Vancouver Avenue/N Wheeler Avenue during events, has been replaced with one SB and two NB travel lanes between N Weidler Street and N Ramsay Way.
- The NEPA concept for pedestrian/bicycle connection from N Williams Avenue to the Clackamas Pedestrian and Bicycle Bridge and the Green Loop, including bidirectional protected bike lane.
- Investigating multiple design alternative layouts for the N Williams Avenue cross section within Study Zone 5. A detailed discussion is included in subsection 4.5.3.8.

4.5.3 Key Issues and Assumptions

4.5.3.1 Roadway

N Vancouver Ave/N Wheeler Ave

The existing horizontal and vertical geometry would be maintained.

The number of lanes and lane assignments have been established by the traffic operations and analysis. The design has one SB and two NB travel lanes between N Weidler Street and N Ramsay Way.

At the 15% milestone, the City provided their standard minimum widths of travel lanes, sidewalks, and bicycle facilities. This information is documented in Appendix L Roadway Design Criteria Sheets.

Modified widths may be required in specific locations based on vehicle turning movements at intersections or ROW constraints. For these specific locations, it is anticipated that additional coordination with the agency partners will be required after the 20% milestone. Any widths less than the minimums provided by the City will require a Design Exception with the City and are noted in Appendix K.

N Ramsay Way

The existing horizontal and vertical geometry would be maintained west of the Garden Garage entrance. East of the Garden Garage entrance the road geometry will curve to meet N Wheeler Avenue at an 80-degree angle.

The number of lanes and lane assignments have been established by the traffic operations and analysis. The design has N Ramsay Way narrowing from two lanes in each direction to one lane in each direction as it approaches the T-intersection with N Wheeler Avenue/N Williams Avenue.

At the 15% milestone, the City provided their standard minimum widths of travel lanes, sidewalks, and bicycle facilities. This information is documented in Appendix L Roadway Design Criteria Sheets.

At the April 22, 2020 Local Roads subteam meeting, the City provided its preliminary concepts of the Green Loop West of Winning Way. This conceptual design for a revised street cross section on Ramsay Way west of N Center Court Street is reflected in the current design.

N Williams Ave

The existing horizontal and vertical geometry would be maintained.

N Williams Avenue between N Weidler Street and N Ramsay Way would be bus only with the southern portion also allowing local access to the adjacent apartment building (Madrona Studios). Between N Ramsay Way and NE Multnomah Street, the design has one SB lane and one NB bus only lane.

At the 15% milestone, the City provided their standard minimum widths of travel lanes, sidewalks, and bicycle facilities. This information is documented in Appendix L, Roadway Design Criteria Sheets.

Modified widths may be required in specific locations based on vehicle turning movements at intersections or ROW constraints. For these specific locations, it is anticipated that additional coordination with the agency partners will be required after the 20% milestone. Any widths less than the minimums provided by the City will require a Design Exception with the City and are noted in Appendix K.

Typical sections are included in Appendix D. Plan and profile maps are included in Appendix A through Appendix G.

Active Transportation

The N Broadway/ N Weidler Street couplet and Moda Center areas are critical locations for pedestrian and bicycle circulation. Each location has especially high volumes during weekday AM and PM peak, as well as before and after events at the Moda Center and Veterans Memorial Coliseum.

The following streets are identified as Major City Walkways in the City of Portland's recently adopted Ped PDX Plan:

- N Wheeler Avenue/N Williams Avenue
- N Ramsay Way

The following streets are identified as Major City Bikeways in the City of Portland's Bicycle Plan for 2030:

- N Wheeler Avenue
- N Williams Avenue
- NE Multnomah Street (part of Study Zone 6)

During Moda Center events, the intersections in the Broadway/Weidler interchange area experience an increased level of pedestrian activity. Most of the pedestrian traffic volumes appear to originate from various commercial parking lots or on-street parking along N Broadway Street and N Weidler Street and within the surrounding area. Table 15, below, summarizes pedestrian volumes at key intersections for a Trail Blazers playoff game in 2019. The sold-out game with full capacity attendance represents one of the Moda Center's largest events.

Table 15. Existing Pre and Post Peak Hour Pedestrian Volumes in Broadway/Weidler Interchange Area, 2019

Intersection	Pre-Moda Center Event	Post-Moda Center Event
N Broadway & N Vancouver	166	645
N Weidler & N Vancouver	375	1,548
N Broadway & N Williams	411	886
N Weidler & N Williams	800	1611

Source: ODOT/HDR traffic counts. Data was collected between 5:30 p.m. and 7:30 p.m. for pre-event conditions and 9:30 p.m. and 11:00 p.m. for post-event conditions on Tuesday, April 23, 2019.

The proposed active transportation network improvements emphasize safety and direct connections to destinations whenever possible. They are intended to provide the shortest and safest path for people walking and bicycling through the district and are also intended to minimize multimodal conflicts. Further investigation and design are needed to resolve remaining multimodal conflicts.

The 20% Design improvements include:

- A directional protected bicycle route for SB bicycle on N Vancouver Avenue/N Wheeler Avenue south of N Weidler Street through the Moda Center access.
- A directional protected bicycle route on N Williams Avenue between N Weidler Street and N Ramsay Way.
- Woonerf on N Williams Avenue just south of N Weidler Street is organized into pedestrian, transit, and bicycle zones to enhance safety, minimize multimodal conflicts, and maintain through function.
- Directional protected bicycle routes on N Williams Avenue between N Ramsay Way and NE Multnomah Street.
- A westside touchdown of the Clackamas Crossing to provide direct WB, NB, and SB connections for bicycles and pedestrians.
- Retained existing on-street bicycle circulation with enhanced treatments and refined intersection solutions.
- Sidewalk on both sides of N Ramsay Way between N Winning Way and N Williams Avenue.
- Two way protected bikeway on the north side of N Ramsay Way between N Winning Way and N Williams Avenue.
- On street EB bike lane on N Ramsay Way between N Winning Way and N Williams Avenue.

For the 20% Design Memorandum, Table 16 outlines the assumed pedestrian and bicycle facilities within the Project limits:

Table 16. Pedestrian and Bicycle Facilities

Street	Pedestrian Facilities	Bicycle Facilities
N Wheeler Ave (from N Weidler St to N Ramsay Way)	Sidewalk on both sides between N Weidler St and N Ramsay Way.	Southbound bicyclist are routed to a directional sidewalk level protected bike lane on the west side of N Wheeler Ave. At Ramsay Way, Southbound bicyclists transition to a street level bike lane. Westbound bicyclists turn onto a bidirectional sidewalk level protected bike lane, and eastbound bicyclists cross Wheeler to Williams.
N Williams Ave (from N Weidler St to N NE Multnomah Ave)	Sidewalk on both sides between N Weidler Ave and NE Multnomah St. Existing sidewalk on west side maintained.	Southbound street level bike lane on west side. Bidirectional sidewalk level Northbound protected bike lane on east side. Further discussion is needed on bikeway on the east side of N Williams Ave between Clackamas Landing and NE Multnomah St.
N Ramsay Way (future Green Loop)	The City's Green Loop is anticipated to run in two directions on Ramsay Way west of Center Court. A sidewalk and street-level eastbound bike lane is anticipated on the south side of Ramsay Way. West of Center Court, a sidewalk and bi-directional sidewalk level protected bike lane would be constructed on the north side of Ramsay Way to avoid the Garden Garage entrance and better align with the Clackamas Overcrossing.	
Clackamas Pedestrian and Bicycle Bridge	Shared ADA accessible (<5% grade) highway overpass from NE Clackamas Street on the east to N Wheeler Ave/N Williams Ave/N Ramsay Way on the west.	

Transit

Study Zone 5 includes the following existing bus routes:

- #4 and #44 operate north-south on N Vancouver Avenue/N Wheeler Avenue and N Williams Avenue.
- #85 circulates around the Moda Center, NB on N Larrabee Avenue, EB on N Ramsay Way, and SB on N Williams Avenue.
- #157 (C-Tran) is an express line carrying passengers between the C-Tran facility in Vancouver, WA and the Lloyd District. The line operates N/S on N Vancouver Avenue and N Williams Avenue, circulating on 11th, 13th, and NE Multnomah Street.

With the installation of a bike lane on the west side of N Vancouver Avenue between N Broadway and N Weidler Street, the existing N Vancouver Avenue and N Weidler Street bus stop is planned to be relocated to the south of N Weidler Street. The stop is anticipated to be a floating bus island to support the continuous bike lane. Coordination of design details with C-Tran and TriMet would continue through design.

4.5.3.2 Pavement

The pavement section for the roadways in Study Zone 5 is assumed to be the same as for the roadways in Study Zone 4n/4s: 9 inches of asphalt concrete above 12 inches of aggregate base rock. See Section 4.4.3.2 for additional discussion. For areas of concrete pavements, the assumed section is 9-inch Portland cement concrete above 12 inches of aggregate base rock.

4.5.3.3 Structures/Geotechnical

The Clackamas Pedestrian and Bicycle Bridge, a new crossing over I-5 NB and SB, is located in Study Zone 5, along with other retaining walls. See Appendix G and Appendix H for details of the Clackamas Pedestrian and Bicycle Bridge and retaining walls required within Study Zone 5.

The Clackamas Pedestrian and Bicycle Bridge is a two-span cast-in-place post-tensioned box girder bridge providing approximately 24 feet of clear distance for a path between barriers. Utilizing this bridge type allows for an aesthetic and affordable bridge that can accommodate the non-tangent bridge alignment. Barriers bounding the path on both sides include a concrete parapet and pedestrian railing and a Type A protective fencing. Concrete barriers have been included on this bicycle and pedestrian bridge to provide protection to maintenance vehicles that may cross the structure; this assumption will be further evaluated in design progression. To maintain vertical clearances over I-5 during construction, it is assumed that the superstructure would be constructed high on falsework and lowered into place. This assumption will also be further vetted as design progresses.

The center support for the structure consists of a bent column with architectural treatment supported by 5-foot-diameter drilled shafts. The abutments consist of a reinforced concrete bent cap supported by 24-inch-diameter pipe piles. Retaining walls surround the abutments and support the west and east approaches of the structure. Corrugated metal pipe sleeves surround the pipe piles within the retaining wall backfill. The corrugated metal pipe sleeves would be sized appropriately in design progression to prevent interaction between the MSE retained fill and the pipe piles. However, interaction between the MSE retained fill and wingwalls, and also between the MSE retained fill and superstructure end diaphragm, are anticipated.

Estimated preliminary foundation data for new foundations in the Clackamas Pedestrian and Bicycle Bridge has been included in the Footing Plan within the JF drawings in Appendix H. This

information has been included in the drawings to illustrate assumptions supporting quantity development and to assist with constructability conversations with the CM/GC. For additional discussion pertaining to foundation selection and geotechnical considerations in this area of the Project, see the Draft GER for the Clackamas Pedestrian and Bicycle Bridge and the Draft GDR.

Geological Conditions

See the Draft GER for the Clackamas Pedestrian and Bicycle Bridge and the Draft GDR for geotechnical and geological considerations and discussions in this area of the Project. These documents will be updated after all geological exploration and testing is complete, and also as design progresses.

4.5.3.4 Stormwater

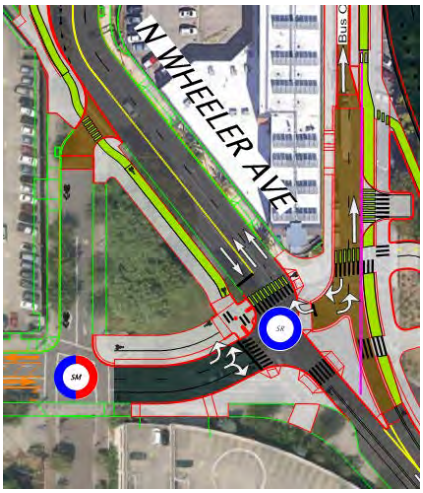
Stormwater for the roadways within City of Portland ROW in Study Zone 5 would follow the same approach as Study Zones 4n/4s (see Chapter 4.4.3.4).

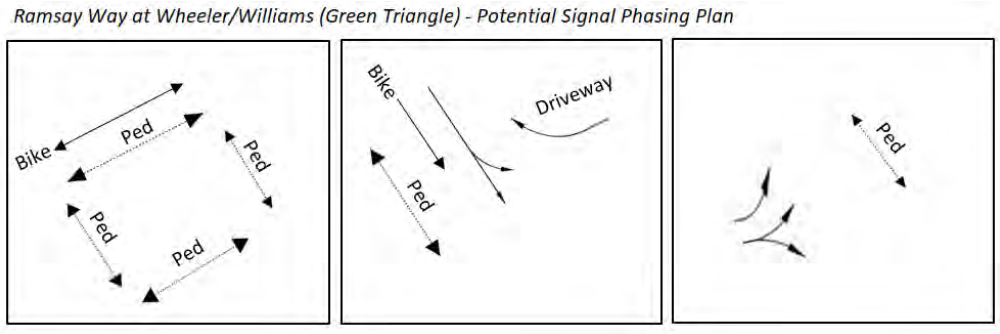
4.5.3.5 Traffic Operations and Design

Operations and Analysis

As stated in Chapter 4.5.1, this Project includes modifications to the Moda Center access, including a reconfiguration of the N Wheeler Avenue/N Williams Avenue/N Ramsay Way intersection. This reconfiguration, now referred to as the “Green Triangle” concept, was specifically developed as a Moda Center mitigation concept to facilitate the post-event egress traffic from the Garden Garage to the relocated I-5 SB entrance ramp on N Weidler Street. The post-event egress traffic from the Garden Garage currently turns right to EB N Ramsay Way and directly accesses the I-5 SB entrance ramp from the signalized intersection of N Ramsay Way and N Wheeler Avenue. Under the Green Triangle concept, vehicles exiting the Garden Garage would turn right to N Ramsay Way, turn left at the new signal at N Wheeler Avenue to travel NB onto N Wheeler Avenue/N Vancouver Avenue, and then turn right at N Weidler Street, followed by an immediate right turn to the I-5 SB entrance ramp. With the relocation of the I-5 SB entrance ramp, the traffic demand SB on N Wheeler Avenue and N Ramsay Way would be significantly reduced, improving the operations of the Moda Center Garden Garage egress traffic. In addition, the new signal at the intersection of N Ramsay Way and N Wheeler Avenue would enhance the safety of pedestrians and bicyclists traveling through the intersection with protected pedestrian and bike signal phases with fewer conflicts and less out of direction travel. Based on preliminary traffic analysis, the Green Triangle concept is expected to function well for traffic circulation in and out of the Rose Quarter Complex. Further coordination with the Project’s agency partners and the Moda Center will be made to confirm the concept. This concept is shown in Appendix A and Appendix B. A potential signal phasing diagram is shown in Figure 14.

Figure 14. Ramsay Way/N Wheeler Ave/N Williams Ave Intersection Layout





Signing

Study Zone 5 signing consists of local street signs in the Broadway/Weidler area near the Moda Center. Several overhead guide signs directing traffic to the freeway would be replaced, as the roadway configurations are changing. All existing signs would be replaced; new signs and their supports would meet the latest versions of the ODOT Traffic Sign Design Manual, MUTCD, City Sign Code Book, and City Specifications.

Signals

The existing traffic signal at N Ramsay Way and Center Court would be modified to allow diagonal bike crossing in the northeast-southwest direction while the existing traffic signal at N Ramsay Way and N Williams Avenue would be replaced.

Local Street Illumination

A large portion of the local street illumination design on local streets will take place in Study Zone 5. In this section, existing facilities are being impacted in addition to the construction of a new cyclist and pedestrian path, which would require pedestrian-scale lighting. Early coordination with PBOT will be necessary to determine the desired light levels and approved fixtures for this new facility.

Illumination would be reinstalled on all City-owned facilities impacted by the Project, with design extending beyond Project limits as needed to tie into the existing systems. Several styles of existing local street luminaires would be impacted by the Project, which include:

- Ornamental poles (single and twin)
- Cobra heads on metal poles
- Cobra heads on Pacific Power-owned wood poles
- Cobra heads on signal poles
- Pedestrian-scale luminaires

Proposed Lighting System Options would be determined by the City of Portland's Guidelines for Lighting Options for New or Reconstructed Streets. A portion of the proposed illumination falls within the Lloyd District, which requires Option C (owned and maintained by the City) lighting. All other areas impacted would fall under either Option A (owned and maintained by the utility) or Option C; Option B (owned by the City and maintained by the utility) is not permitted. Additionally, lighting equipment and design in the Lloyd District will require direction from City of Portland staff, per the Design Guidelines for C.O.P. Street Lighting Systems.

The power utility covering the entire Project area, including Study Zone 5, is Pacific Power. Coordination will be required at an early stage of design to determine power source locations and utility conflicts.

Freeway Illumination

No freeway lighting is required in Study Zone 5.

ITS

The Project would impact portions of the existing PBOT aerial fiber cable along N Williams Avenue and N Wheeler Avenue, requiring sections of the cable to be relocated or replaced. Construction should be staged in such a way that downtime is limited for the multiple networks on the cable throughout the duration of the Project. It is assumed that construction will include all new underground conduit and fiber. The quantity assumes fiber will run on one side of the street along N Williams Avenue and N Wheeler Avenue. It also assumes temporary fiber during construction will be one third of the proposed fiber quantity.

Emergency services such as police, fire, and 9-1-1, are likely to have interconnect cable in Study Zone 5. Information on these and other third-party communications would be needed to determine impacts and temporary connections during construction. These have not been included in the cost estimate.

Access Management

Key access management consideration in Zone 5 includes one driveway on N Williams Avenue and two driveways on N Wheeler Avenue. Each of these driveways are assumed to be maintained with the Project; however, as a result of the changes to roadway travel patterns, additional coordination and considerations with the existing driveway use will be included as part of the 30% Design Package. PBOT design criteria will apply.

Zone 5 also includes a number of driveway access points to Moda Center event parking facilities. Access to parking garages would be maintained with the Project. Specific circulation and access accommodations as well as an updated event management plan would be

coordinated with ODOT, PBOT, and Moda Center event management staff as part of the 30% Design Package.

4.5.3.6 Utilities

There are a number of existing utilities along local city streets within Study Zone 5. Utility conflict identification and protect or relocation strategies will be refined as part of the 30% Design Package.

4.5.3.7 ROW Considerations

ROW impacts within Study Zone 5 west of I-5 primarily include temporary construction easements. East of I-5, permanent ROW acquisition for the new Clackamas Pedestrian and Bicycle Bridge is assumed in addition to temporary construction easements for construction of the proposed facilities. The 20% Design assumptions for ROW include small revisions to, but are generally consistent with, the assumed ROW needs anticipated during the NEPA Phase.

4.5.3.8 Alternative Design Layouts

The 20% Design includes design alternative layouts related to the City street network included in Appendix B (referred to as “base design”). These alternatives were anticipated to be discussed and resolved in subteam meetings leading up to the 20% milestone. However, with the Portland City Council direction for City staff to suspend all work on the I-5 Rose Quarter Project, consensus could not be reached on preferred alternatives for several topics. The alternatives still being considered are shown in Appendix R and are described below.

N Williams Avenue (Formerly Wheeler Avenue) Cross Section Alternatives (Ramsay to Multnomah)

There are two alternative designs to the base design cross section for N Williams Avenue between N Ramsay Way and NE Multnomah Street. Along the east side of N Williams Avenue, the 20% base design includes an 8-foot buffered, directional street-level NB bike lane, a frontage zone, and an 8-foot sidewalk. The first alternative design includes a 7-foot NB directional sidewalk level protected bike lane and an 8-foot sidewalk along the east side of N Williams Avenue. The second alternative design includes a bi-directional multiuse path along the east side of N Williams Avenue that varies in total width from 18 feet to 22 feet.

The base design and each of the alternative designs include a SB general purpose travel lane, a NB bus only lane, a directional street-level SB bike lane and maintaining the Moda Center loading zones and sidewalk on the west side of N Williams Avenue. In all options, at approximately midway between N Ramsay Way and NE Multnomah Street, the total ROW width between the Moda Center and I-5 narrows. This requires a slight narrowing of buffers and active transportation facilities along the east side of N Williams Avenue for approximately 200 feet.

Future coordination after the 20% milestone includes:

- The Project’s agency partners’ input on cross sections
- The Project’s agency partners’ input on SB bike lane location at N Ramsay Way/NE Multnomah Street intersection (curb tight or splitting left and right turn lanes)
- The Project’s agency partners’ input on lane width to accommodate buses and design vehicles

4.5.4 Findings and Conclusions

The findings and conclusions are working assumptions and do not reflect final Project design/scope decisions. The assumptions herein may be modified based on stakeholder and community input and additional technical information gathered as a natural part of the design progression process.

- Initial operations testing of two-way N Wheeler Avenue show acceptable operational performance while accommodating typical ingress and egress traffic patterns for Moda Center event traffic as well as 2045 AM and PM rush hour operations.
- Based on revised Moda Center access (Green Triangle) and projected traffic volumes, N Williams Avenue, south of N Ramsay Way, requires a single vehicle lane in each direction.
- SB bicycle movements on N Wheeler Avenue and N Williams Avenue through the Moda Center is an important route to maintain/enhance because it is a major connection to the Steel Bridge.
- The westerly touch-down point of the Clackamas Pedestrian and Bicycle Bridge would connect with N Williams Avenue and N Ramsay Way.
- N Williams Avenue south of N Ramsay Way would consist of two travel lanes, with the NB lane operating as bus only. In addition, the Project would construct separated pedestrian and bicycle facilities along Williams Avenue between N Ramsay Way and NE Multnomah Street.

4.6 Study Zone 6

4.6.1 20% Design Description

Figure 15. Study Zone 6

Within Study Zone 6, as shown in Figure 15, improvements include an auxiliary lane extension in both the NB and SB directions. This results in:

- Widening the existing I-5 NE Holladay Street viaduct structure.
- Widening and reconstructing approximately 330 linear feet of at-grade roadway.
- Reconstructing the existing freeway retaining walls.
- Temporary impacts to the existing Rose Quarter light rail transit station

4.6.2 Concepts Discussion

The following design concepts were investigated within Study Zone 6:

- Modified span configuration of the NE Holladay Street viaduct to avoid foundation conflicts with existing light rail tracks.
- Encase the existing retaining wall at Wall 14 with a soldier pile wall with tie-backs.

4.6.3 Key Issues and Assumptions

4.6.3.1 Roadway

Roadway modifications within Study Zone 6 primarily include alterations to the existing freeway cross section for the purpose of accommodating the proposed auxiliary lanes. The Project will construct standard 12-foot right-side and left-side (median) shoulders.

No roadway work is anticipated on NE Multnomah Street below the I-5 modifications. However, the City may require sidewalk modifications based on impacts from additional I-5 columns.

Active Transportation

Proposed bridge modifications would include additional bridge columns located within the existing sidewalk and within the Rose Quarter transit station area. New foundations would be of similar size and in line with existing bridge columns. As such, existing pedestrian and bicycle facilities within Study Zone 6 are being functionally maintained.

Transit

Study Zone 6 includes operation of TriMet's light rail system along NE Holladay Street, crossing under I-5. The existing Rose Quarter Transit Center is located below I-5. The transit center services the Blue, Red, and Green MAX alignments. Blue and Red Line trains enter the transit center from both east and west maintenance yards to populate the system from Gresham to Hillsboro. The Yellow, Green (Mall segment), and Orange Lines are populated from the east side only, populating the Mall, Interstate, and Milwaukie alignments from Ruby Junction maintenance yard.

As a result of the I-5 Bridge widening above the Rose Quarter Transit Center, new columns would be placed on each side of I-5 to support the elevated freeway. The 20% Design assumes a temporary shutdown of existing light rail operations to construct the columns between the Special Events and westbound tracks. See Section 5, Maintenance of Traffic Approach during Construction, more information.

4.6.3.2 Pavement

Within Study Zone 6, the 20% Design assumes the existing I-5 freeway section would be reconstructed (with CRCP pavement) and widened to match the existing grade at Bridge #08583.

4.6.3.3 Structures/Geotechnical

Structural needs within Study Zone 6 include widening of Bridge #08583 on both sides of the structure, several retaining walls, and Noise Wall 25. See Appendix G, Appendix H, and Appendix I for details of structures, retaining walls, and the noise wall within Study Zone 6.

Widening on each side of Bridge #08583 would be accomplished with additional girder lines supporting a deck extension and Type F barrier. The existing structure utilizes AASHTO Type III and IV girders, and the ability to utilize those exact girder types in the widening would depend on availability of formwork at local precast manufacturers. If AASHTO girders are not available, the new girders supporting the deck extension would be precast, prestressed members that approximately match the depth of the existing AASHTO girders, such as a modified deck BT45 prestressed girders or modified WF50G prestressed girders. As previously mentioned, the Modified DBT45 are expected to require alterations to the flange width, which can likely be accomplished without modifying the standard forms used by precast manufacturers for these girders. The modified WF50G girder would likely require some modifications to standard precast forms to achieve the required girder height. Design progression will include additional conversations with precast manufacturers to identify the least expensive precast girder solutions if standard girder shapes are not satisfactory to achieve the widenings.

Substructures and foundations supporting the widened superstructure would be single-column bents supported by drilled shaft foundations and permanent casings; columns would be 4 feet in diameter, and drilled shafts would be 5 feet in diameter to satisfy requirements of ODOT BDM Table 1.10.5.5. Permanent casings are currently predicted for all drilled shaft locations in this bridge, but it is likely that they can be removed from the drilled shafts at abutments after more investigation is performed in design progression. Crossbeams in the widened regions would likely be structurally connected to the existing crossbeams of the structure to help improve the lateral response of the bridge during seismic events. Because Bent 6 is located between two TriMet LRT MAX track lines, precast columns and crossbeams using accelerated bridge construction techniques are assumed. This method is expected to minimize the overall construction durations and reduce impacts to the heavily used LRT tracks. At all other bent locations, the columns and crossbeams would utilize traditional cast-in-place construction.

Estimated preliminary foundation data for new foundations in Bridge #08583 has been included in the Footing Plan within the JG drawings in Appendix H. This information has been included in the drawings to illustrate assumptions supporting quantity development and to assist with constructability conversations with the CM/GC. For additional discussion pertaining to foundation selection and geotechnical considerations in this area of the Project, see the Draft GER for Bridge #08583 and the Draft GDR.

An alternative widening concept was investigated to determine the feasibility of widening the structure without impacting the Bent 6 track lines. This concept utilized longer bridge spans that did not require a new bent between the track lines, but would require a longitudinal deck joint between the widening elements and the existing bridge. This alternative concept was dismissed because:

- Differential deflections across the joint introduce safety concerns for I-5 traffic traversing the joint, especially motorcycles.
- Lane closures and traffic disruptions to perform more frequent maintenance on the longitudinal joints was considered to be unacceptable.
- Vertical clearance over the track lines would likely be reduced due to increased girder depths required to accommodate longer span lengths.

The SB bridge also includes a new deck overlay for the full length and width of the bridge to address the deck improvements required for this structure. This overlay requires removal of existing overlays and Class 2 preparation to a clear distance of 0.75 inch below the top mat of

deck reinforcement for the full area of the overlay. Hydro-demolition is assumed to be used to accomplish the Class 2 preparation. Future deck coring and testing would be conducted to investigate the expected remaining lifetime of the existing deck and to confirm its material integrity. If future testing determines the existing deck to be inadequate, then a full deck replacement would be required for this structure, and it will likely be accomplished utilizing precast deck panels.

Geological Conditions

See the Draft GER for Bridge 08583 and the Draft GDR for geotechnical and geological considerations and discussions in this area of the Project. These documents will be updated after all geological exploration and testing is complete, and also as design progresses.

4.6.3.4 Stormwater

There are no proposed stormwater treatment facilities within Study Zone 6. See Chapter 4.1.3.4 for a summary of the conceptual stormwater management plan.

The existing conveyance system consists of a few catch basins within the freeway at the ends of the bridges with a 36-inch-diameter mainline located below the surface streets with manholes along NE Holladay Street and NE Oregon Street. It is anticipated that inlets may need to be replaced to accommodate the bridge and roadway improvements, but these would connect to the existing laterals and the mainline system would not be replaced.

4.6.3.5 Traffic Operations and Design

Operations and Analysis

The NB weave section between the I-84 entrance ramp and the NE Weidler Street exit ramp is expected to operate over the ODOT HDM mobility standard in the Design Year 2045 morning and evening peak hours. A Design Exception will be required.

The SB weave section between the NE Weidler Street exit ramp and the I-84 exit ramp is expected to operate over the ODOT HDM mobility standard in the Design Year 2045 morning and evening peak hours. A Design Exception will be required.

Signing

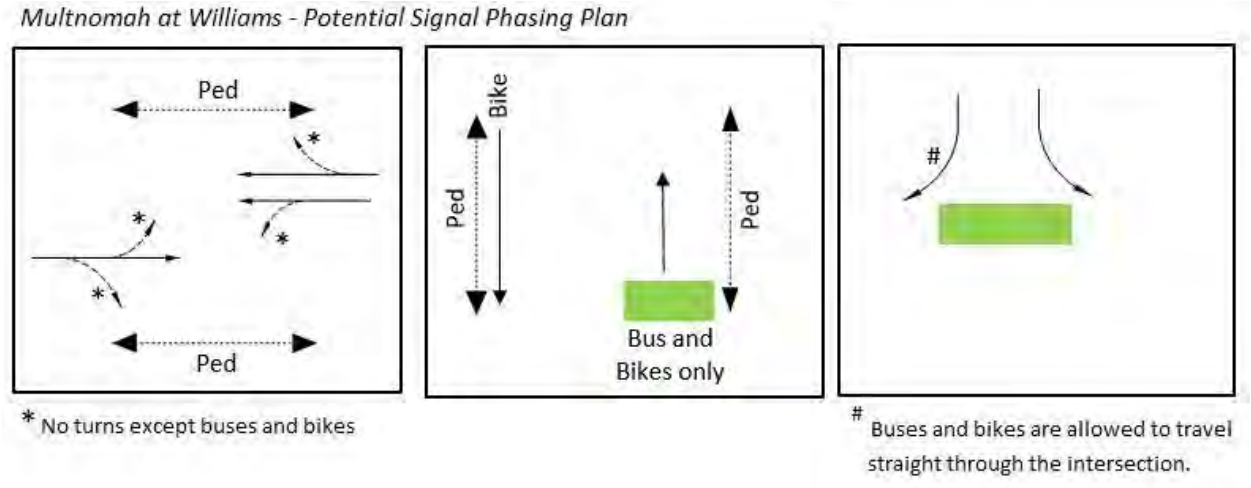
Study Zone 6 signing would have a new sign bridge structure to support proposed signage. All existing signs would be replaced; new signs and their supports would meet the latest versions of the ODOT Traffic Sign Design Manual and MUTCD.

Signals

NE Multnomah Street and N Williams Avenue would require a signal modification to replace a mast arm pole and luminaire pole impacted by construction in the NE corner. These modifications would trigger the need for ADA improvements, including pedestrian push buttons as there are none today. A new SB bike lane would be added on the west side; existing sharrows would be removed. Bicycles are still allowed in the vehicle lanes and would obey the vehicle signal if in those lanes. The Project would add a bike signal for the directional sidewalk level protected bike lanes and consider louvers for the bike signal heads so they are not visible to bicyclists who may be in the vehicle lanes. The bike phase will run separately from the SB

vehicle phase. The SB right turn cannot be overlapped with the bike phase without modification to the signal pole in the SW corner.

Figure* 16 – *Potential Signal Phasing Plan at Multnomah Boulevard and N Williams Avenue



NE Holladay Street and NE 1st Avenue would require a signal modification as well. Coordination with TriMet would be required to establish rail signal operation. Work at this intersection may trigger ADA requirements for ramp and pedestrian pushbutton improvements.

Local Street Illumination

Freeway widening over NE Multnomah Street and NE Holladay Street would impact the wall-mounted luminaires underneath the freeway structure. These luminaires provide lighting for the MAX stop underneath, so impacts of widening would need to be assessed and the luminaires would potentially be replaced. Additionally, the new freeway overhang has the potential to “shade” the nearby decorative street lighting. Analysis will be performed to determine if this impact warrants re-design of the lighting.

Freeway Illumination

The freeway lighting analysis and design standards presented in Chapter 2.3.7 apply to Study Zone 6.

ITS

No impacts to existing ITS infrastructure are anticipated within Study Zone 6 along I-5. ODOT currently has a fiber optic communications connection through the Rose Quarter area on a PBOT-owned cable that currently terminates in a communications cabinet located on the SE corner of NE Multnomah Street/Wheeler Avenue. More information is required to assess potential ITS impacts on the local streets. The estimate of quantities assumes minor fiber optic cable impacts associated with light rail track work.

New fiber, conduit, and communications hand holes would be installed along the freeway to the south from the Rose Quarter Transit Center to connect with a new camera in Zone 7 and to provide for future ITS expansion. The fiber optic conduit would be installed along the shoulder in areas where the freeway is at-grade. The bridge structures within this zone would require the

fiber optic conduit be attached to the underside of the structure or embedded within the bridge rail.

A new radar for traffic count data would be installed for SB I-5 traffic. This would be installed on a new guide sign structure near the I-5 SB to I-84 EB ramp.

Small VMS and lane restriction signs associated with the FLS system are discussed in Zones 4n and 4s.

Access Management

There are no impacts to existing driveways within Study Zone 6.

4.6.3.6 Utilities

An existing aerial power transmission line is located along NE 1st Avenue within this study zone. There are potential staging and construction conflicts with the existing steel pole at the corner of NE 1st Avenue and NE Holladay Street in addition to the overhead transmission lines. Existing light rail overhead catenary wires and poles are in conflict with the proposed structure widening and are assumed to require temporary accommodations.

There are also a number of existing subsurface utilities located within the NE Multnomah Street and NE Holladay Street ROW. SUE mapping is currently underway. Record mapping of large sewers has been considered to the degree feasible in advance of having the SUE mapping available. The BES 54-inch combined sewer pipe in NE Holladay Street is not anticipated to have any direct conflicts with the bridge foundation. The I-5 columns are proposed in line with the existing columns, which parallel the sewer with more than a travel lane of separation. Additional conflict identification and utility coordination will be included with the 30% Design Package.

A 115 kV power transmission line is located on NE 1st Avenue from NE Lloyd Boulevard to NE Multnomah Street, primarily on the eastern side of the road. However, the location of the power transmission switches to the western side of NE 1st Avenue within Study Zone 6, and has two steel transmission poles and one guy pole between the existing I-5 viaduct and NE 1st Avenue's western edge of pavement. During the Project's NEPA phase, these poles were envisioned to relocate to the eastern side of NE 1st Avenue to accommodate beam setting and structure construction. Currently, a building is being built that is anticipated to be a major constraint to the feasibility of relocating the poles to the eastern side of NE 1st Avenue. Options for protection or relocation of these poles will be developed as part of the 30% Design Package.

There are a number of existing utilities along local city streets within Study Zone 6. Utility conflict identification and protect or relocation strategies will be refined as part of the 30% Design Package.

4.6.3.7 ROW Considerations

The southern portion of Study Zone 6 is located within existing UPRR ROW. The existing freeway is located within a permanent highway easement within this area. As a result of the Project improvements, additional permanent easement will be required.

Also within Study Zone 6 is an existing CSO tunnel easement. This easement precludes improvement options that would infringe on its specified lateral and horizontal offset buffers. As a consequence, bridge foundation improvements within Study Zone 6 had to remain above the CSO's easement.

4.6.4 Findings and Conclusions

The findings and conclusions are working assumptions and do not reflect final Project design/scope decisions. The assumptions herein may be modified based on stakeholder and community input and additional technical information gathered as a natural part of the design progression process.

- Auxiliary lane widenings to both sides of Bridge #08583 while matching the existing bridge span configuration. The work would be based on Accelerated Bridge Construction (ABC) principles to minimize the construction duration.
- Temporary impacts to the existing WB and special event light rail tracks during the accelerated construction of the new foundations result in the need for temporary LRT short-duration bus bridging.

4.7 Study Zone 7

4.7.1 20% Design Description

Figure 17. Study Zone 7

Study Zone 7 is the southernmost zone of the Project that spans over NE Lloyd Boulevard and the UPRR tracks near the I-5/I-84 Banfield interchange, as shown in Figure 17. In the SB direction, the Project would include the modification of a portion of the I-5 SB to I-84 EB flyover connection and extend an auxiliary lane to the I-5 SB Morrison exit ramp. To accommodate the southbound auxiliary lane extension to the Morrison exit ramp, the existing median barrier would be relocated and the existing NB and SB travel lanes would be adjusted. This results in less than full width shoulders between the I-84 EB exit ramp and the Morrison exit ramp.

In the NB direction, the Project would include restriping the NB I-5 travel lanes to provide approximately 5.5 feet of additional width in the SB direction. The Project would also retrofit the existing curbed bridge rail system with a bridge rail that meets current design standards. The Project would have a two-lane I-84 WB to I-5 NB entrance ramp through a combination of restriping and widening of the existing ramp. It is assumed some modifications to NE Lloyd Boulevard and NE 1st Avenue. The Eastbank Esplanade will not be modified and will remain open during construction.

This section physically overlaps with potential improvements and construction work areas for Multnomah County's *Earthquake Ready Burnside Bridge* Project. Although neither project has

full construction funding at this time, ongoing coordination between the two projects will occur to minimize conflicts for construction staging and traffic control.

4.7.2 Concepts Discussion

The following design concepts and objectives were investigated within Study Zone 7:

- Minimizing impacts to UPRR property and maximizing horizontal clearances to existing track lines.
- Alternative foundation placements for the widening of the I-5 SB to I-84 EB exit ramp to avoid potential conflicts.
- Satisfying easement clearances to the east side CSO tunnel easement.
- Stormwater treatment facility below the freeway near UPRR.
- Compliance with City of Portland Title 33 and Tittle 24

4.7.3 Key Issues and Assumptions

4.7.3.1 Roadway

Study Zone 7 includes widening in the SB direction of I-5 to extend a new auxiliary lane from the I-84 EB exit ramp to the I-5 SB exit ramp to the Morrison Bridge and OR 99E. In the NB direction, the Project would extend a second lane along the I-84 WB to I-5 NB entrance ramp, creating a two-lane connection with I-5 NB.

In the SB direction, the FONSI / Revised EA included mainline bridge widening from the start of Study Zone 7 to just south of the UPRR tracks. To accommodate the extension of the SB auxiliary lane the existing NB and SB travel lanes would be shifted to the east, the median barrier relocated, and the NB and SB shoulders would be modified. This is a revision from the Draft EA, which included widening along the Eastbank Esplanade. The 20% Design layout includes a narrowing of the approximately 1400 linear feet of the existing median shoulder from approximately six feet to approximately three feet and reducing the median travel lane from 12 feet to 11 feet in both directions.

The proposed mainline bridge widening results in a new foundation within the existing sidewalk and landscape buffer along NE Lloyd Boulevard at Bent L7 and a new placed within the Open Space River General design overlay zone. Additionally, the proposed bent cap would extend over the existing NE Lloyd Boulevard travel lanes, limiting the new vertical clearance. The 20% Design concept also includes bridge widenings along the I-5 SB to I-84 EB exit ramp which would have foundation work that requires excavations and reconstruction of parts of Lloyd Boulevard and the adjacent sidewalk. These modifications are described further is Section 4.7.3.3. These design elements and resulting approvals will be coordinated as part of the 30% Design Package.

Also in the NB direction, the 20% Design layout would restripe a portion of the existing I-84 WB to I-5 NB entrance ramp to accommodate the second travel lane, which is a revision from the bridge widening concept developed within the NEPA base layout. This structure was originally constructed as a two-lane ramp from I-84 with a drop lane at the NE Holladay Street exit ramp forming a 2-1-1 split with a single lane continuing on I-5 NB. The NEPA concept was proposing to restripe the first 350 feet within the existing available ramp width, which is approximately 31 feet. This would result in two 12-foot travel lanes with left and right shoulders of approximately 3.5 feet.

The 20% Design concept maintains the 15% Design layout which would extend the restriping to the north from Bent #12 to Bent #9 (approximately 500 feet). No right side shoulder widening is required within the NE Holladay Street exit ramp. A Design Exception for shoulder width in this area is required. The proposed gore area for the I-5 ramp connection would result in an 8-foot minimum shoulder for a short distance and transition back to a standard 12-foot right shoulder approximately 100 feet downstream of the physical gore. The resulting gore and ramp transition area would have a relatively constant slope with a grade break between the two ramps of less than 4 percent. Extending the physical gore limits further north beyond what is proposed would result in a notable grade break due to the differing profiles beyond the proposed ramp gore and was therefore not considered.

Based on the complexities anticipated with widening and foundation improvements over the UPRR railroad, NE Lloyd Boulevard, and existing MSE wall (along NE Lloyd Boulevard) it is recommended that the structure widening be limited to the areas shown within the 20% Design. The additional widening of the left side shoulder was evaluated; however, due to the profile differences between I-5 NB mainline and the I-84 WB to I-5 NB entrance ramp, widening or relocated the existing gore area (physical connection to I-5 mainline) is not recommended and the existing left side shoulder barrier should be maintained.

Active Transportation

As part of the NE Lloyd Boulevard roadway modifications noted above, there is a new bridge column located within the existing sidewalk buffer area.

The Eastbank Esplanade traverses portions of I-5 within this study zone. The 20% Design maintains the NEPA FONSI / Revised EA assumption of maintaining the existing Esplanade trail on the existing alignment.

Transit

There are no impacts to transit within Study Zone 7.

4.7.3.2 Pavement

All freeway work within Study Zone 7 is on existing structures. Small areas of pavement restoration are required as a result of the proposed foundation work. NE Lloyd Boulevard assume the same pavement section as other local streets.

4.7.3.3 Structures/Geotechnical

Structural needs within Study Zone 7 include widenings that would impact Bridges #S8588E, N8588E, #08588C, and 08588A. See Appendix G, Appendix H, and Appendix I for details of structures and retaining walls within Study Zone 7. Note that the bridge concepts presented in this study zone are significantly influenced by existing retaining walls, the UPRR track lines, the CSO tunnel, many existing utilities, and other roadway amenities.

Bridge #S8588E

Widening is only required on the west side of Bridge #S8588E. The Span 1 widening would be accomplished using voided slab girders and a new deck with Type F barrier. The widening in all other spans would be accomplished with additional steel girder lines to support a deck extension and Type F barrier. New steel girders would approximately match the depth of the existing structures that are being widened. Bridge widening ends at Bent L9. While the roadway

widening varies within Spans 6 & 7, the bridge has constant-width widening in these spans. A Type F concrete rail retrofit is included from the end of the bridge widening at Bent L9 to approximately the gore location with Bridge #R8588E. Also, strengthening of the interior deck overhand utilizing near surface mounted (NSM) CRFP is included from Bent L7 approximately Bent 18 to accommodate the median barrier relocation from the deck on Bridge #S8588E to the deck on Bridge #N8588E.

Substructures and foundations supporting the widened superstructure would be single-column and double-column bent extensions supported by drilled shaft foundations. Columns would range from 4 to 6 feet in diameter, and drilled shafts would range from 3 to 8 feet in diameter to satisfy requirements of ODOT BDM Table 1.10.5.5. Crossbeams in the widened regions would be cast-in-place concrete and would likely be structurally connected to the existing crossbeams of the structure to help improve the lateral response of the bridge during seismic events. Foundations are expected to extend into the Troutdale Formation. New columns located at Bent L9 are located above the Willamette River OHW, but below the regulated floodplain.

Columns and foundations at most bent locations are positioned under the bridge widening to support the additional loads from the widening. However, this was not possible at Bent L7 due to NE Lloyd Boulevard passing under the widening. At that location, the substructure concept utilizes a reinforced concrete crossbeam that spans over NE Lloyd Boulevard and is supported by the existing bent on the east side and a new column and drilled shaft on the west side. Crossbeam enlargement and foundation enlargement with micropiles is required to strengthen the existing Bent L7 for the increased loading that would be produced with this concept.

Timber trestle wharfs previously existed within the I-84/I-5 interchange area. While these wharfs have been demolished, the foundations for these structures were abandoned and exist as potential subsurface conflicts. Approximate locations of these demolished structures were identified using historical photos and georeferencing and have been included in the JK sheets of Appendix H to call attention to this risk item.

Estimated preliminary foundation data for new foundations in this structure is not included in the JK drawings of Appendix H. This foundation data will be finalized according to the outcome of the EA when it is complete and will be added to the drawings in a later submittal.

Bridge #N8588E

A Type F concrete rail retrofit is included from the gore with Bridge #08588A to approximately Bent 18. See the JK drawings for the limits of this rail retrofit.

Bridge #08588C

Bridge widening is required on the west side of Bridge #08588C, and some bridge removal is required on the east side to accommodate relocation of the gore with Bridge #S8588E. The widening in Spans 5 – 6 would be accomplished with additional steel girder lines to support a deck extension and Type F barrier. New steel girders would approximately match the depth of the existing structures that are being widened. The widening in Span 7 includes reconstruction of the exterior deck overhang with a Type F barrier for approximately one-half of the span, and the new barrier would transition into the existing Type F concrete rail retrofit in the remaining one-half of Span 7.

The substructure and foundation supporting the widened superstructure at Bent L5 would be accomplished with a single-column bent extension supported by a drilled shaft foundation; the

column and drilled shaft diameters are 4 feet and 5 feet, respectively. The superstructure widening at Bent NE6 would be supported by a reinforced concrete crossbeam extension that is accommodated by strengthening of the existing crossbeam, column, and foundation at this location. Similarly, the superstructure widening at Bent NE7 would be supported by a crossbeam extension accommodated by strengthening of the existing crossbeam, column, and foundation at this location. Reinforced concrete enlargement would be used to strengthen crossbeams and columns as applicable at these bents, and foundation enlargement with micropiles would be used to strengthen foundations at these locations. There is no substructure or foundation work in Bridge #08588C south of Bent NE7.

Alternative substructure and foundation concepts at Bents NE6 & NE7 were investigated. These alternative concepts utilized reinforced concrete crossbeams supported by strengthened existing bents at one end and a new column and drilled shaft at the opposite end. To avoid the intersection of the Eastbank Esplanade and Lloyd Boulevard sidewalk, as well as the existing utilities below the sidewalk in these locations, new columns and drilled shafts for these alternative concepts were located in the landscaped area south of the MSE wall. These concepts were considered to be undesirable compared to the crossbeam extensions and bent strengthening that has been proposed at these locations. Widening concepts in Bridge #08588C will continue to be investigated and developed as MOT considerations are discussed prior to the 30% Design.

Timber trestle wharfs previously existed within the I-84/I-5 interchange area. While these wharfs have been demolished, the foundations for these structures were abandoned and exist as likely subsurface conflicts. Approximate locations of these demolished structures were identified using historical photos and georeferencing and have been included in the JJ sheets of Appendix H to call attention to this risk item.

Estimated preliminary foundation data for this structure is not included in the JJ drawings of Appendix H. This foundation data will be finalized according to the outcome of the EA when it is complete and will be added to the drawings in a later submittal.

Bridge #08588A

Widening in this area of the Project includes widening of Bridge #N8588E between Bents 1-5, widening of Bridge #08588A between Bents 5-7, and connecting the decks of Bridges #08588A and #H8588A between Bents 7 and 9. For naming simplicity, however, work in this area of the Project is associated with “Bridge 08588A”.

The Span 1 widening would be accomplished using voided precast slab girders and a new deck with Type F barriers. The widening in all other spans would be accomplished with additional steel girder lines to support a deck extension and Type F barrier. Barrier retrofits to Bridge #08588A are included in sections of the east barrier from Bent 9 to the new gore location with Bridge #H8588A, and sections of the west barrier from Bent 9 to the new gore location with Bridge #N8588E.

The widened superstructure at Bent 1 would be supported by a reinforced concrete abutment pile cap supported by 16-inch-diameter driven steel piles for the foundations. All other bent locations would utilize single-column bent extensions with reinforced concrete crossbeams and columns. A micropile foundation is assumed for the Bent 8 foundation because of limited vertical and horizontal clearances to existing structures, and drilled shaft foundations would be utilized

at all remaining new foundations supporting the widenings. Columns would range from 4.5 to 5.5 feet in diameter, and drilled shafts would range from 6 to 8 feet in diameter.

Estimated preliminary foundation data for new foundations in Bridge #08588A has been included in the Footing Plan within the JH drawings in Appendix H. This information has been included in the drawings to illustrate assumptions supporting quantity development and to assist with constructability conversations with the CM/GC. For additional discussion pertaining to foundation selection and geotechnical considerations in this area of the Project, see the Draft GER for Bridge #08588A and the Draft GDR. Note that micropile capacities are dependent on contractor's design and construction methods (per ODOT Standard Special Provision 00515) and will require a conversation with the CM/GC in design progression.

Girder lines for the new deck in Span 8 would be supported at Bent 9. Given the low load rating of the crossbeam at this bent, crossbeam enlargement and strengthening at this location would be required. The additional loadings at Bent 9 also have potential to require foundation improvements at this location. However, the detailed analysis required to determine the magnitude of increased loadings on these existing foundations, as well as the structural and geotechnical resistance of the existing structure to support increased loadings, have not been completed. The location of this potential foundation improvement has been labeled "potential foundation improvements" within the JH drawings in Appendix H to call awareness to this risk item. If foundation improvements are required at this location, the strengthening would likely consist of micropiles with a reinforced concrete cap connected to the existing foundation. Considering the depth of the bell foundation at this location, connection of the new micropile cap to the existing foundation may need to occur near the ground surface; such a connection could also require shaft/column improvements.

Geological Conditions

See the Draft GERs for Bridges #08588A, #S8588E, and 08588C, and the Draft GDR for geotechnical and geological considerations and discussions in Zone 7. These documents will be updated after all geological exploration and testing is complete, and also as design progresses.

4.7.3.4 Stormwater/Hydraulics

Stormwater

The conceptual stormwater management design developed for the NEPA documentation included a stormwater treatment facility under the freeway adjacent to and south of the UPRR tracks. This concept was a large filter media vault that would treat a portion of the Project CIA. The existing stormwater conveyance system on the south side of the UPRR tracks is approximately 10 feet deep and is too deep to divert stormwater from and make the filter media vault feasible. The proposed solution was to divert the water quality flows from the existing conveyance system north of the railroad tracks and bore a new, shallower pipe across the tracks to the conceptual stormwater management facility. Due to the complications with this construction, along with concerns regarding maintenance access under the freeway in close proximity to the UPRR tracks, this concept was determined to not be feasible. Without this facility, and depending on the final stormwater management plan, the Project is able to provide treatment of 127 percent to 150 percent of the CIA. As such, there are no proposed stormwater treatment facilities within Study Zone 7. See Chapter 4.1.3.4 for a summary of the conceptual stormwater management plan.

The existing stormwater conveyance system would remain in place with inlets added as needed to accommodate the proposed roadway improvements. The main stormwater conveyance system from the north crosses the UPRR tracks at the I-84 interchange and outfalls into the Willamette River. As part of the subsurface utility investigations this pipe under the tracks would be videoed and any issues discovered will be addressed as design progresses.

Hydraulics

The Project would include both temporary and permanent foundations below the Willamette River 100-year floodplain. A net removal of material would be required, resulting in no floodplain impacts. A FEMA no-rise analysis and certification would be needed for any modifications to the floodplain. There are no proposed improvements below OHW. The hydraulic evaluation of temporary and permanent foundations will be completed as part of the Project's 30% Design Package.

4.7.3.5 Traffic Operations and Design

Operations and Analysis

The addition of the SB auxiliary lane would eliminate the bottleneck just south of the Broadway exit ramp where the existing SB auxiliary lane currently terminates and improve mobility for the mainline through traffic. The SB auxiliary lane would be extended to the Morrison exit ramp resulting in a freeway lane drop condition to this high volume exit ramp.

Signing

Study Zone 7 signing would have a new sign bridge to support proposed signage as well as new signs mounted on the existing sign bridge at MP 301.13 as NB signing south of the Project limit would be updated to match the proposed sign design. Within Project limits, all existing signs would be replaced; new signs and their supports would meet the latest versions of the ODOT Traffic Sign Design Manual and MUTCD.

Signals

There are no signalized intersections in this study zone.

Local Street Illumination

In Study Zone 7, the existing local street lighting along Lloyd Boulevard would be replaced as needed as a result of the mainline and exit ramp bridge work.

Freeway Illumination

The freeway lighting analysis and design standards presented in Chapter 2.3.7 apply to Study Zone 7.

ITS

The new fiber optic trunk line would be extended south to the Project limits. This would occur near the I-84 WB to I-5 SB ramp. The new fiber optic cable installation would be designed to ODOT and NEC standards.

A new PTZ camera would be placed on the I-5 SB to I-84 EB ramp. This would be place on a new camera pole.

Small VMS and lane restriction signs associated with the FLS system are discussed in Zones 4n and 4s.

No impacts to existing ITS infrastructure are anticipated within Study Zone 7.

Access Management

There are no impacts to existing driveways within Study Zone 7.

4.7.3.6 Utilities

The east side CSO tunnel is a 264-inch combined sewer overflow main that crosses diagonally under I-5 within Zone 7. It is located east of I-5 south of the UPRR tracks, and west of I-5 near NE Oregon Street. An easement exhibit furnished to the design team indicates there is an existing 52-foot horizontal easement for the east side CSO tunnel. This easement exhibit indicates a requirement of 13 feet of horizontal clearance from the exterior of the pipe and a minimum of 39 feet of vertical clearance to load bearing underground supports (26 feet for non-load bearing supports). The easement exhibit allows for improvements to occur over the tunnel provided that the improvements do not encroach within the easement. Portland BES, the owner of the CSO tunnel, has reported that easement dimensions and clearance requirements vary along the CSO tunnel alignment, and the easement exhibit may not be representative of the extents of the CSO tunnel within the project limits. Actual easements along the CSO tunnel must be obtained and their specific criterion applied. As design progresses, the bridge and wall designs would reflect foundation design options, which would comply with the easement requirement along with other construction requirements as needed to ensure protection of the east side CSO tunnel.

The Sullivan Gulch Sewer, a 96 inch semi-elliptical mono-tunnel sanitary interceptor for gravity sanitary sewer, crosses under I-5 and its associated ramps within Zone 7. It crosses under the I-5 SB to I-84 WB ramp (Bridge #08588C) in the vicinity of its crossing of NE Lloyd Boulevard. It appears to cross under I-5 SB (Bridge #S8588E) and I-5 NB (Bridge #N8588E) on an alignment north of NE Lloyd Boulevard. It then appears to cross under the I-84 WB to I-5 NB structure (Bridge #08588A) near the intersection of NE 1st Avenue and NE Lloyd Boulevard. As design progresses, the bridge and wall designs would reflect foundation design modifications as required to protect the Sullivan Gulch Sewer in place.

The East Central Interceptor, an 84-inch CSO pipeline, flows from SE to NW in an RCP and connects to a 72-inch concrete sewer pipe (CSP) under I-5 NB. Downstream of the connection to the 84-inch CSO, the 72-inch CSP crosses under I-5 SB's Bridge #S8588E as a storm sewer pipe and outfalls into the river at Outfall 40. Upstream of the 84 inch CSO, the 72 inch CSP is part of the CSO system, crossing under the railroad tracks and connecting into NE Lloyd Boulevard east of NE 1st Avenue. The 84-inch CSO pipeline crosses under Bridges #S8588E and #08588C as it flows toward NE Oregon Street. No conflict is anticipated with the 72-inch CSP pipeline or its Outfall 40 discharge location into the Willamette River. As design progresses, the bridge designs would reflect foundation design modifications as required to protect the East Central Interceptor.

Two sanitary force mains cross the Willamette River from the Ankeny Pump Station and tie into the Sullivan Gulch Sewer on the western side of NE Lloyd Boulevard. The force mains are sized

42 inch and 30 inch. BES reports that the force mains are shallow and fragile where they connect to the 96-inch tunnel, and the connection chamber is located in the road. Under the railroad, they are encased in a concrete structure. The pumps to which the force mains connect are seasonal; in the summer they do not pump that much. Their purpose is to keep water from flooding the businesses downtown. BES reports that physically, relocation of the force mains could be done, but it would be complex and expensive.

The I-5 SB to I-84 ramp structure design will be threading the needle on a location for the columns due to the proximity to the large sewers. One column is expected to be near the confluence of the pipelines for the East Central Interceptor, the Sullivan Gulch Sewer, and the Ankeny force mains. The SUE mapping is underway to more accurately locate the large sewer facilities. The design intent is to find the sewers and design the foundations to protect them.

The Sullivan Pump Station is under the I-84 interchange ramps and located underneath Bridges #08588A and #08588B. Proposed improvements to Bridge #08588A (the ramp from I-84 WB to I-5 NB) would begin northwest of the pump station. No improvements are proposed to bridge #08588B (the ramp from I-5 NB to I-84 EB). Therefore, the pump station is outside the improvement limits.

The pump station's downstream force main and gravity piping is located to the north and west of the pump station and crosses under the UPRR tracks, tying into systems on NE Lloyd Boulevard west of NE 1st Avenue. These reimbursable utility segments of the system piping may be in conflict with Project improvements located along NE Lloyd Boulevard. As mapping of existing utilities is completed, the Project design will be adjusted as needed to avoid conflicts with these facilities.

Fiber optic communications are located within the UPRR ROW for several utility providers. It is assumed that the fiber optic systems will be determined to be in conflict with the bridge foundations and would be relocated. These facilities are assumed to qualify for reimbursement.

There are a number of other existing utilities along the local city streets and under the bridges within Zone 7. Utility conflict identification and protection or relocation strategies will be refined as part of the 30% Design Package.

4.7.3.7 ROW Impacts

The Project improvements would require additional permanent and temporary easements from both UPRR and DSL. The assumed impacts are consistent with the NEPA phase assumptions.

4.7.4 Findings and Conclusions

The findings and conclusions are working assumptions and do not reflect final Project design/scope decisions. The assumptions herein may be modified based on stakeholder and community input and additional technical information gathered as a natural part of the design progression process.

- Pursue Design Exceptions for I-5 NB and SB mainline shoulder and lane width between the I-84 ramps and the Morrison exit ramp in order to accommodate a SB auxiliary lane while avoiding conflicts with the Eastbank Esplanade.
- Maintain Eastbank Esplanade access during construction.
- Pursue a Design Exception for shoulder width to restripe the portion of the existing I-84 WB to I-5 NB entrance ramp south of Bent #9, thereby limiting impacts to UPRR and NE Lloyd Boulevard.

- Refine foundation placements near 96-inch inceptor pipe to avoid potential utility relocation following additional utility designation.
- Utilize shallower foundation strategies to avoid conflicts with east side CSO tunnel easement setbacks where needed.
- All project elements previously identified to occur within Ordinary High Water (OHW) have been removed from the project. Improvements within the regulated floodplain would be mitigated as required to result in no net rise.

5 Maintenance of Traffic Approach during Construction

5.1 Construction Dependencies and Schedule

For the purpose of establishing the 20% Design Maintenance of Traffic (MOT) strategies, a baseline construction sequence and schedule was assumed. The assumed sequence of work and MOT approach is based on a combination of the NEPA phase construction sequencing and ongoing design refinements. To develop the construction sequence and MOT plan, independent work zones, or those areas where work can commence without a dependency on other work, were established. The construction dependencies provided herein are assumptions, and will be re-evaluated and redeveloped in cooperation with the CM/GC as part of future design phases. Within this section, the Project describes Study Zones 4n and 4s as distinct highway cover areas and stages. While the Project design assumes a single highway cover, for the purposes of MOT and staging the highway cover is discussed as distinct and separate construction elements. The following section outlines the assumed Project elements by zone and associated dependencies on other construction activities.

5.1.1 Construction Sequence Dependencies

Utilizing the seven study zones identified earlier in this 20% Design Memorandum, construction activities within each zone were evaluated for sequencing dependencies within itself and from other zones. The subsequent sections present the conclusions from that assessment.

5.1.1.1 Study Zone 1: Northern Freeway

Work at the I-405 Interchange is independent from other zones. Work could benefit from the Study Zone 2 work being completed first because it would provide additional space for MOT activities and eliminate a temporary transition zone. The following bullets represent the assumed construction sequence:

- Widen NB I-5 Bridge.
- Widen NB Greely Avenue exit ramp bridge.
- Widen WB I-405 exit ramp bridge.

5.1.1.2 Study Zone 2: Eliot Viaduct

This work to construct the Eliot Viaduct and retaining walls is independent of all other work. The following bullets represent the assumed construction sequence:

- Construct approximately 1,065 linear feet of wall north of N Flint Avenue along NB I-5.
- Construct approximately 470 linear feet of wall attached to the widened bridge structure.
- Construct the Eliot Viaduct wall using top-down construction methods to minimize impacts.
- Widen NB I-5 and reconstruct the existing I-5 pavement section in the NB direction.

- Pave the existing NB I-5, which is dependent on the completion of the new wall and widened freeway.
- Pave the existing SB I-5 section, consisting of a 2-inch grind and inlay. This work is assumed to be independent of other work.

5.1.1.3 Study Zone 3: I-5 Central Freeway

This work is in the center of the Project. It includes the widening and lowering of I-5, and the reconstruction of the existing pavement section. The I-5 widening is dependent on a prior completion of the freeway widening in Study Zones 2 and 6, as well as the demolition of the existing freeway overcrossings located in Study Zones 4n and 4s. Study Zone 3 is also dependent on the lowering of the existing 56-inch BES Combined Sewer near N Hancock Street. The following bullets represent the assumed construction sequence:

- Once the existing N Flint Avenue, N Vancouver Avenue, N Williams Avenue, N/NE Broadway, and N/NE Weidler Street bridges have been demolished, it is possible to maintain four lanes of I-5 traffic on one side of the freeway while the other direction is widened and lowered. It is also possible for traffic to be shifted towards the inside or outside while the remaining travel lanes in the same direction are reconstructed at the finished grade with the use of temporary paving and a combination of permanent or temporary retaining walls. This work can be staged concurrently with the Study Zone 4s construction to provide additional space to construct the center piers.
- The maximum lowering of I-5 occurs beneath the proposed highway cover, and temporary ramp connections to the Broadway/Weidler Interchange would be maintained throughout the lowering operation. Due to vertical clearance along the Broadway exit and entrance ramps, the timing of the ramp lowering must occur prior to the construction of the new North Cover.
- The relocation of the existing 56-inch BES combined sewer is located within Study Zone 3. This work is dependent on being constructed prior to installation of the North Cover and lowering of the I-5 NB entrance ramp from N/NE Broadway. In order to most effectively stage the partial replacement of the 56-inch combined sewer line, the work is assumed to be completed after the completion of the temporary I-5 SB pavement widening, which is assumed for the staged construction of the North Cover median foundations. As the existing N Vancouver Avenue and N Flint Avenue overcrossings include additional clearance between existing foundations, this temporary widening, and relocation of the combined sewer, can be completed prior to the demolition of the existing structures.

5.1.1.4 Study Zone 4n: North Cover Area

Construction of the North Cover is dependent on prior completion of the 56-inch BES Combined Sewer relocation in Study Zone 3. In order to preserve efficient MOT within the Project, Study Zone 4n is also assumed to be dependent on the construction of the South Cover.

- After demolishing the existing N Vancouver Avenue overcrossing, I-5 traffic can be shifted to the outside utilizing temporary paving along the I-5 mainline. This would maintain two traffic lanes in each direction while providing enough room to construct the highway cover's center piers.
- The North Cover would be constructed and an extension of the new Hancock-Dixon road crossing would be phased to maintain the existing N Flint Avenue connection for the majority of Study Zone 4n construction. At least one of the Study Zone 4n highway overcrossings would be maintained at all times.

5.1.1.5 Study Zone 4s: South Cover Area

Construction of the South Cover can be completed either before or after the North Cover construction. For the purposes of maintenance of traffic, it is not recommended that the entire cover be constructed at the same time. The Project assumes construction of the cover's southern portion prior to the construction of the northern portion. The timing and sequencing of the cover construction will continue to be coordinated with CM/GC and stakeholder input. Study Zone 4s is dependent with the I-5 SB entrance ramp relocation work within Study Zone 5. Demolition of the existing N/NE Broadway, N Williams Avenue, and NE Weidler Street overcrossings are required prior to the I-5 widening within Study Zone 4s. Work activities are as follows:

- The recommended construction sequence calls for temporary shoofly bridge to detour N/NE Broadway. N/NE Weidler Street traffic would be maintained using the existing N/NE Weidler Street Bridge for the initial construction stages and a temporary detour alignment on the new highway cover for later stages. The abutments of the temporary bridge must be placed to provide enough room to construct the center piers while still maintaining four lanes of I-5 traffic. Doing so would allow for the widening and lowering of I-5 to occur simultaneously with the Study Zone 4s construction.

5.1.1.6 Study Zone 5: Moda Center

Due to the existing location and access to the I-5 SB entrance ramp, Study Zone 5 is dependent on the prior completion of Study Zone 4s. Work activities are as follows:

- The new I-5 SB entrance ramp construction cannot begin until the existing N/NE Weidler Street Bridge has been removed.
- Due to the conflict with heavy vehicular travel patterns accessing the existing I-5 SB entrance ramp, the new Clackamas Pedestrian and Bicycle Bridge would not function as a viable pedestrian and bicycle detour route during construction.

5.1.1.7 Study Zone 6: Rose Quarter Transit Center

Widening of the existing I-5 bridges, walls, and pavement is independent of all other Project work. Work activities are as follows:

- Re-paving and widening of I-5 extends south to the existing bridge abutments on the north side of NE Oregon Street.
- To maintain traffic, the bridge widening would be completed prior to the mainline pavement reconstruction and widening within Study Zone 6.
- New foundations at Bent No. 6 would be located between two existing TriMet light rail tracks. There is approximately 7 feet between the track slabs. Additional discussion is included within Chapter 5.2.7 of this report.

5.1.1.8 Study Zone 7: Southern Freeway

Work within the I-84 interchange is independent from other zones, but would benefit from the Study Zone 6 work being completed prior to, or concurrent with, the widenings near the I-5/I-84 ramp connections. Doing so would simplify the MOT activities and eliminate a temporary transition area. Study Zone 7 also includes the widening of multiple freeway structures. Work would require multiple temporary connections and phases that must be coordinated to maintain access or minimize disruption during construction. Work activities are as follows:

- Widen SB I-5 mainline bridge.

- Retrofit existing I-5 mainline bridge rail.
- Widen a portion of the I-5 SB to I-84 EB flyover ramp to transition to the new mainline widening.
- Widen I-84 SB to I-5 NB entrance ramp bridge.

5.1.2 Construction Sequencing

Construction sequencing and phasing will be evaluated and developed in cooperation with the CM/GC as part of future design phases. For the purposes of establishing MOT strategies a general construction sequence was developed based on the construction dependencies and the assumption that the work follows a linear progression. This progression begins with construction activities that facilitate the maintenance of traffic while also accommodating needed contractor work areas. A linear progression could result in a longer total construction duration, but would minimize temporary “throw away” work and impacts to the traveling public. As proposed, the assumed construction sequence would be completed in the following six steps:

1. Study Zone 1 and Study Zone 7
2. Study Zone 2 and Study Zone 6
3. Study Zone 4s
4. Study Zone 3 Sewer and Study Zone 4n
5. Study Zone 3
6. Study Zone 5

Based on the required dependencies, it is also possible to implement an accelerated construction sequence that progresses multiple zones simultaneously – beginning each successive step as soon as possible, regardless of location. The accelerated approach would have more of the Project under construction at one time, which could increase disturbance to the travelling public. Ultimately, the construction sequencing will be developed in coordination with the CM/GC, agency, EWPs, and stakeholder input. One potential accelerated construction sequence could include the following sequence:

1. Study Zone 1, Study Zone 3 Sewer, Study Zone 6, and Study Zone 7
2. Study Zone 2 and Study Zone 4s
3. Study Zone 4n, Study Zone 3, and Study Zone 5

5.2 Maintenance of Traffic

The over-arching concept behind the Project’s MOT approach is to provide a safe and efficient means to move all traffic modes through, or around, a work zone while at the same time providing a safe working environment for construction crews. This includes a consideration of autos, freight, pedestrian, bicycle, bus, streetcar, and light rail. The maintenance and accommodation for all modes was a primary objective for the assumed MOT approach. Small temporary construction easements may be needed within local roadway network to aid in accommodating Temporary Pedestrian Accessible Routes (TPARs) that would maximize pedestrian and worker safety, while minimizing out-of-direction pedestrian travel distances. Conceptual construction phasing and MOT strategies for primary work areas is included within Appendix Q.

While MOT and the construction staging will ultimately be determined using the CM/GC’s input, this 20% Design Memorandum utilized several guiding principles and key considerations as part

of its MOT strategy. While additional consideration will be required for all routes and modes in and around the work zone, the considerations herein represent the primary routes of interest for each representative mode.

MOT Guiding Principles:

- Pedestrian and Bicycle Routing
    - Maintain east-west movement through the Project area with protected/buffered accommodations where possible and in coordination with ODOT, the CM/GC, and the Project's agency partners.
    - Maintain north-south movement between the Rose Quarter area and the Vancouver/Williams area north of the Project with protected/buffered accommodations where possible and in coordination with ODOT, the CM/GC, and the Project's agency partners.
    - Minimize disruptions that could lead to declines in walking and bicycling activity.
- Transit Routing
    - Maintain east-west movement through the Project area for Portland Streetcar, light rail, and bus lines.
    - Maintain north-south movement through the Project area for bus lines.
    - Minimize temporary routing and/or service disruptions that could compromise ridership.
- Vehicular Traffic on Local Roads
    - Maintain reasonable local access within the Project area.
    - Accommodate event traffic.
    - Avoid substantial diversion or out-of-direction travel for detours.
- Vehicular Traffic on Freeways
    - Maintain reasonable local access within the Project area.
    - Accommodate event traffic.
    - Avoid substantial diversion or out-of-direction travel for detours.
    - Provide reasonable mobility routes during construction.

MOT Key Factors and Considerations:

- Temporary MOT (vehicular, transit, pedestrian and bicycle)
- Mobility Requirements (operational performance, height/width and access needs)
- Constructability and Construction Staging Strategies
- Temporary Impacts (mobility, ROW, utility, other)
- Traffic Control Devices
- Traffic Operations (traffic, transit, and multi-modal)
- Temporary Facilities (structures, roads, transit elements, pedestrian and bicycle facilities)
- Right-of-way (temporary and/or permanent property impacts and access considerations)
- Utilities (impact, avoidance and relocation)

5.2.1 Study Zone 1 MOT Activities:

5.2.1.1 Vehicular Traffic

The existing NB I-5 and WB I-405 bridges each contain two lanes of traffic. It is assumed two lanes can be maintained for the majority of the bridge widening. There may be some short-term

closures or temporary reductions to a single lane, particularly for work within the existing physical gore area.

The existing Greely Avenue NB exit ramp contains a single lane that is being widened to the inside. This results in a shifted gore area to the north. Most of the foundation and superstructure can be completed using temporary width reductions. It is anticipated this exit ramp would be closed to all traffic during portions of construction to complete parts of the bridge widening, including final bridge rails and new impact attenuator.

5.2.1.2 Multimodal Impacts

Impacts to multimodal traffic in this work zone would be limited. Express bus service, like C-TRAN, should be able to continue its usual service routes.

5.2.2 Study Zone 2 MOT Activities

5.2.2.1 Vehicular Traffic

Northbound I-5 Traffic

It is anticipated that minimal traffic impacts would be required for the retaining wall construction. It is assumed a sufficient work zone can be created by shifting traffic toward the median barrier.

While new pavement is being placed adjacent to the existing shoulder, traffic would need to be reduced to a total of two lanes for this work. This may result in a temporary closure of the existing auxiliary lane between the Broadway entrance ramp and I-405 exit ramp. Alternatively, this work, particularly concrete paving, may need to be constructed during a short-term directional closure or over many nights.

Following the completion of the right shoulder paving, enough new pavement would be placed to accommodate two lanes of traffic during subsequent phases. To accommodate the re-paving of the existing NB I-5 lanes, two lanes of traffic would be shifted onto the new pavement adjacent to the retaining wall.

During each of the construction phases, design speeds may need to be reduced to provide sufficient merge and shift transition lengths for access.

Southbound I-5 Traffic

There are currently two SB auxiliary lanes, resulting in a total of four lanes through the Study Zone 2 work area.

Work within this area consists of a grind and inlay of the existing asphalt wearing course under nighttime lane reductions or a nighttime directional detour.

5.2.2.2 Multimodal Impacts

Impacts to multimodal traffic in this work zone would be limited. Express bus service, like C-TRAN, should be able to continue its usual service routes.

5.2.3 Study Zone 3 MOT Activities:

5.2.3.1 Vehicular Traffic

The existing N Flint Avenue, N Vancouver Avenue, N/NE Broadway, N/NE Weidler Street, and N Williams Avenue bridge abutments restrict the ability to temporarily shift traffic in order to

lower and reconstruct I-5. Once the existing bridges have been demolished, additional space would be provided to generally allow for the maintenance of two lanes of traffic in each direction of I-5.

Construction of Study Zone 4n can be either constructed prior to or concurrent with Study Zone 3. Freeway MOT strategies to complete the overcrossing work are addressed within Chapter 5.2.4.

Construction of Study Zone 4s requires widening pavement to provide a work zone to construct the center piers. Instead of placing temporary pavement, it may be possible to place this pavement at the future finish grade. It is anticipated that the two controlling factors for effective maintenance of traffic during mainline paving within Study Zone 3 are potential conflicts with existing structures and the accommodation of a minimum work zone to access new foundation elements. For this reason, temporary pavement widening has been assumed with the 20% Design.

Under some construction stages, all four lanes of I-5 traffic may be temporarily placed on one side of the freeway, however it is assumed that each direction of travel would be maintained within their individual directions of travel. Maintaining the existing design speed in this scenario would require a transition area that extends through adjacent work zones and into Study Zones 2 and 6. It may be necessary to lower the speed limit to reduce these transition lengths. Reversing curves are proposed to reduce transitions; however, the existing I-5 super-elevation may limit the effectiveness of this at the south end of Study Zone 3.

To minimize ramp closure durations, ramp reconstruction would be completed using a combination of construction stages and temporary widenings. It is anticipated that each of the four entrance/exit ramps in Study Zone 3 would have to be closed over some duration to facilitate their reconstruction and a lowering to their final grade. It is also anticipated that the NB entrance ramp and SB exit ramp would need to be lowered prior to construction of the north highway cover.

5.2.3.2 Multimodal Impacts

Impacts to multimodal traffic in this work zone would be limited. Express bus service, like C-TRAN, should be able to continue its usual service routes.

5.2.4 Study Zone 4n MOT Activities:

During the construction of the north highway cover, N Vancouver Avenue between N Tillamook Street and NE Broadway would be closed to all modes of traffic for possibly an extended period of time (18 to 24 months). A detour route would need to be determined. Pending further public input or input from the CM/GC, a temporary detour using NE Russell Street to MLK Boulevard is assumed for through auto traffic. Additionally, a temporary detour from N Vancouver Avenue to N Flint Avenue via N Tillamook Street is assumed for bicycles and pedestrians, in addition to local traffic. It is assumed that traffic cannot be diverted to N Flint Avenue in front of Harriet Tubman Middle School.

5.2.4.1 Vehicular Traffic

It appears possible to maintain two lanes of traffic for both I-5 directions, if utilizing temporary pavement widening.

Construction of the highway cover abutments would require the closure of I-5 entrance and exit ramps at N/NE Broadway for some construction activities. These activities may include temporary streetcar tracks as well as during some portions of the eastern shoofly bridge abutment. Additionally, because I-5 is being lowered, it may not be possible to reconstruct the ramps concurrently. This could result in a separate ramp closures when I-5 is lowered.

The MOT plan and vehicular detours should minimize the increase of vehicular traffic on N Flint Avenue after the demolition of the N Vancouver Avenue bridge and the construction of the North Cover.

5.2.4.2 Multimodal Impacts

Pedestrian and Bicycle

The existing roadway network in this area provides extensive infrastructure for sidewalks, bike lanes, and in some locations, protected bike lanes. Both N Flint Avenue and N Vancouver Avenue experience significant bicycle traffic traveling SB (along N Vancouver Avenue) and SB to WB (N Flint Avenue to NE Broadway). During all construction stages, these movements are assumed to be maintained with temporary detours. Alternative strategies for detours, staging concepts will continue to be investigated as design advances. In some areas, temporary improvements for pedestrian and bicycle users will be required.

With the demolition of the existing N Vancouver Avenue bridge, all pedestrian and bike traffic would need to be detoured. The Project assumes pedestrian and bicycle traffic would be diverted onto the existing N Flint Avenue bridge from NE Tillamook Street.

Upon completion of the North Cover, the existing N Flint Avenue bridge over I-5 would be demolished. As such, all pedestrian and bicycle access would be provided via the North Cover.

Temporary Impacts to Bus Service

For each construction phase in Study Zone 4n, TriMet and C-Tran bus services are assumed to be maintained and integrated into the temporary traffic control for general purpose traffic. Temporary bus stops would be replaced at or near their existing locations, including on proposed temporary roadway shooflys, for extended duration construction activities. Continued coordination with TriMet and other key stakeholders would be conducted to ensure temporary routing and accommodation strategies minimize the impact on bus service.

5.2.5 Study Zone 4s MOT Activities:

For the purposes of the 20% Design, it is assumed east-west traffic on N/NE Broadway and N/NE Weidler Street would be maintained during construction. To do this, the South Cover would employ two temporary shoofly bridges over I-5 (one each for N/NE Broadway and N/NE Weidler Street). The cross section of each shoofly would include three travel lanes, a directional sidewalk level protected bike lane, and a sidewalk on both sides. The sidewalk on the temporary freeway overcrossings, however, may be reduced to one-side during portions of construction.

During construction of the South Cover, N Williams Avenue between Broadway and N/NE Weidler Street would be closed to all modes of traffic. Traffic would be detoured to other routes, including NE Victoria Avenue.

5.2.5.1 Vehicular Traffic

The existing NE Broadway, NE Weidler Street, and N Williams Avenue bridge abutments restrict the ability to shift I-5 traffic to the outside to construct the new median bridge columns while maintaining two traffic lanes.

Temporary, single span bridges are proposed to maintain three lanes of traffic on N/NE Broadway and NE Weidler Street, and two lanes of traffic in each direction of I-5.

The exiting NE Broadway and NE Weidler Street bridges would remain in service until the temporary bridges are constructed. There would be temporary closures of these streets, however, while the temporary bridges are tied into the existing roadway network.

Vehicular speeds on N/NE Broadway and NE Weidler Street may be reduced during construction to accommodate MOT activities across the bridges.

Users travelling north-south on N Williams Avenue would have to detour onto the existing roadway network to access the temporary bridges.

5.2.5.2 Multimodal Impacts

Pedestrian and Bicycle

MOT activities would allow for pedestrians and bicyclists to safely travel through the construction area.

During the construction of the South Cover, both pedestrian and bicyclist's east-west access would be maintained on the temporary N/NE Broadway and N/NE Weidler Street shoofly bridges.

Once the temporary shoofly bridges have been demolished, MOT activities would accommodate both pedestrians and bicyclists on the portion of the newly constructed highway cover.

Users travelling north-south on N Williams Avenue would have a designated and appropriately designed detour route in coordination with ODOT, the CM/GC, and the Project's agency partners, to detour onto the existing roadway network to access the temporary bridges.

Temporary Impacts to Portland Streetcar

The demolition and replacement of the existing highway overcrossings on N/NE Broadway and N/NE Weidler means that the existing streetcar infrastructure cannot be maintained as-is during construction. Temporary streetcar alignments would be needed to maintain the existing streetcar service while the overcrossings are being constructed; these temporary alignments would be constructed as part of the roadway shooflys planned for both N/NE Broadway and N/NE Weidler. The temporary track on N/NE Broadway (the Westbound, or B Loop) would occupy the southern-most lane in the Broadway Shoofly. The temporary track on N/NE Weidler (Eastbound, or A Loop) would occupy the northern-most lane within the Weidler Shoofly. The B Loop and roadway would be supported by a temporary bridge over I-5, while the A Loop would be routed over the new permanent highway overcrossing.

Short-duration, temporary streetcar shutdowns would be required in order to construct the Project. The plan currently being discussed would be to construct the bulk of the temporary streetcar tracks outside of the existing alignments in order to keep the existing service(s) uninterrupted. Then, during a temporary shutdown of both the roadway and the streetcar,

construct the connections from the existing tracks to the temporary ones, rerouting the streetcar as quickly as possible. Each track – A Loop and B Loop – would be shut down independently, with the B Loop (on N/NE Broadway) being rerouted first, followed by the A Loop on N/NE Weidler. One shutdown for each track is proposed, with the connections to the existing tracks being constructed simultaneously on each end of the temporary alignment.

The duration for each shutdown would depend on several factors, including the type of temporary track being constructed (see Chapter 4.4.3.1), the need for overhead catenary system equipment, streetcar systems, and traffic signal testing before use, the need for safety certification before use, and the extent of use of night and weekend crews and of 24-hour shifts. Further conversations with the CM/GC are required before more information on duration is known; however, it is currently estimated that each shutdown would take between one to two weeks (including weekends) to construct, as well as to remove. This plan results in a total of two streetcar shutdowns for each track (each independent of each other), or four for the whole Project.

Bus Bridging for Portland Streetcar

The 15% design included constructing streetcar turnbacks on NE 1st Avenue and N Ross. The 20% Design includes a turnback only on NE 1st Avenue. The benefit of providing the NE 1st Avenue turnback is to shorten the physical distance of the bus bridge needed while the temporary alignment on N/NE Broadway (the B Loop) is being constructed. Once the 1st Avenue turnback is constructed, the bus bridge distance would shortened on the B Loop from the OMSI station to NE Broadway and 2nd Avenue station. Installation of the NE 1st Avenue would require a bus bridge for the streetcar.

The N Ross temporary turnback would shorten the physical distance of the bus bridge needed on N/NE Weidler (the A Loop), but only by a short distance (two stops). This was discussed with the City and Portland Streetcar Inc., including the proximity to the existing special trackwork at the east end of the Broadway Bridge and the anticipated impacts to the existing Ross station. It was concluded that the impacts outweigh the benefits of a Ross turnback that only shortened the bus bridge by two stops. Therefore, the turnback at N Ross is no longer under consideration.

During streetcar shutdowns for the installation of the 1st Avenue turnback, bus bridges would be provided on the A Loop between the NW 10th and Johnson station at the north end and the OMSI station at the south end, and on the B Loop between the OMSI station on the south end and the NW 10th and Northrup station on the north end. After the 1st Avenue turnback is operational, the bus bridge for the A Loop would circulate between the NW 10th and Johnson station and NE 2nd Avenue, and the bus bridge for the B Loop would circulate between the NW 10th and Northrup station and NE 2nd Avenue.

At a minimum, streetcar bus bridging would provide the same hours of operation and headways as the existing service. This includes 15-minute headways during peak hours. Further refinements, including updated costs, will be provided at the next phase of design.

Temporary Impacts to Bus Service

TriMet and C-Tran bus services are assumed to be maintained and integrated into the temporary traffic control for general purpose traffic. Temporary bus stops would be replaced at or near their existing locations, including on proposed roadway shooflys, for extended duration

construction activities. Continued coordination with TriMet and other key stakeholders will be conducted to ensure temporary routing and accommodation strategies minimize the impact on bus service.

5.2.6 Study Zone 5 MOT Activities:

5.2.6.1 Vehicular Traffic

To minimize construction impacts to the SB I-5 entrance ramp, it is recommended that the new entrance ramp be constructed prior to street modifications within Study Zone 5.

Construction of the new SB I-5 entrance ramp would require short duration closures of the existing SB I-5 entrance ramp.

A portion of the proposed improvements located within Study Zone 5 may be constructed without impacting current Moda Center event accesses, or access to the existing SB I-5 entrance ramp.

Once the SB I-5 entrance ramp has been relocated, the remaining infrastructure improvements between NE Weidler Street and Ramsay Way would be constructed. This work would maintain Moda Center event accesses.

The Clackamas Pedestrian and Bicycle Bridge can be constructed with minimal impact on traffic on the relocated SB I-5 entrance ramp.

N Williams Avenue south of Ramsay Way can be completed without significantly impacting traffic.

5.2.6.2 Multimodal Impacts

The Clackamas Pedestrian and Bicycle Bridge is a new feature and its construction would not impact any existing multi-modal routes.

Because of the high volume of vehicular users accessing the SB I-5 entrance ramp, it assumed that the Clackamas Pedestrian and Bicycle Bridge would not serve as a viable detour for pedestrians and bicycles along NE Broadway and NE Weidler Street until after the SB entrance ramp has been relocated. This will be explored further as part of the 30% Design Package.

5.2.7 Study Zone 6 MOT Activities

5.2.7.1 Vehicular Traffic:

During the initial widening work, three lanes of I-5 traffic (two general purpose lanes and an auxiliary lane in each direction) would be shifted toward the existing median barrier. Vehicular speed reductions may be required to provide sufficient merge and shift transitions from the I-84 interchange.

After I-5 has been widened with new pavement, three lanes of I-5 traffic would be shifted to the outside.

Due to the limited available space for MOT, and the presence of existing auxiliary lanes between I-84 and the Broadway/Weidler interchanges, an extended-duration partial closure is anticipated. This would consist of one or more I-5 travel lanes to complete the necessary pavement reconstruction and potentially some elements of the Holladay/Hassalo bridge deck rehabilitation work. These MOT assumptions and construction strategies will continue to be

refined as assumptions for pavement and bridge work are better defined through design progression. Directional I-5 detours will also be explored as part of the 30% Design Package.

Reconstruction of the existing retaining walls within Study Zone 6 are assumed to utilize temporary shoring to avoid I-5 lane reductions. Alternatively, the existing median barrier and travel lanes could be temporarily relocated to maintain the existing travel lanes with reduced need for temporary shoring. This along with directional I-5 detours will be explored as part of the 30% Design Package.

5.2.7.2 Multimodal Impacts

Impacts to multimodal traffic in this work zone would be limited. Express bus service, like C-TRAN, should be able to continue its usual service routes.

Impacts to multimodal traffic and services on NE Multnomah Street and NE Holladay Street in the Rose Quarter Transit Center would include temporary shoulder and sidewalk closures as required to complete the proposed bridge improvements.

Pedestrian and Bicycle

MOT activities would allow for both pedestrian and bicycle riders to travel through the construction zone.

Temporary Impacts to TriMet Max Light Rail

The existing Rose Quarter Transit Station and existing light rail tracks would be temporarily affected by the proposed bridge widening. The new I-5 bridge columns would be placed in line with the existing columns, between and within close proximity to both the WB track and the Special Events track. This would directly affect the operations of the Red, Blue, and Green MAX lines.

In order to construct the new columns at the constrained site, existing light rail operations would need to be suspended for two to three weeks to accommodate the bridge construction and the potential relocation of several transit systems conduits. Further underground investigation is needed to determine the extent of the systems conduit relocations.

Bus bridging of the Red, Blue, and Green MAX lines around the Rose Quarter Transit Center would be required. Further conversations with the Project partners, as well as the CM/GC, regarding construction methods, night and weekend work, and the use of multiple shifts and crews, will be needed before further clarity on the closure duration is known.

Once the new bridge substructure elements have been constructed, it may be possible to resume light rail service while the bridge widening operations above are performed. Limited service disruptions, however, may still be necessary until the bridge widening is complete.

Temporary Impacts to TriMet Bus Lines

Multiple TriMet bus routes operate along NE Multnomah Street and N Williams Avenue. MOT activities would allow for buses to continue operations on these routes through the construction zone.

5.2.8 Study Zone 7 MOT Activities:

5.2.8.1 Vehicular Traffic

Due to the extent of bridge superstructure widening, it is anticipated that each ramp bridge would have to be closed to traffic for durations ranging from short (nights or weekends) to long term (several weeks to months). Bridge substructure work, however, appears to avoid impacting traffic along I-5. Some foundation work in the SB direction would require lane and sidewalk closures along Lloyd Boulevard. Temporary detours would be investigated further as part of 30% Design.

Freeway detours are assumed to utilize I-5/I-405 for all ramp closures.

The Project will prioritize the use of directional detours over single-lane operations, and this will be explored further as part of the 30% Design Package.

The Project will coordinate simultaneous activities requiring closures to minimize the total number of closures.

Vehicular speeds during construction may need to be reduced to provide sufficient merge and shift transition lengths for access to the various ramp movements within the interchange.

5.2.8.2 Multimodal Impacts

Impacts to multimodal traffic in this work zone would be limited. Express bus service, like C-TRAN, should be able to continue its usual service routes.

Improvements within Study Zone 7 are located near existing UPRR mainline tracks. The Project assumes no impacts to the existing tracks would be permitted. Staging options, in coordination with UPRR, will be explored further as part of the 30% Design Package. Work near the Eastbank Esplanade will be accessed and constructed from or within ODOT and UPRR ROW. There will be no permanent or temporary impacts to the Eastbank Esplanade during construction.

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