Hydraulic Impact Analysis Technical Report

Multnomah County | Earthquake Ready Burnside Bridge Project

Portland, OR

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Earthquake Ready Burnside Bridge Hydraulic Impact Analysis Technical Report

Prepared for

Multnomah County Transportation Division – Bridges
1403 SE Water Ave
Portland, OR 97214

Prepared by

HDR
1050 SW 6th Ave, Suite 1800
Portland, OR 97204
T (503) 423-3700

Parametrix
700 NE Multnomah St, Suite 1000
Portland, OR 97232
T (503) 233-2400

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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

REGISTERED PROFESSIONAL ENGINEER
78453PE
OREGON
SEPTEMBER 19, 2006
JULIE GARNET BRANDT
EXPIRES: 12/31/2021

Signature Reserved for Final Version

Prepared by Julie Brandt, PE (Senior Engineer, Hydraulics Lead)

Signature Reserved for Final Version

Checked by Jeffrey Coop, PE (Senior Engineer, Hydraulics QC Lead)

Signature Reserved for Final Version

Approved by Heather Catron (Consultant Project Manager)

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Acronyms, Initialisms, and Abbreviations

ADA	Americans with Disabilities Act
API	Area of Potential Impact
CFR	Code of Federal Regulations
CRD	Columbia River Datum
CSZ	Cascadia Subduction Zone
DEQ	Oregon Department of Environmental Quality
EIS	environmental impact statement
EQRB	Earthquake Ready Burnside Bridge
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
HEC-RAS	USACE Hydrologic Engineering Center's River Analysis System
ODOT	Oregon Department of Transportation
PCC	Portland City Code
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey

Executive Summary

Introduction

This technical report has been prepared to identify and evaluate potential hydraulic impacts (changes to scour and base flood elevation) within the Project's Area of Potential Impact (API) by comparing the proposed geometry of each Alternative against the geometry of the existing bridge. The API for hydraulics extends along the 500-year floodplain boundary upstream to the Marquam Bridge and downstream to the Fremont Bridge.

Affected Environment

The existing Burnside Bridge was constructed in 1926 and consists of three separate bridge approaches (West, Main channel, and East approaches). Due to the low velocity of the Willamette River and tidal influence from the downstream Columbia River, the river channel in the API is generally depositional in nature. However, channel and local pier scour has been observed around the existing bridge. Scour can compromise the structural integrity of the bridge and can also mobilize pollutants where sediment contamination is present. Based on 2016 and 2017 FHWA inspections and National Bridge Inventory (NBI) data, the bridge has been classified as scour critical and the bridge foundations (piers or abutments) were determined to be unstable (FHWA 1995, FHWA 2019). The Burnside Bridge Maintenance Project, completed in 2020, included repairs to keep the bridge working safely for another 15 to 20 years.

In addition to the local scour observed at the bridge piers, the Vera Katz Eastbank Esplanade columns are likely creating a flow constriction where the river's main flow bends around the east bank and results in documented eddy scour at the riverbend. Proposed expansion of structures around the Eastbank Esplanade would likely exacerbate the already increased scour evident at this location, which could affect local scour on the proposed bridge eastern pier as well as mobilize contaminated sediments.

Environmental Consequences

The level of seismic resiliency incorporated into each Build Alternative is expected to produce bridge structures that are insensitive to effects from local scour. To meet seismic safety requirements, each Build Alternative would place a larger bridge structure in the floodway than is currently occupied by the existing bridge. As a result, the Project would be expected to increase the base flood elevation and could mobilize contaminated sediments through scour, with some Alternatives having greater impacts than others as summarized in Table 1.

The impacts associated with the construction of the temporary bridge could result in impacts to the water surface elevation. The river would likely rise in response during the stages of placement, then likely decrease when temporary construction features are removed upon completion.

Table 1. Potential Hydraulic Impacts

Alternative	Expected Base Flood Elevation Increase	Potential Scour Increase	Combined Potential Hydraulic Impact
No-Build (existing)	No change	No change	No Change
Long-Span Alternative – vertical lift	Lowest increase	Lowest increase	Lowest
Short-Span Alternative – vertical lift	Lower increase	Lower increase	Lower
Couch Extension – vertical lift	Lower increase	Medium increase	Medium
Long-Span Alternative – bascule lift	Higher increase	Lowest increase	Medium
Short-Span Alternative – bascule lift	Higher increase	Medium increase	Higher
Couch Extension – bascule lift	Highest increase	Medium increase	Highest
Retrofit	Higher increase	Highest increase	Highest

Mitigation Measures

There are limited opportunities to mitigate hydraulic encroachment impacts associated with the Project because encroachment offsets need to occur at the same location as the encroachment. The minimization measures would focus on limiting an increase in base flood elevation and reducing scour potential that could impact habitat and mobilize contaminated sediments.

Detailed modeling and scour analysis would be conducted before final design of the preferred alternative or bridge type to evaluate the potential impact on base flood elevation and the scour footprint more precisely. If modeling shows that the Project would result in an unavoidable increase to the base flood elevation, the project team could request a variance to the Portland Municipal Code no-rise standard based on PMC 24.50.060(D) Floodways and PMC 24.50.070 Appeals and Variances and could supply the City with information to apply to FEMA for a Conditional Letter of Map Revision under the provisions of 44 CFR 60.3(d)(4), 44 CFR 65.6, 44 CFR 65.7, and 44 CFR 65.12. Because the Project would place pier structures in the regulatory floodway, the Project design will be guided by key requirements of 23 CFR 650 (FHWA procedures for compliance with Floodplain Management Presidential Executive Order 11988).

Separately from flood rise impacts and mitigation, the City of Portland requires a balance of cut and fill within the 100-year floodplain or the 1996 flood extent, whichever is more expansive.

1 Introduction

As a part of the preparation of the Environmental Impact Statement (EIS) for the Earthquake Ready Burnside Bridge (EQRB) Project, this technical report has been prepared to identify and evaluate potential hydraulic impacts within the Project's Area of Potential Impact (API). This hydraulic impact analysis qualitatively evaluates channel hydraulics, scour, sediment transport, pier impacts and encroachment (as they relate to hydraulics), and flood elevation impacts for the Willamette River. Detailed modeling and scour analysis would be conducted before final design of the preferred alternative or bridge type to evaluate the potential impact on base flood elevation and the scour footprint more precisely.

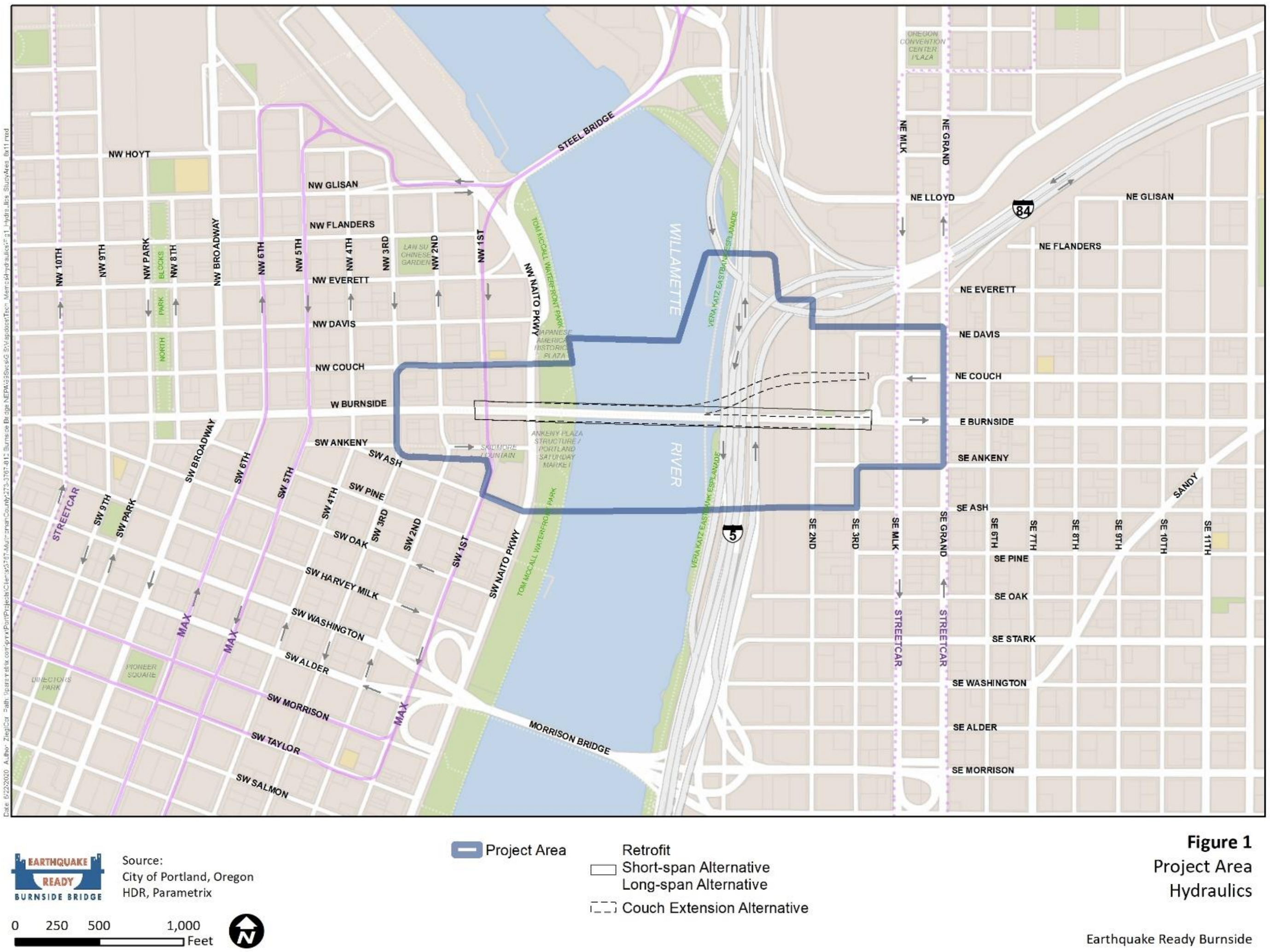
1.1 Project Location

The Project Area is located within the center of the city of Portland. The Burnside Bridge crosses the Willamette River connecting the west and east sides of the city. The Project Area encompasses a one-block radius around the existing Burnside Bridge and W/E Burnside Street, from NW/SW 3rd Avenue on the west side of the river to NE/SE Grand Avenue on the east side. Several neighborhoods surround the area including Old Town/Chinatown, Downtown, Kerns, and Buckman. Figure 1 shows the Project Area.

1.2 Project Purpose

The primary purpose of the Project is to build a seismically resilient Burnside Street lifeline crossing over the Willamette River that would remain fully operational and accessible for vehicles and other modes of transportation following a major Cascadia Subduction Zone (CSZ) earthquake. The purpose is also to provide a reliable crossing for emergency response, evacuation, and economic recovery after an earthquake and a long-term safe crossing with low maintenance needs. Due to the nature of these emergency river crossing needs, the proposed action must be located in the flood plain and no alternatives that fully span the floodplain are structurally feasible.

Figure 1. Project Area



Source: City of Portland, HDR, Parametrix

2 Project Alternatives

The Project Alternatives are described in detail with text and graphics in the EQRB Description of Alternatives report (Multnomah County 2021b). That report describes the Alternatives' current design as well as operations and construction assumptions.

Briefly, the Draft EIS evaluates the No-Build Alternative and four Build Alternatives. Among the Build Alternatives, there is an Enhanced Seismic Retrofit Alternative that would replace certain elements of the existing bridge and retrofit other elements. There are three Replacement Alternatives that would completely remove and replace the existing bridge. In addition, the Draft EIS considers options for managing traffic during construction. Nomenclature for the Alternatives/Options are listed below:

- No-Build Alternative
- Build Alternatives
  - Enhanced Seismic Retrofit Alternative (Retrofit Alternative)
  - Replacement Alternative with Short-span Approach (Short-span Alternative)
  - Replacement Alternative with Long-span Approach (Long-span Alternative)
  - Replacement Alternative with Couch Extension (Couch Extension Alternative)
- Construction Traffic Management Options
  - Temporary Detour Bridge Option (Temporary Bridge) includes three modal options:
    - Temporary Bridge: All Modes
    - Temporary Bridge: Transit, Bicycles and Pedestrians only
    - Temporary Bridge: Bicycles and Pedestrians only
  - Without Temporary Detour Bridge Option (No Temporary Bridge)

3 Definitions

The terms below are used throughout this report. Flood-related terms are based on the definitions found in Portland City Code (PCC) 24.50.030.

- **Project Area –** The area within which improvements associated with the Project Alternatives would occur and the area needed to construct these improvements. The Project Area includes the area needed to construct all permanent infrastructure, including adjacent parcels where modifications are required for associated work such as utility realignments or upgrades. For the EQRB Project, the Project Area includes approximately a one-block radius around the existing Burnside Bridge and W/E Burnside Street, from NW/SW 3rd Avenue on the west side of the river to NE/SE Grand Avenue on the east side.

- **Area of Potential Impact (API) –** This is the geographic boundary within which physical impacts to the environment could occur with the Project Alternatives. The API is resource-specific and differs depending on the environmental topic being addressed. The API for hydraulics is defined in Section 5.1.
- **Project vicinity –** The environs surrounding the Project Area. The Project vicinity does not have a distinct geographic boundary but is used in general discussion to denote the larger area, inclusive of the Old Town/Chinatown, Downtown, Kerns, and Buckman neighborhoods.
- **Base flood –** The flood having a 1 percent chance of being equaled or exceeded in any given year. Also referred to as the 100-year flood.
- **Regulatory floodway –** The channel of a river or other watercourse and the adjacent land areas that have been reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot, as based on computer simulation or other calculations.
- **100-year flood –** A common term used for the base flood.
- **500-year flood –** The flood having a 0.2 percent chance of being equaled or exceeded in any given year.
- **No-rise certification –** A technical analysis for a project in a regulatory floodway demonstrating that the project will not increase the base flood elevation. The no-rise certification must be conducted before a permit can be issued, signed by a registered professional engineer, and supported by technical data based on the standard step-backwater computer model used to develop the regulatory floodway boundaries.
- **Scour –** Scour is the erosion of streambed material caused by the flow of water around structures and through the channel. Total scour is the sum of long-term degradation, contraction scour, and local scour. If the streambed material is contaminated, scour can mobilize pollutants into the water. The threshold for scour depends on several factors including bed material grain size and water velocity. The risk of scour is usually increased during the construction phase of in-water work.
- **Long-term degradation –** Long-term changes to streambed elevation due to natural or human-made causes that can affect the reach of river on which a bridge is located. Degradation involves the lowering or scouring of the streambed over relatively long reaches, which is generally due to the lack of sediment coming into the river from upstream. (Aggradation happens when mobilized sediments from an upstream area are deposited near a structure. Aggradation is more commonly associated with low velocity flows and is not considered as a component of total scour.)
- **Contraction scour –** Scour that is caused by a narrowing of the channel that increases velocity of the water and shear stress on the riverbed, generally resulting in scour of material from the bed across all or most of the channel.
- **Local scour –** Scour that is caused by the water's momentum being interrupted by a structure in its path and pressure differences that cause the flow to be pushed downward and scour holes near the structure. Local scour generally removes material from around the piers, abutments, spurs, and embankments of a channel.

Local scour along the banks impacts overall channel hydraulics and scour along bridge piers can impact bridge stability.

4 Legal Regulations and Standards

The evaluation includes review of federal, state, and local regulations that provide the legal requirements applicable to hydraulic impact analysis in the API, as well as a review of local plans, policies, and manuals that provide additional guidance. The list below is a general summary of federal, state, and local laws, regulations, plans, and policies that guide or inform the assessment of floodplains, floodways, and channel hydraulics.

The requirements of several laws regarding floodplain encroachment will critically guide the Project design. These laws are emphasized in bold italicized text below and are discussed in detail in Section 7.5.

4.1 Federal

- National Environmental Policy Act of 1969, 42 United States Code (USC) Section 4321
- ***23 Code of Federal Regulations (CFR) 650 – Federal Highway Administration (FHWA), Bridges, Structures, and Hydraulics*** *(which outlines FHWA procedures for compliance with Floodplain Management Presidential Executive Order 11988)*
- Clean Water Act, 33 USC Section 1344 et seq., Public Law Section 404 – Permits for Dredge or Fill (also Section 10 of the Rivers and Harbors Act)
- Floodplain Management Presidential Executive Order 11988
- National Flood Insurance Act of 1968 and Flood Disaster Protection Act of 1973, 42 USC 4001 et seq.
- Endangered Species Act Biological Opinion for the Implementation of the National Flood Insurance Program in the State of Oregon (NMFS 2016)
- Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for City of Portland, Oregon, Multnomah, Clackamas, and Washington Counties (FEMA 2010)
- FEMA Flood Insurance Rate Map (FIRM) for City of Portland, Oregon, Multnomah, Clackamas, and Washington Counties (FEMA 2004), including effective revisions and amendments
- ***44 CFR Part 60 – Criteria for Land Management and Use (including floodplains)***
- The U.S. Army Corps of Engineers (USACE) National Levee Database

4.2 State

- Oregon Revised Statute Title 45 – Water Resources, Irrigation, Drainage, Flood Control, Reclamation

- Oregon Department of Transportation (ODOT) Hydraulics Design Manual (ODOT 2014)

4.3 Regional and Local

- Climate Action Plan (Multnomah County 2015)
- Multnomah County Multi-Jurisdictional Natural Hazards Mitigation Plan (Multnomah County 2017)
- ***PCC Chapter 24.50 – Flood Hazard Areas***
- PCC Chapter 33.475 – River Overlay Zones
- PCC Chapter 33.865 – River Review
- Burnside Street: Willamette River Bridge Painting and Rehabilitation No-rise Memorandum (Multnomah County 2016)
- EQRB Feasibility Study Project documents

4.4 Design Standards

The Project would place pier structures in the regulatory floodway. As a result, the following key requirements will guide the Project design:

- 23 CFR 650 (which outlines compliance with Floodplain Management Presidential Executive Order 11988) requires FHWA projects like this one to demonstrate the project necessity and why the alternative selected is the only practicable choice.
- PCC 24.50.060.D and 44 CFR 60.3(d)(3) require such projects to demonstrate that no increase of the base flood elevation would occur, as documented through a no-rise certification.
- Construction within the Special Flood Hazard Area requires a permit from the City of Portland to ensure floodplain protection requirements are met. Outside of the floodway, construction must balance cut and fill at or below the protected 100-year flood elevation. Within the floodway, if bridge piers are found to create a net rise, the pier design must be altered or conveyance mitigation must be included to bring the net rise back to zero. With any impact resulting in base flood elevation increase, the Project would either be required to provide conveyance offsets or could request approval from the City for revision to the regulated base flood elevation to accommodate the new bridge piers.

Additional design standards required by federal, state, and local law, or by agency policy relating to floodplains, floodways, and channel hydraulics, are those listed in the above plans and policies. Guidance for the analysis was also taken from the ODOT *Bridge Hydraulics Performance Specification* (ODOT 2018).

5 Affected Environment

5.1 Area of Potential Impact

The API for hydraulics (Figure 2 for the Project vicinity extends laterally along the Willamette River concurrent with the 500-year floodplain boundary, upstream to the Marquam Bridge and downstream to the Fremont Bridge.

The 500-year floodplain was selected as the API horizontal boundary based on the geographical extent that structures will be placed within the floodplain.

The upstream and downstream ends of the API are based on the modeling that was performed for the *Burnside Street: Willamette River Bridge Painting and Rehabilitation No-rise Memorandum* (Multnomah County 2016). These boundaries represent the extent of potential hydraulic impacts within the channel and coincide with the FEMA FIS River Section M near the Fremont Bridge and River Section U near the Marquam Bridge.

The API for hydraulics applies to all timeframes and extents of the impact analysis (construction, operational, indirect, and cumulative), because the analysis of each aspect of these potential impacts focuses on the area relating to hydraulic conditions within the river channel.

5.2 Resource Identification and Evaluation Methods

5.2.1 Published Sources and Databases

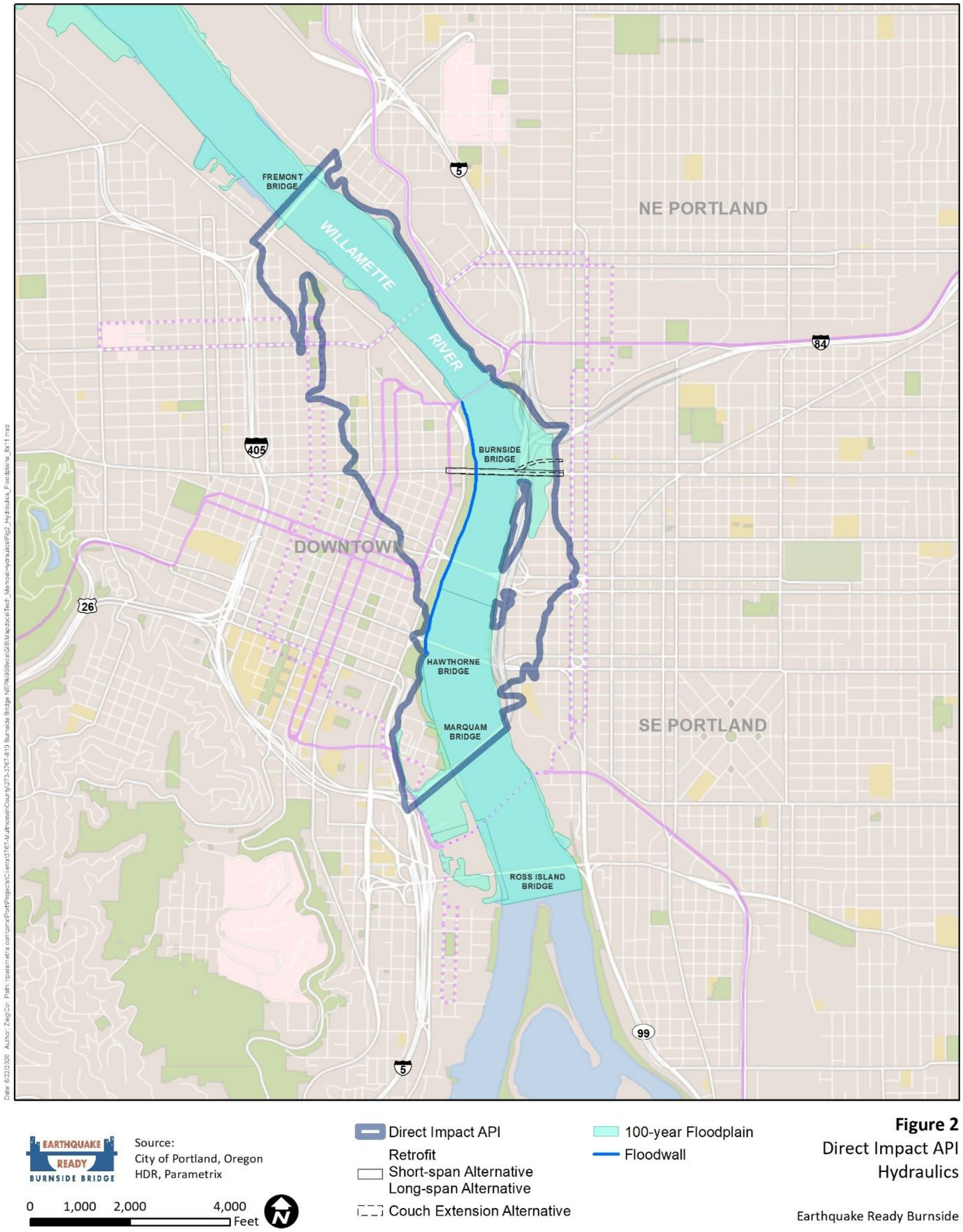
Published sources and databases used in the hydraulic impact analysis include the following:

- FEMA FIS for City of Portland, Oregon, Multnomah, Clackamas, and Washington Counties (FEMA 2010)
- FEMA FIRM for City of Portland, Oregon, Multnomah, Clackamas, and Washington Counties (FEMA 2004)
- Burnside Street: Willamette River Bridge Painting and Rehabilitation No-rise Memorandum and associated USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS) model results (Multnomah County 2016)
- National Levee Database (USACE 2010)
- U.S. Geological Survey (USGS) Gage Data for the Willamette River (USGS 2019)
- Oregon Department of Environmental Quality (DEQ) 303(d) List of Impaired Waters (DEQ 2018a)

5.2.2 Field Visits and Surveys

No field visits or surveys were conducted as part of the hydraulic impact analysis.

Figure 2. Direct Impact API



Source: City of Portland, HDR, Parametrix

5.2.3 Evaluation Methods

The EIS hydraulic impact analysis qualitatively compares the proposed geometry of each Alternative against the geometry of the existing bridge, focusing on the elements (such as lateral surface area in the floodway and openings between columns) that affect how flow would move around piers and footings and the potential for hydraulic changes that could impact scour or base flood elevation. Following review of the EIS and selection of a Preferred Alternative, the bridge design would be advanced, detailed hydraulic modeling of the channel would be conducted, and results would be documented in a technical hydraulic design report that could support a no-rise certification.

5.3 Existing Conditions

Relevant geometry of the existing bridge and other key characteristics of the existing conditions of the Willamette River hydraulics are discussed in the following sections.

5.3.1 Natural Floodplain

Floodplains can provide fish and wildlife habitat, flood water storage and conveyance, water quality protection, and groundwater recharge. This area of the Willamette River floodplain has been highly modified by urban development over the past 100 years, and most of the original natural and beneficial floodplain values have been modified or diminished. Therefore, the floodplain and hydraulic impacts analysis focuses mainly on the potential for base flood increase and scour compared to the existing bridge and channel.

5.3.2 Existing Bridge Geometry

The existing Burnside Bridge was constructed in 1926 in the Willamette River near river mile 12.4. It has a total length of approximately 2,300 feet and consists of three separate bridges: The west approach bridge (approximately 603 feet long), the main river bridge (approximately 856 feet long), and the east approach bridge (approximately 849 feet long). Plan and elevation views of the existing bridge are shown in Figure 3 through Figure 5. The main river bridge contains two 268-foot steel deck truss side spans and a 252-foot double-leaf bascule draw span. The existing pier structures in the main channel are the west pier (Pier 1); the west and east bascule piers (Piers 2 and 3), each approximately 55 feet wide and equipped with cutwater bulwarks (tapered structures projecting into the direction of flow, meant to ease the current around each pier); and the east pier (Pier 4). In addition, the west approach Bridge has 19 smaller piers and the east approach bridge has 15 smaller piers, all above the ordinary high water mark. As shown in Figure 2, the bridge has minimal skew and is generally perpendicular to the channel flow. (Multnomah County 2019; ODOT 2017) Many of the piers associated with the west and east approach bridges are located outside of the hydraulics API. Consequently, hydraulic-related impacts to the existing piers outside of the API are not anticipated.

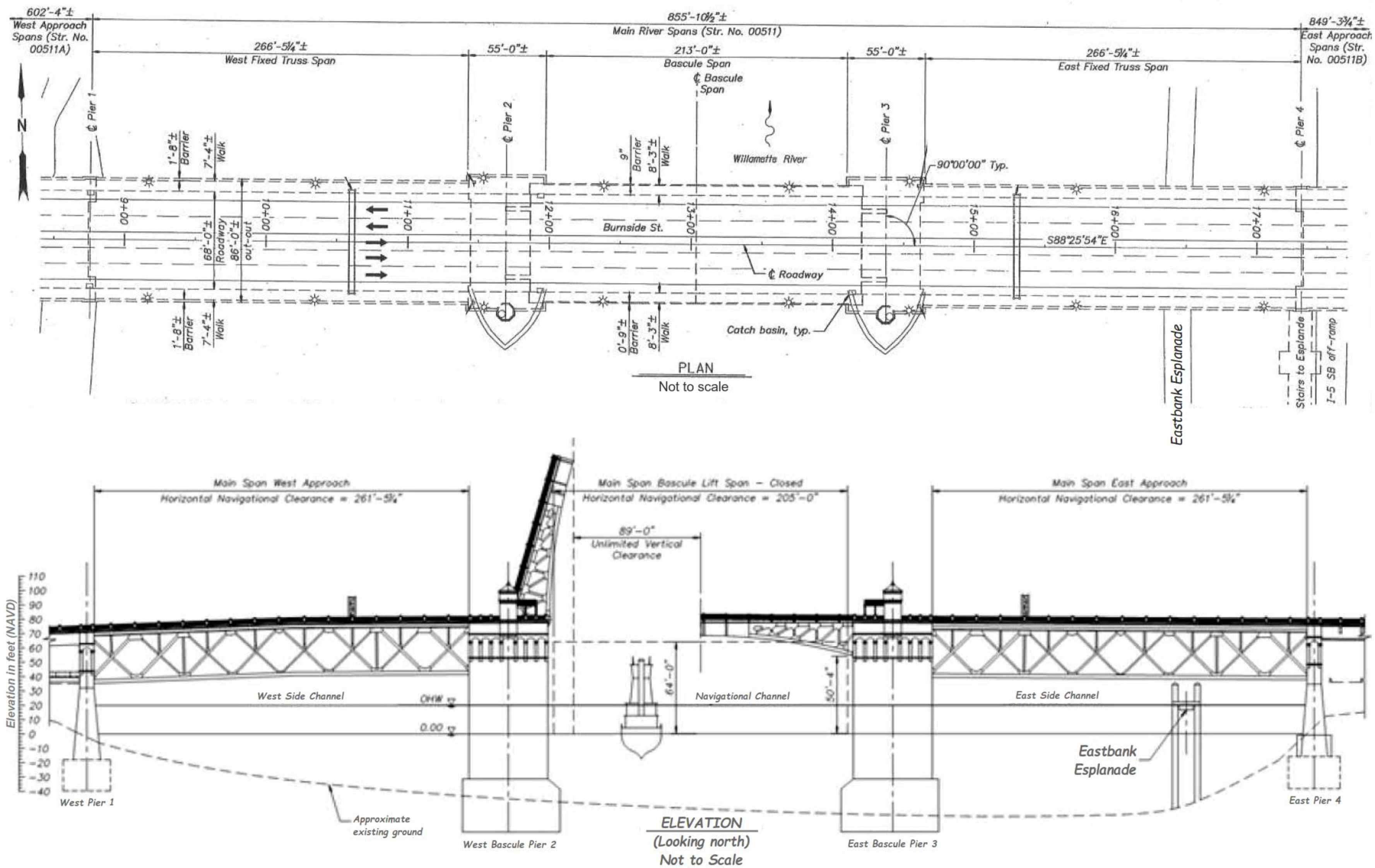
5.3.3 Existing Bridge Condition

Based on results of FHWA inspections in 2016 and 2017 and other data compiled in the National Bridge Inventory (NBI), the Burnside Bridge has been classified as scour critical, and the bridge foundations (piers or abutments) were determined to be unstable for calculated scour conditions (FHWA 1995; FHWA 2019).

ODOT also evaluates Oregon state highway system bridges every year using FHWA National Bridge Inspection Standards. The 2020 ODOT Bridge Condition Report listed the bridge as having a low service life, meaning the bridge may not provide the desired level of performance or functionality with any amount of repair or maintenance (ODOT 2020).

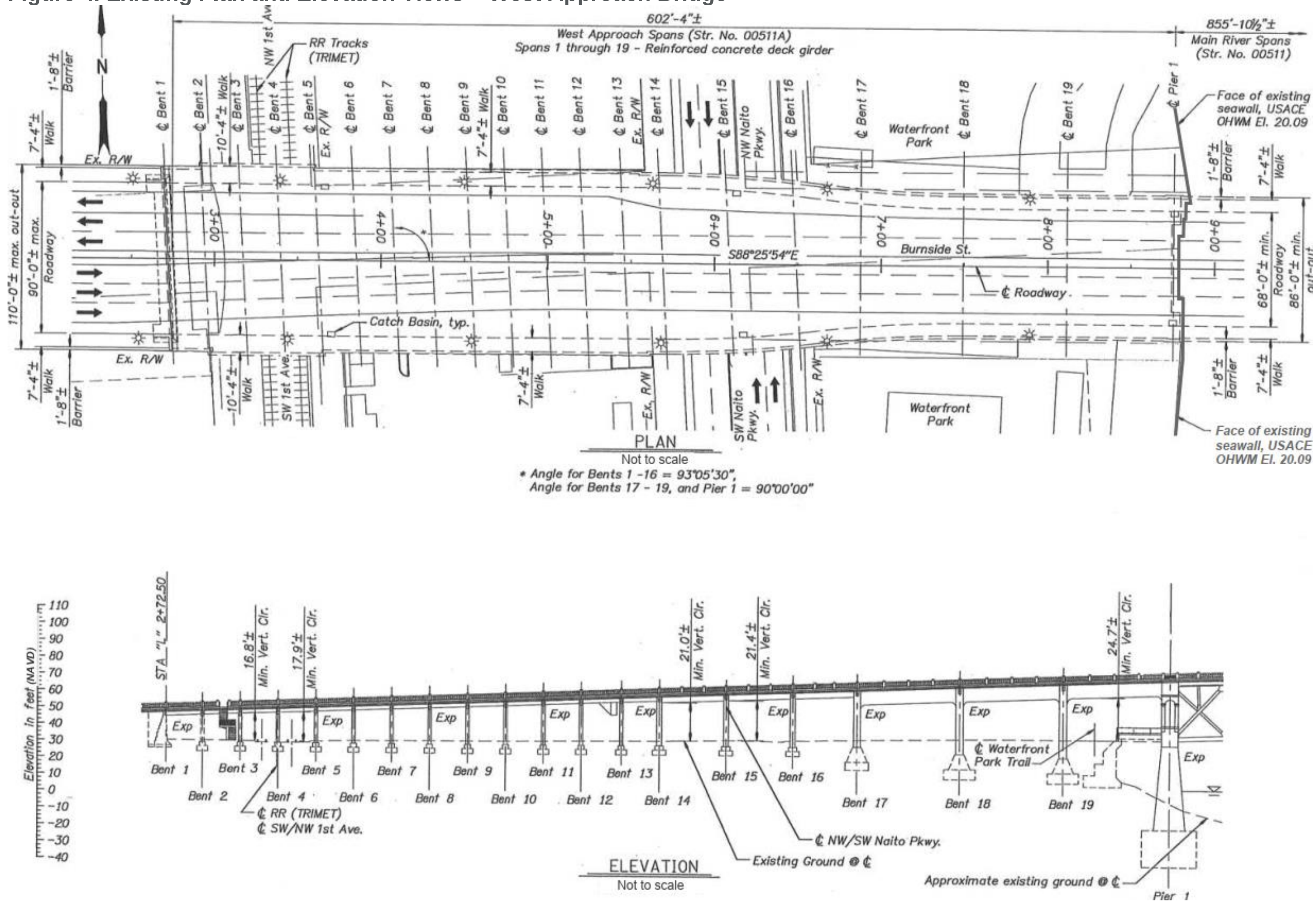
The Burnside Bridge Maintenance Project, which was completed in 2020, implemented hydraulic structural repairs on the bridge including repair of cracks in the piers, repair of the concrete columns that hold up the bridge, and strengthening of beams and girders which support the columns. These repairs were intended to keep the bridge working safely for another 15 to 20 years while an alternative plan is developed. (Multnomah County 2020).

Figure 3. Existing Plan and Elevation Views – Main River Bridge



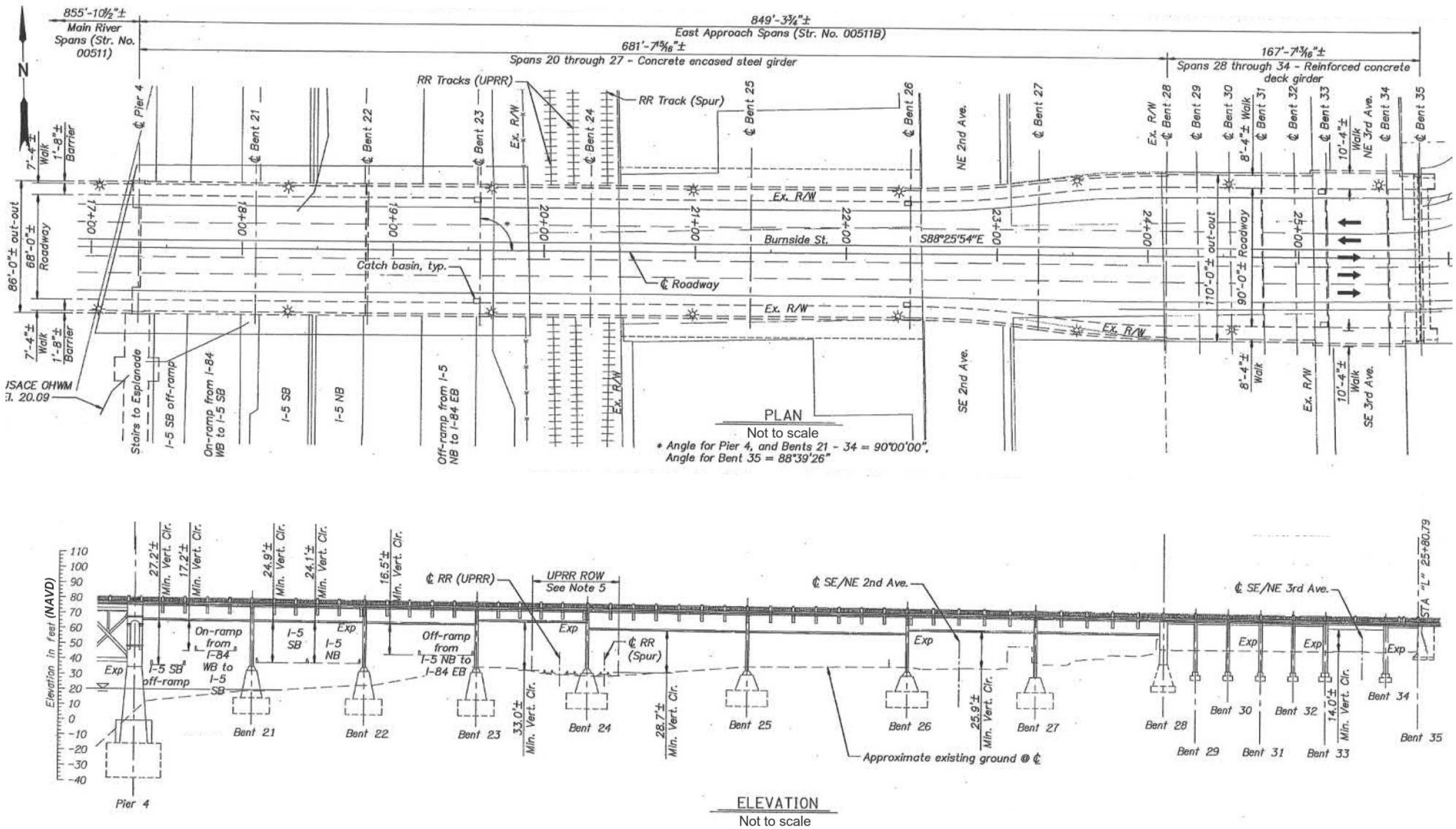
Source: ODOT 2017; Multnomah County 2018

Figure 4. Existing Plan and Elevation Views – West Approach Bridge



Source: ODOT 2017

Figure 5. Existing Plan and Elevation Views – East Approach Bridge



Source: ODOT 2017

5.3.4 Vera Katz Eastbank Esplanade

A relevant structure located within the channel at the Burnside Bridge is the Vera Katz Eastbank Esplanade (Figure 3), which is a 1.5-mile-long public trail and demonstration project for improved habitat areas for fish and wildlife and riverbank restoration. Attached to the Esplanade on the north side of the Burnside Bridge is the Kevin J. Duckworth Memorial Dock, a floating dock that provides recreational boaters with short-term tie-up and access to enter the Esplanade and the upland businesses. The Eastbank Esplanade extends north from the Hawthorne Bridge, under the east span of the Burnside Bridge, to the Steel Bridge. At the Burnside Bridge, the Esplanade connector is held in place by pilings sunk into a concrete base (City of Portland 2019). The location and the configuration of the Eastbank Esplanade affects the existing scour in the river, as discussed later in Section 5.3.7.

5.3.5 Portland Floodwall

The Portland Floodwall (also known as the harbor wall) runs along the west bank of the Willamette River in the study area from the Hawthorne Bridge to the Steel Bridge (see Figure 4). The USACE National Levee Database lists the floodwall as System ID Number 5005915401 and classifies it as “Locally Constructed, Locally Operated and Maintained.”

5.3.6 Base Flood Characteristics

The hydraulics impacts analysis for the Draft EIS is qualitative, and no new modeling or flow calculations are included. However, the quantitative characteristics of the existing floodplain are useful points of reference and are summarized in this section. The study area includes a FEMA Special Flood Hazard Area (designated as Zone AE), also known as the 100-year floodplain. The width of the 100-year floodplain is shown on Figure 2. Base flood elevations, floodway widths, and flood-event channel velocities for the API are shown in Figure 6. The profile of the base flood is shown in Figure 7.

Figure 6. Existing Floodplain Elevations, Floodway Widths, and Channel Velocities

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY[2] (FEET NAVD)	WITH FLOODWAY[2] (FEET NAVD)	INCREASE (FEET)
WILLAMETTE RIVER								
A	0.38	1,600 / 846[4]	85,130	3.1	30.8	29.4	30.2	0.8
B	1.52	1,700 / 756[4]	113,090	2.3	30.9	29.5	30.3	0.8
C	3.03	2,073 / 1,273[4]	110,545	2.4	30.9	29.6	30.4	0.8
D	3.50	1,896	110,822	3.4	30.9	29.6	30.4	0.8
E	4.54	1,710	116,277	3.2	31.0	29.7	30.5	0.8
F	5.00	1,716	103,773	3.6	31.2	29.7	30.5	0.8
G	6.00	1,420	85,079	4.4	31.2	29.8	30.6	0.8
H	6.70	1,417	80,505	4.7	31.2	29.9	30.7	0.8
I	7.00	1,440	82,091	4.5	31.3	30.0	30.8	0.8
J	7.68	1,870	123,102	3.0	31.4	30.3	31.1	0.8
K	8.40	2,045	122,118	3.1	31.4	30.4	31.2	0.8
L	9.66	1,697	98,255	3.8	31.5	30.5	31.2	0.7
M (Fremont Bridge)	11.00	1,023	68,973	5.4	31.6	30.6	31.4	0.8
N (Broadway Bridge)	11.72	928	54,397	6.9	31.7	30.6	31.4	0.8
O	11.94	740	53,452	7.0	31.7	30.8	31.5	0.7
P (Steel Bridge / Burnside Bridge)	12.30	1,144	70,636	5.3	32.0	31.3	32.1	0.8
Q (Burnside Bridge / Morrison Bridge)	12.62	849	60,729	6.2	32.1	31.3	32.1	0.8
R (Morrison Bridge / Hawthorne Bridge)	12.99	1,197	67,540	5.6	32.3	31.7	32.4	0.7
S	13.16	1,295	69,242	5.4	32.4	31.8	32.5	0.7
T (Marquam Bridge)	13.33	1,378	66,329	5.7	32.4	31.8	32.6	0.8
U	13.51	1,339	69,350	5.4	32.5	31.9	32.7	0.8
V	13.73	1,339	69,350	5.4	32.6	32.0	32.7	0.7
W	13.84	1,371	73,934	5.1	32.7	32.1	32.9	0.8
X	14.00	1,585	73,405	5.1	32.7	32.2	32.9	0.7
Y	14.90	1,611[3]	68,291	5.5	33.1	32.7	33.2	0.5
Z	15.66	2,948[3]	122,470	3.1	33.3	33.0	33.9	0.9

[1]Miles Above Mouth

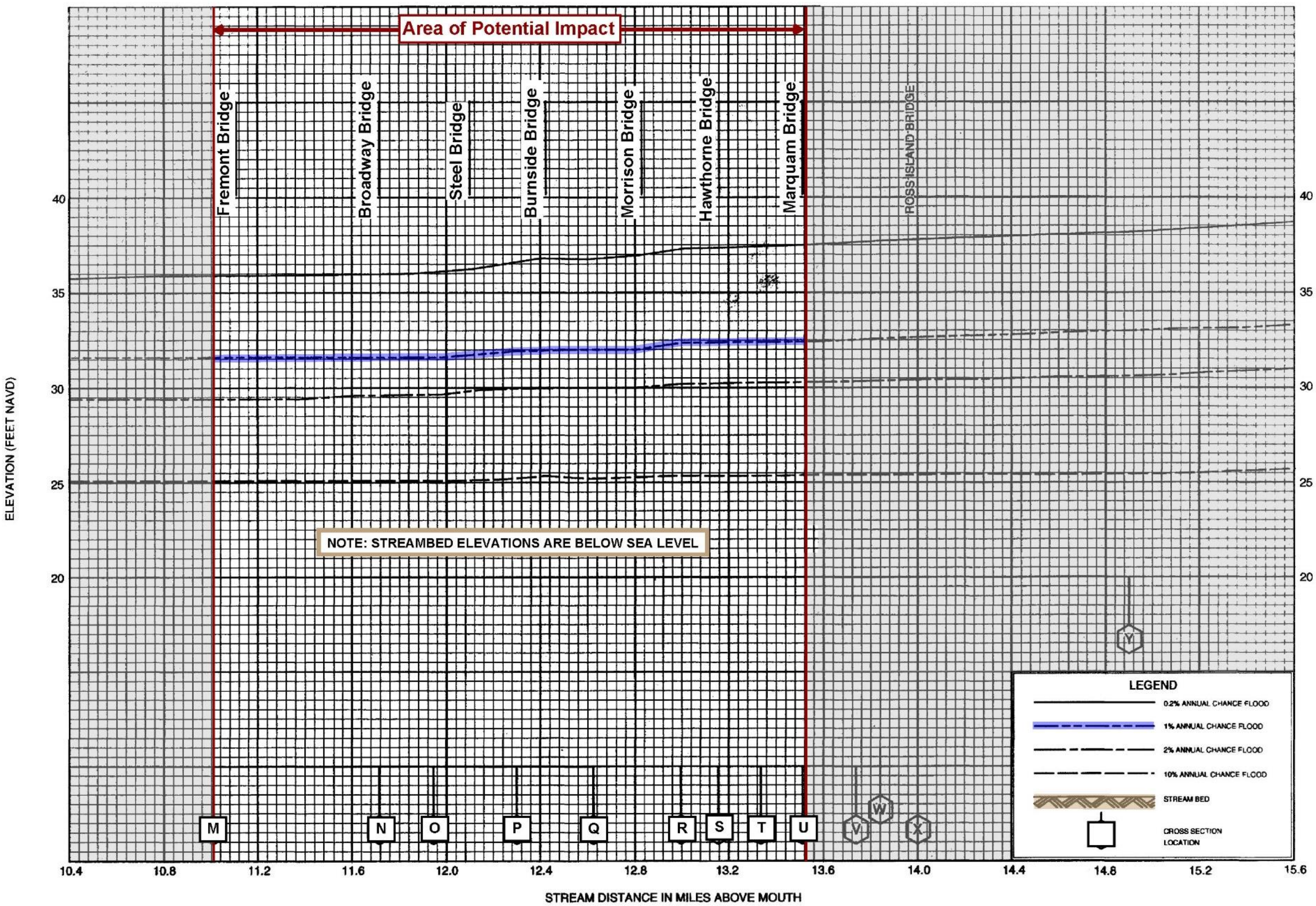
[2]Elevations computed without consideration of influence from Columbia River

[3]Width does not include island

[4]Width/width within City of Portland

Source: FEMA 2010

Figure 7. Base Flood (100-Year) Profile



Note: Streambed elevations are below sea level and are not shown in profile. Source: FEMA 2010

5.3.7 Flow Dynamics, Scour Potential, and Contaminant Mobilization

Scour is the erosion of streambed material caused by flow around structures and through the channel that can cause instability for structures anchored in the streambed. The threshold for scour depends on several factors including bed material grain size and water velocity. The risk of scour is usually increased during the construction phase of in-water work. The hydraulic impacts analysis considers the three primary components of total scour (these terms are also discussed in Chapter 3):

- Long-term degradation – Long-term changes to streambed elevation due to natural or human-made causes that can affect the reach of river on which a bridge is located. Degradation involves the lowering or scouring of the streambed over relatively long reaches, which is generally due to the lack of sediment coming into the river from upstream. (Aggradation happens when mobilized sediments from an upstream area are deposited near a structure. Aggradation is more commonly associated with low velocity flows and is not considered as a component of total scour.)
- Contraction scour – Caused by a narrowing of the channel that increases the velocity of the water and shear stress on the riverbed, generally resulting in scour of material from the bed across all or most of the channel.
- Local scour – Caused by the water's momentum being interrupted by a structure in its path and pressure differences that cause the flow to be pushed downward and scour out holes near the structure. Local scour generally removes material from around the piers, abutments, spurs, and embankments of a channel. Local scour along the banks impacts overall channel hydraulics and scour along bridge piers can impact bridge stability.

Streambed scour is of additional concern when it can mobilize pollutants where sediment contamination is present. The Willamette River in the API is identified on the Oregon DEQ Section 303(d) List as an impaired waterbody for multiple metals and other toxic substances[1] (DEQ 2018a). The north end of the API is part of the Portland Harbor Superfund Site, which extends from river mile 1.9 near the mouth of the Willamette River upstream to river mile 11.8 near the Broadway Bridge. A Pre-Remedial Design Investigation was implemented for the site between March 2018 and May 2019 to provide baseline sampling, and results demonstrate significant recovery since the last comprehensive sampling in 2004. Concentrations of the focused contaminants of concern[2] have decreased in surface water, surface sediment, and fish tissue, and areas of elevated concentrations have not migrated substantially (EPA 2019). DEQ is also conducting sampling and sediment cleanup at multiple locations throughout the API (Figure 8).

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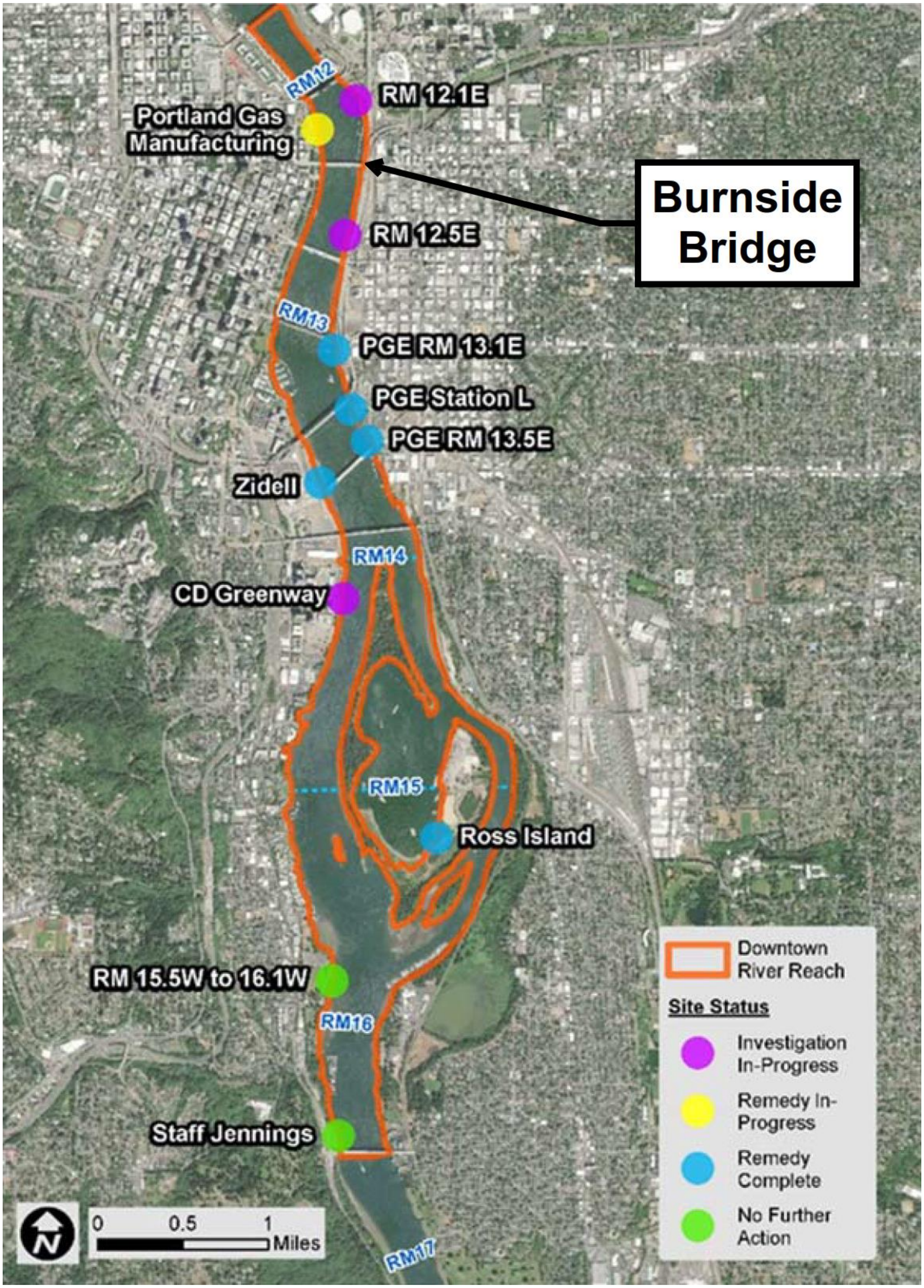
[1] 303(d) listing includes copper; iron; lead; aldrin; chlordane; cyanide; dichlorodiphenyltrichloroethane and its derivatives (DDx); dieldrin; dioxin (2;3;7;8-TCDD); hexachlorobenzene; pentachlorophenol; polychlorinated biphenyls (PCBs); and polynuclear aromatic hydrocarbons (PAHs) (DEQ 2018a).

[2] The focused contaminants of concern are total PCBs; total PAHs; DDx; and three dioxin/furan congeners (2,3,7,8-tetrachlorodibenzo-p-dioxin; 1,2,3,7,8-pentachlorodibenzo-p-dioxin; and 2,3,4,7,8-pentachloro-dibenzofuran) (EPA 2019).

Figure 8. Oregon DEQ Sediment Monitoring and Cleanup

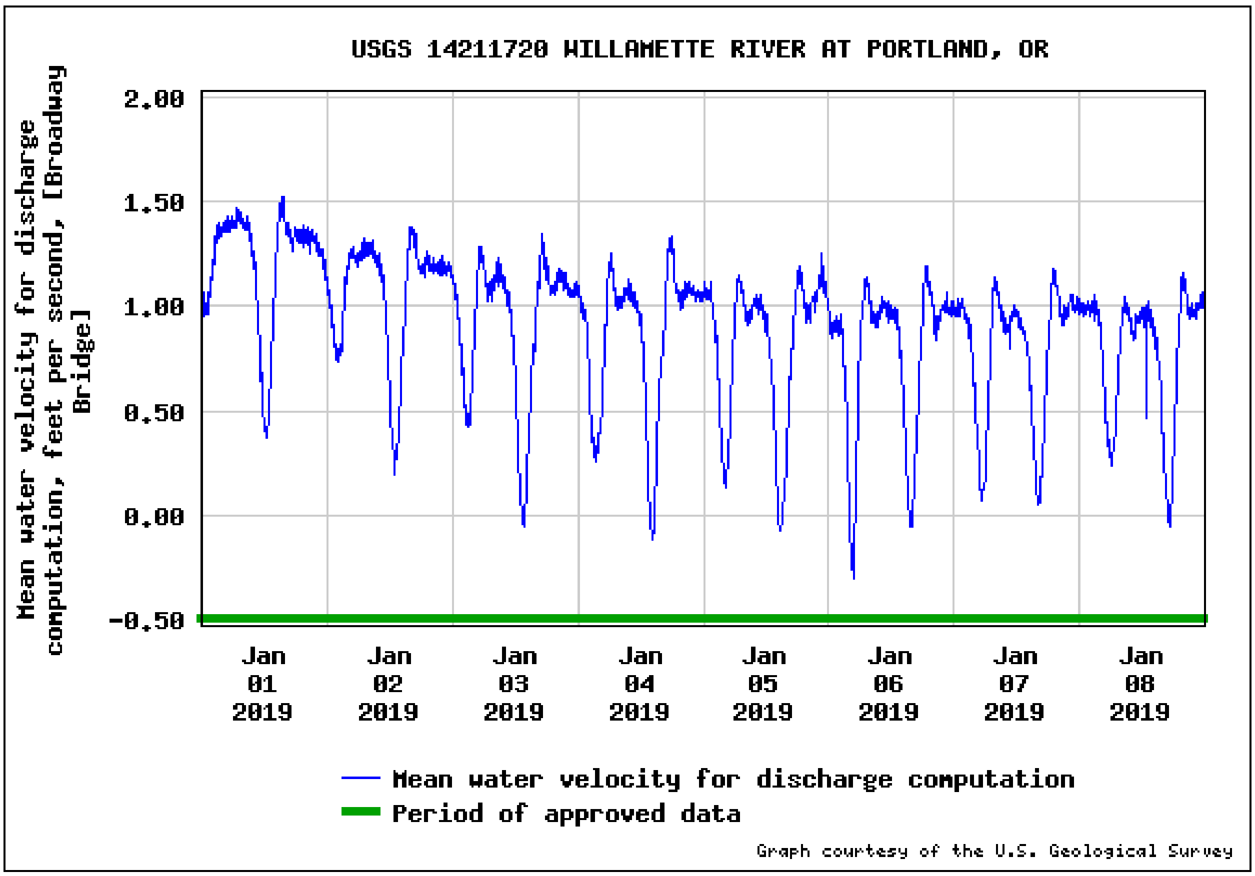


Source: DEQ 2018b.

As shown on Figure 8, the Portland Gas Manufacturing Site is just downstream of the Burnside Bridge. Potential impacts are addressed in the EQRB Hazardous Materials Report (Multnomah County 2021c).

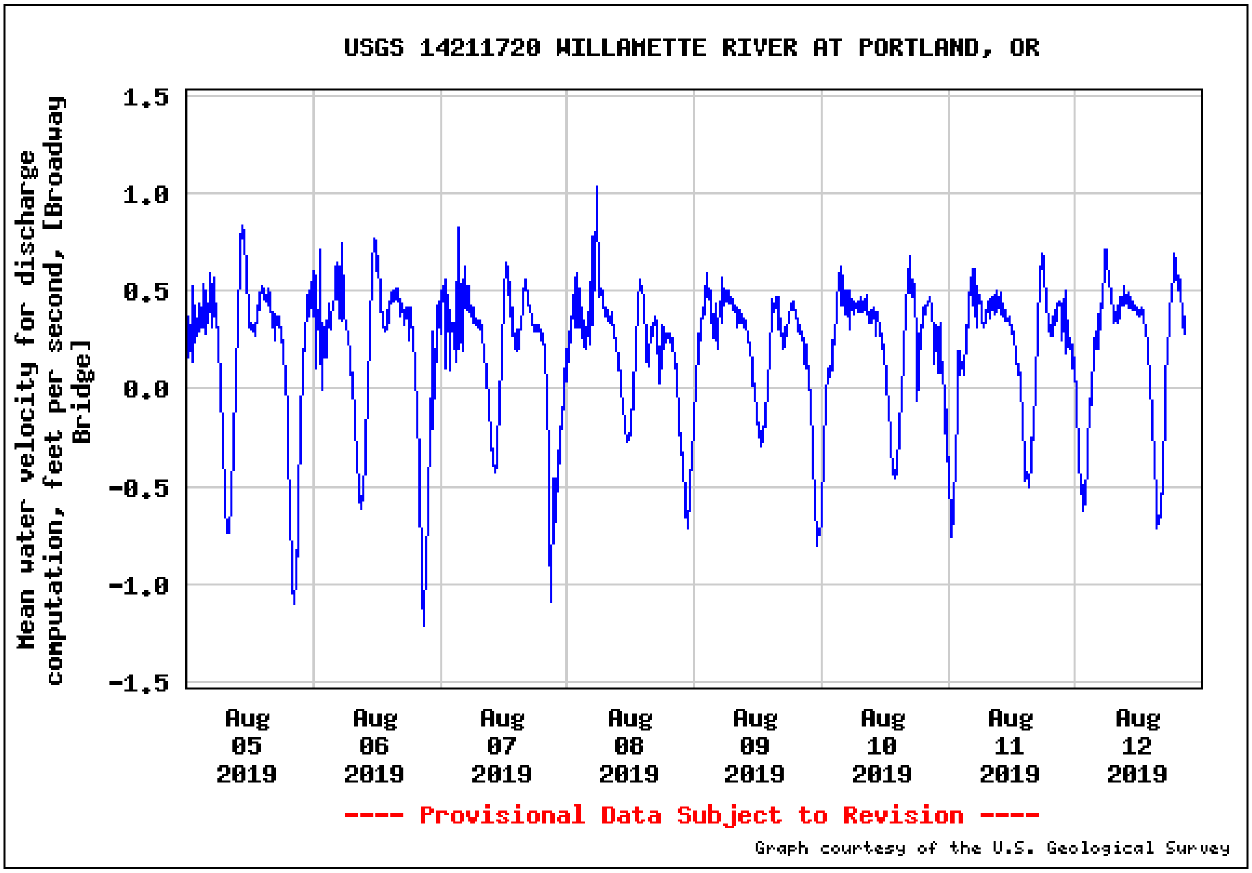
Velocities at the existing Burnside Bridge are generally low and are tidally influenced by the downstream Columbia River and Pacific Ocean. USGS gage data at the Broadway Bridge (approximately 3,800 feet downstream of the Burnside Bridge) in winter and summer is presented in Figure 9 and Figure 10, respectively. Generally, velocities in the outflow (downstream/northerly) direction are higher in the winter months, but inflow (upstream/southerly) velocities influenced by the tide are higher in the summer. Based on the U.S. Army Corps of Engineers Lower Willamette River Federal Navigation Channel maintenance dredging program (EPA 2020), the low velocities may be causing aggradation in this reach of the Willamette River.

Figure 9. Willamette River Velocities in the API – Winter



Source: USGS 2019

Figure 10. Willamette River Velocities in the API – Summer

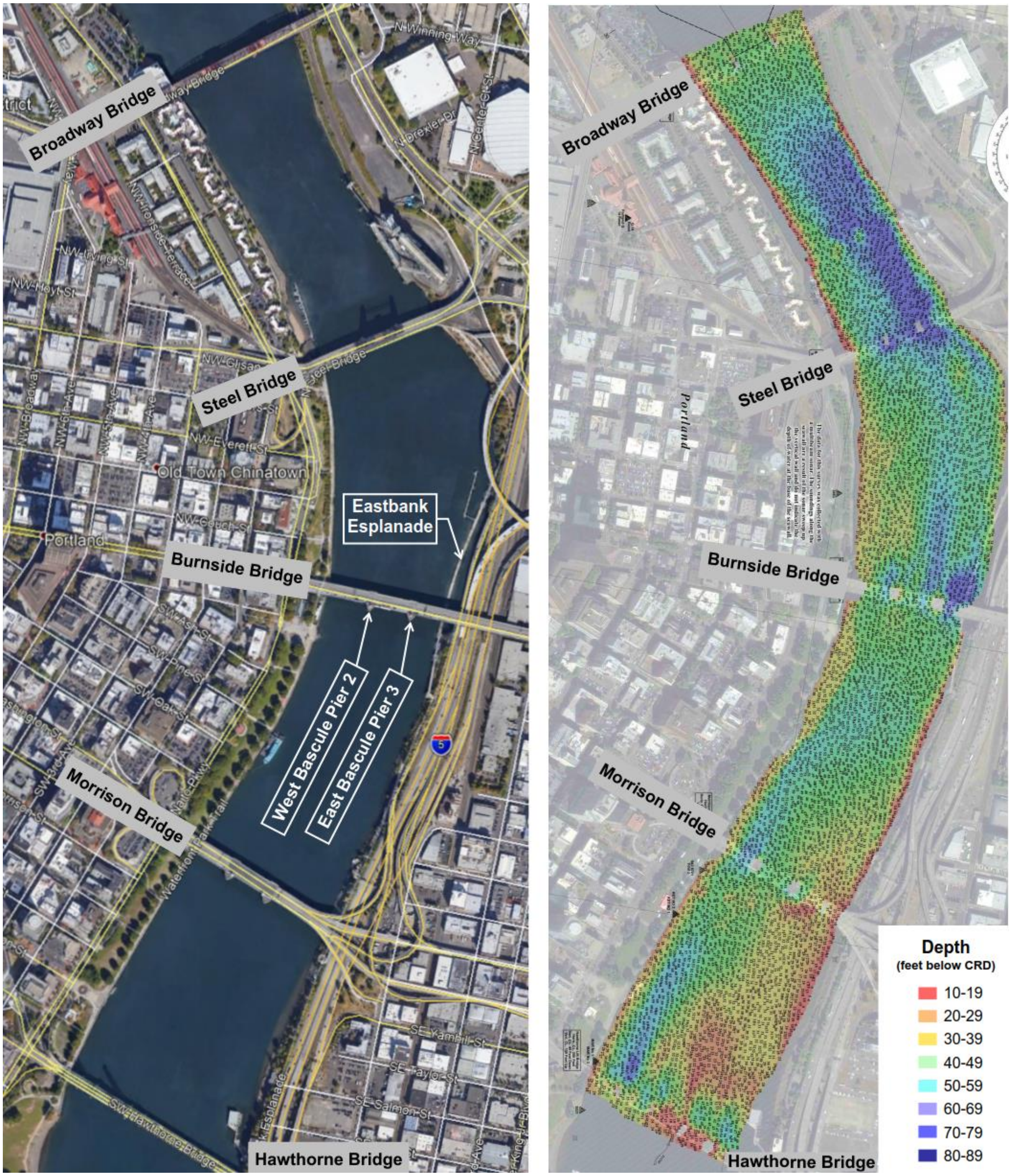


Source: USGS 2019

Channel bed elevation patterns are shown in Figure 11. At approximately 50 feet below the Columbia River Datum (CRD),[3] the channel's natural centerline, or thalweg, is visible. A thalweg typically runs down the center of a channel at straight segments and curves closer to the outer bank at riverbends, where the flows are deepest and velocities are highest. Elevation patterns indicate localized scour at the existing Burnside Bridge; however, the channel bed elevation self-corrects before reaching the Steel Bridge. Also visible in Figure 11 is the increase in the local Burnside Bridge scour at the Vera Katz Eastbank Esplanade columns that likely create a flow constriction at the thalweg and also create associated eddy (circular water movements in the opposite direction of main channel flow) scour at the riverbend. Continuation of these scour patterns at the Eastbank Esplanade could lead to pier instability of the bridge and have the potential to mobilize sediments, some of which have been identified as contaminated.

[3] The CRD is a gradient vertical datum that changes relative to the North American Vertical Datum of 1988 (NAVD88) by river mile above the Columbia. The Burnside Bridge is located approximately at Willamette River mile 12.4, where CRD = NAVD88 - 5.35 feet (DEA 2016).

Figure 11. Willamette River Depths and Scour Patterns



Source: Google Earth Pro; USACE 2019
Note: CRD (Columbia River Datum) at Burnside Bridge = NAVD88 – 5.35 feet (DEA 2016)

6 Impact Assessment Methodology and Data Sources

6.1 Long-Term Impact Assessment Methods

The analysis conducted to estimate direct long-term hydraulic impacts is preliminary and intended to provide a comparison of the Alternatives at this early design stage rather than provide a final assessment of quantitative impacts to the hydraulics of the Willamette River. The analysis considers the potential for effects on the base flood elevation, the floodplain boundary, and scour/deposition patterns through review of existing preliminary hydraulic analyses from the *Burnside Street: Willamette River Bridge Painting and Rehabilitation No-rise Memorandum* (Multnomah County 2016), the EQRB Feasibility Study Project, and the current range of Alternatives. No new models have been developed for this comparative analysis. Following selection of a Preferred Alternative, the bridge design would be advanced, detailed hydraulic modeling of the channel would be conducted, and results would be documented in a technical hydraulic design report that could support a no-rise certification. Future weather patterns and tidal elevations have been qualitatively considered for this report, and further discussion of resiliency is included in the EQRB Climate Change Technical Report (Multnomah County 2021a).

Evaluation of hydraulics in this phase is based on proposed floodway lateral area encroachment and pier configurations for each Alternative. A change in structure width and the alignment angle to the flow that would result in changes to the channel conveyance area would also affect the potential risk of scour. In addition, changes to the footing lengths result in changes to scour lengths. For this hydraulic impacts analysis, estimated changes in scour potential were calculated based on the proposed changes in footing length for each Alternative. Scour impacts for a final design would be determined through detailed hydraulic modeling.

Calculations used to compare the potential magnitude of impacts among the Alternatives are detailed in Appendix A with a complete list of assumptions.

6.2 Short-Term Impact Assessment Methods

The analysis of direct short-term environmental impacts is comparative and qualitative based on the layout proposed and considers construction impacts from exposing potentially contaminated sediments in the Project Area and potential temporary impacts to river hydraulics from temporary in-water fill, including the temporary bridge.

6.3 Indirect Impact Assessment Methods

Indirect impacts are potential effects that could be caused by the Alternatives at a later time or a farther distance but are still reasonably foreseeable. In general, floodplain and floodway regulations are specifically based on protections against indirect impacts, so Project mitigation to prevent base flood rise would also address indirect impacts. In some cases, habitat (such as wetland areas) can be affected by floodplain mitigation efforts (like vegetation removal and excavation of flood storage); however, no habitat impacts are expected in the highly urbanized Project vicinity. Once a Preferred Alternative has been selected following the review of the EIS, the bridge design would be advanced, and detailed hydraulic modeling of the channel would be conducted to determine the estimated flow velocities for the channel reach extending upstream and downstream of the Project Area to the extent of the hydraulic influence of the pier encroachment. Due to the relatively low velocities of the existing channel and the design goal of minimizing constricting floodway encroachments, impacts to upstream and downstream boating facilities from river hydraulics are not anticipated.

6.4 Cumulative Impact Assessment Methods

The cumulative impacts analysis addresses the long-term and short-term cumulative impacts of the Project Alternatives. Other projects considered in the analysis include major transportation, development, utility infrastructure, and environmental enhancement projects recently constructed, under development, or scheduled for construction, as well as the planned projects that are reasonably likely to be constructed. Based on the list of foreseeable transportation and other development projects that are anticipated to occur in the Project vicinity within the same time frame, as well as relevant past actions that have defined the Project vicinity, a qualitative analysis of potential cumulative effects has been conducted for hydraulic impacts. The analysis of potential cumulative impacts is examined for both near-term construction effects, as well as long-term operational impacts. Future weather patterns and tidal elevations have been qualitatively considered; resiliency issues are further addressed in the EQRB Climate Change Technical Report (Multnomah County 2021a).

7 Environmental Consequences

7.1 Pre-Earthquake Impacts

This section describes the effects of the Alternatives prior to a CSZ earthquake.

7.1.1 No-Build Alternative

The No-Build Alternative does not propose placement of any additional structures in the channel and would not result in changes to base flood elevation, floodplain width, or scour potential.

7.1.2 Impacts Common to all Build Alternatives

The proposed Build Alternatives would each replace or retrofit all piers on deep foundations and support the bents on both approaches by columns on drilled shafts. The level of seismic resiliency incorporated into each Build Alternative is expected to produce bridge structures that are insensitive to effects from local scour (i.e., changes in scour are not expected to weaken any of the Build Alternatives). Scour would be carefully assessed in the design stages and necessary countermeasures incorporated as needed. To meet seismic safety requirements, each Build Alternative would place a larger bridge structure in the floodway than is currently occupied by the existing bridge. As a result, the Project would be expected to increase the base flood elevation and could mobilize contaminated sediments through scour, with some Alternatives having greater impacts than others. The increase would likely require design modifications to meet permitting requirements, with some Alternatives likely requiring more changes than others to meet requirements. Meeting permitting requirements would require consideration of design refinements, detailed modeling analyses to evaluate potential changes to the base flood elevation, and incorporating floodplain impact mitigation into the Project. The Project design would follow the requirements of 23 CFR 650 - Bridges, Structures, and Hydraulics, which outlines the Federal Highway Administration (FHWA) procedures for compliance with Executive Order 11988. A comparison of the magnitude of floodway encroachment (based on the Willamette River floodway cross-sectional area calculated by FEMA) for each Build Alternative is presented in Table 2, and the range of potential scour length increase for the proposed Alternatives is presented in Table 3.

The harbor wall currently acts as a levy, and proposed bridge structures placed within the API beyond the western extent of the harbor wall are not expected to significantly impact velocities or associated scour potential. An increase in scour is more likely for bridge foundation elements within the river located on the east, channel-side of the harbor wall (see Figure 4). However, low velocities within the API outside of the harbor wall could result in sedimentation outside of the harbor wall during extreme flood events and may require a long-range maintenance plan to keep the floodplain free of conveyance obstructions. The range of conceptual scour impacts is presented in Table 3.

Each of the Alternatives has a movable center span, either as a vertical or bascule lift design. Of the two lift options, the footings and columns required to support the bascule option are larger and would result in greater hydraulic impacts.

A new south-side, east approach bridge access point is being considered for bike, pedestrian, and Americans with Disabilities Act (ADA) access to connect the bridge to the Eastbank Esplanade. The two concepts being considered include a common connection configuration for the Short-span, Long-span, and Retrofit Alternatives, as well as a configuration for the Couch Extension Alternative connection. The proposed designs would involve excavation of contaminated soils, placement of fill within the floodplain in the form of structural columns, and would aim to avoid widening the embankment. Permanent impacts resulting from the placement of structural support shafts include the potential to increase base flood elevations. In addition, the placement of structural support shafts at this location directly in the main flow section (thalweg) where the river bends around the east side of the Burnside Bridge would likely exacerbate the already increased local scour evident at the existing Eastbank Esplanade. This scour has the potential to affect local pier scour on the proposed bridge as well as mobilize contaminated sediments when compared to the No-Build Alternative.

Table 2. Estimated Floodway Encroachment

Alternative	Total Lateral Surface Area (sq ft)[a]	Change Compared to Existing (sq ft)[b]	Floodway Cross-Sectional Area (sq ft)	Percent of Floodway Occupied by Permanent Structures	Percent Increase Compared to Existing
No Change					
No-Build (existing)	11,213	-	65,683	17	-
Lower Impact					
Retrofit	11,394	181	65,683	17	0
Long-Span Alternative[c] – vertical lift	11,105	-107	65,683	17	0
Short-Span Alternative – vertical lift	11,783	570	65,683	18	1
Couch Extension – vertical lift	12,583	1370	65,683	19	2
Higher Impact					
Long-Span Alternative[c] – bascule lift	15,159	3,946	65,683	23	6
Short-Span Alternative – bascule lift	15,447	4,234	65,683	24	7
Couch Extension – bascule lift (highest impact)	15,428	4,216	65,683	23	6

Source: Existing base flood elevation of 32 feet (FEMA 2010).

[a] Total lateral surface area: In contact with the flow of the water at base flood elevation.

[b] Total increase in lateral surface area: difference between proposed lateral surface area and existing lateral surface area.

[c] The Long-span Alternatives were analyzed using the tied-arch configuration. Cable-stayed configurations would have similar impacts.

sq ft = square feet

Table 3. Estimated Percent Increase in Scour Length [a]

Alternative	Pier 1 [b]	Pier 2	Pier 3	Pier 4
No Change				
No-Build (existing)	-	-	-	-
Lowest Increase				
Long-Span Alternative[c] – bascule lift	-	15	15	-100
Long-Span Alternative[c] – vertical lift	-	15	15	-100
Short-Span Alternative – vertical lift	-	15	15	56

Table 3. Estimated Percent Increase in Scour Length [a]

Alternative	Pier 1 [b]	Pier 2	Pier 3	Pier 4
Medium Increase				
Couch Extension – bascule lift	-	43	43	109
Couch Extension – vertical lift	-	15	15	109
Short-Span Alternative – bascule lift	-	43	43	56
Highest Increase				
Retrofit (highest impact)	42	116	116	66

Source: Lengths sourced from respective design plan sets (Multnomah County) and measured in Bluebeam.

[a] Percent increase calculated based on percent increase in footing length compared to existing condition.

[b] The scour analysis is based on footprint size change to each pier. It is assumed for the Replacement Alternatives that Pier 1 would be cut off but that the footing would remain in place; therefore, no resulting change in scour is anticipated. For the Retrofit Alternative, Pier 1 would be extended and the estimated change in scour is shown in the table.

[c] Long-span Alternatives were analyzed using the tied-arch configuration. The cable-stayed configurations would be anticipated to have similar in-channel impacts.

Indirect

No indirect impacts to hydraulics are expected, but without mitigation, the Project could possibly result in changes to the channel morphology during high-flow events. However, if the Project could be designed to minimize or prevent increase in the base flood elevation, no long-term changes to the channel morphology are expected. This potential will be evaluated in greater detail during the bridge type determination study.

7.1.3 Enhanced Seismic Retrofit Alternative

The Retrofit Alternative involves the complete underwater rebuild of the piers and reinforcement of their foundations, which would extend below existing landforms and riverbed to increase seismic resiliency. All of the supporting bents (piers with multiple footings) and the two abutments would be replaced or retrofit in their current locations. This Alternative has similar amounts of lateral surface area in the floodway as the existing bridge piers, but it would have significantly larger footprint lengths that extend along the direction of the flow.

Compared to the other Build Alternatives, this Alternative has the following impact potential:

- Floodway encroachment (Table 2): Second Lowest
- Scour increase (Table 3): Highest
- Floodplain encroachment outside of floodway (Table 4): Highest

Table 4. API Floodplain Encroachment (Outside of the Floodway)

Proposed Alternative	West Approach (ft)	East Approach (ft)	Design Total (ft)
No Change			
No-Build (existing)	180	61	241
Lower Impact			
Couch Extension	158	128	286
Long-Span Alternative – cable-stayed	111	47	158
Long-Span Alternative – tied-arch	106	12	118
Short-Span Alternative	158	96	254
Higher Impact			
Retrofit	299	125	424

7.1.4 Replacement Alternative with Short-Span Approach

The Short-span Alternative with either the bascule or vertical lift movable span would have a greater area of permanent structure proposed in the floodway than the No-Build Alternative, as well as larger footings than the existing structure. The bascule lift proposes the most significant increases in both length and width of piers in the main channel. The exposed lateral surface area of the in-water structures resulting from the bascule lift would have the greatest potential to increase base flood elevations, as compared to the vertical lift.

Both lift options could increase the constriction effect of piers by increasing the velocity of the water and shear stress on the riverbed. Also, the longer length of the footings has the potential to increase the local pier scour patterns, ultimately increasing the potential to mobilize contaminated sediments when compared to the No-Build Alternative.

The Short-span Alternative with bascule lift proposes both the largest footprint and lateral surface area in the main channel among the Replacement Alternatives. The Short-span Alternative with a vertical lift has smaller foundational support elements than the bascule option and places the same number of structures in the main channel of the river.

Short-Span Alternative with Bascule Lift

- Floodway encroachment (Table 2): Highest
- Scour increase (Table 3): Medium
- Floodplain encroachment outside of floodway (Table 4): Lower

Short-Span Alternative with Vertical Lift

- Floodway encroachment (Table 2): Lower
- Scour increase (Table 3): Lower
- Floodplain encroachment outside of floodway (Table 4): Lower

7.1.5 Replacement Alternative with Long-Span Approach

The Long-span Alternative has two proposed vertical support options above the bridge deck, a cable-stayed option or a tied-arch option, in addition to a movable center span option. The Long-span Alternative would place fewer bent and pier structures in the main river channel than the other Build Alternatives, eliminating Piers 1 and 4 of the existing bridge and Retrofit Alternative bridge design. The vertical lift option proposes the smallest permanent structure footprint, and, therefore, could have the least potential to impede conveyance and encroach on the floodplain. The footings are longer in the direction of the flow which could increase the potential for pier scour as compared to the No-Build Alternative. The Long-span Alternative would place the fewest structures in the channel, and the vertical lift option would have the lowest potential for increasing the base flood elevation and scour among the Build Alternatives. A cable-stayed bridge type would place fewer shafts in the 500-year floodplain outside of the mapped floodway than the Short-span or Couch Extension Alternatives, but more than the tied-arch type, which would have the lowest floodplain encroachment outside the floodway among any of the Build Alternatives.

Compared to the other Build Alternatives, this Alternative has the following impact potential:

Long-Span Alternative with Bascule Lift

- Floodway encroachment (Table 2): Higher
- Scour increase (Table 3): Lowest

Long-Span Alternative with Vertical Lift

- Floodway encroachment (Table 2): Lowest
- Scour increase (Table 3): Lowest

Long-Span Alternative with Cable-Stayed Support

- Floodplain encroachment outside of floodway (Table 4): Lower

Long-Span Alternative with Tied-Arch Support

- Floodplain encroachment outside of floodway (Table 4): Lowest

7.1.6 Replacement Alternative with Couch Extension

The Couch Extension Alternative is composed of the same west approach and movable span options as the Short-span Alternatives, with a split configuration for the east approach section connecting the Burnside/Couch couplet over the river. The split configuration results in a slightly larger lateral surface area and foundational footprint than the Short-span Alternative. The Couch Extension with the bascule lift is estimated to have the second highest change in lateral surface area across the channel cross section, resulting in the highest potential for increasing the base flood elevation. The potential for scour and the impacts to the floodplain outside of the floodway would be lower when the

Couch Extension is paired with a vertical lift movable span based on footing size and placement of fewer bents along the east and west approach floodplains.

Compared to the other Build Alternatives, this Alternative has the following impact potential:

Couch Extension with Bascule Lift

- Floodway encroachment (Table 2): Second Highest
- Scour increase (Table 3): Medium
- Floodplain encroachment outside of floodway (Table 4): Lower

Couch Extension with Vertical Lift

- Floodway encroachment (Table 2): Medium
- Scour increase (Table 3): Lowest
- Floodplain encroachment outside of floodway (Table 4): Lower

Couch Extension Bike, Pedestrian, and ADA Access

The Couch Extension configuration of the bike, pedestrian, and ADA access ramp to connect the bridge to the Eastbank Esplanade in its preliminary design stage would place several more support shafts within the main channel of the river than other Build Alternatives would, resulting in a larger amount of exposed lateral surface area of the in-water structures. Permanent impacts resulting from the placement of structural support shafts include the potential to increase base flood elevations. In addition, the placement of structural support shafts at this location directly in the main flow section (thalweg) where the river bends around the east side of the Burnside Bridge would likely exacerbate the already increased local scour evident at the existing Eastbank Esplanade. This scour has the potential to affect local pier scour on the proposed bridge as well as mobilize contaminated sediments when compared to the No-Build Alternative. This would also be anticipated to result in greater hydraulic impacts, as compared to the configuration common to all other Build Alternatives.

7.2 Post-Earthquake Impacts

This section discusses the potential effects to hydraulics and flooding during and after a CSZ earthquake, including immediate effects as well as longer term recovery.

7.2.1 No-Build Alternative

The existing Burnside Bridge is expected to be rendered unusable in the event of a magnitude 8+ CSZ earthquake. The simulated structural failure predicts that the piers and fixed spans would fall into the river’s main channel, obstructing the flow of water and creating a barrier to river traffic and emergency response efforts. The collapse of these structures could result in the liquefaction of soils and landslides which would instantly mobilize massive amounts of potentially contaminated sediments downstream into the Columbia River and potentially the Pacific Ocean (the EQRB Hazardous Materials Technical Report [Multnomah County 2021c] provides a detailed discussion of sediment contamination). The flows resulting from the constriction created by the bridge debris would significantly affect flooding, scour, and the integrity of all other structures downriver that might remain intact. The collapse of the bridge would create barriers both in the river and on land that could delay recovery efforts for months while debris is cleared and removed. The navigation and transportation obstacles to the recovery efforts could delay the regional recovery for years.

7.2.2 Enhanced Seismic Retrofit Alternative

The Retrofit Alternative has been designed for a minimum of 100-year life design and involves the retrofit and replacement of seismically vulnerable elements in order to improve structural viability, and to be usable immediately after the next major CSZ earthquake. However, some original elements of the existing bridge are nearly 100 years old and could have an increased potential to deposit materials during a major earthquake into the river channel compared to the Replacement Alternatives. The risk of post-earthquake material deposits into the channel from the Retrofit Alternative is very low, but higher than with the Replacement Alternatives. If it does occur, the effects would be significantly less than that of the No-Build Alternative, as the No-Build Alternative is expected to collapse into the Willamette River.

7.2.3 Impacts Common to all Build Alternatives

All of the Build Alternatives were designed to facilitate an immediate emergency response after a CSZ earthquake. It is anticipated that the other Willamette River bridges in downtown would be heavily damaged, or inaccessible, thus being unusable after the event. A seismically resilient Burnside Bridge could be the only usable crossing for months and would serve as a crucial link for emergency vehicle and civilian access. Additional debris clearing and inspections may be required after initial life-saving measures have been concluded to minimize the extent to which debris from upstream structural failures could create hazardous conditions or compromise accessibility around the new bridge alternatives. The Build Alternatives, and especially the Long-span Alternative, are all anticipated to have the lowest risk for structural failure and associated deposition of bridge material into the river channel, resulting in the fewest hydraulic impacts.

7.3 Construction Impacts

7.3.1 Without Temporary Bridge

Impacts Common to All Alternatives

The Retrofit and Replacement Alternatives would use cofferdams to isolate the underwater structures and associated work zones for the main channel piers as well as contractor work bridge platforms to access them, which would include temporary pile bents extending out to and around the river piers. The placement of these work-related structures is expected to temporarily increase the base flood elevation and scour lengths during construction. Also, any potential impacts associated with the temporary bridge are avoided with the No Temporary Bridge Option.

The east approach bridge access point for bike, pedestrian, and ADA access connecting the bridge to the Eastbank Esplanade would involve the excavation and removal of contaminated soils in the main channel of the river and in the riparian areas. In-water work to construct the ramp would include the use of cofferdams and a seal course, pile driving, and the placement of the support shafts. These activities would temporarily increase the potential for contraction scour and mobilization of contaminated sediments in the near-shore area during construction, in an area where previous scour effects have been noted.

Enhanced Seismic Retrofit Alternative

The Retrofit Alternative would require relocation of city sewer pipe systems and removal and replacement of a portion of the harbor wall that is recessed into Waterfront Park on the west side of Pier 1. The enlarged pier footing and the new shafts associated with this Alternative could conflict with piles that support the harbor wall and could require the use of a cofferdam during demolition and reconstruction. Use of a cofferdam is expected to increase the base flood elevation and scour lengths during construction. In the main channel, the Retrofit Alternative would involve enlarging and strengthening the existing foundations rather than replacing them, which is anticipated to cause less disruption and suspension of contaminated soil sediments compared to the In-kind or Couch Extension Alternatives.

The Retrofit Alternative would require foundational and ground improvements which would require full demolition at Pier 4, Bents 21, 22, and 24, and partial demolition at Bents 25, 26, and 27 along the east approach span. A cofferdam could be needed to remove the pier in the dry, which could increase the base flood elevation and scour. The Retrofit Alternative would replace the existing Pier 4 with a new pier approximately 34 feet to the west of the current Pier 4 to avoid the constructability restrictions. It could constrict flows by obstructing more lateral surface area in the main channel flows and could increase scour lengths around pier footings in an area where previous scour affects have been noted.

Replacement Alternative with Short-Span Approach

The Short-span Alternative would replace 19 bents with 6 larger shafts drilled farther down into stable soils with less risk of liquefaction on the west approach span. The ground improvements would encompass Bent 6 with a cofferdam, as well as extend in front of existing Pier 1 and under the harbor wall. It is anticipated that proposed jet grouting for stabilization could damage existing timber pile foundations and would require replacement of the harbor wall in this area. Pending the results of a boring investigation, the ground improvements at Bent 6 could be moved to the other side of the bent which would eliminate the impacts to the harbor wall, sewage pipes, and Pier 1. Eliminating the need to reconstruct the harbor wall, sewage pipes and Pier 1 would reduce the potential for the cofferdam to obstruct flows and construction to suspend and mobilize potentially contaminated sediments in the riverbed surface.

The main channel portion of the Short-span Alternative would require destruction of the current pier substructure. The new foundations would be built through and around the current substructure within cofferdams. The footings are significantly larger than those that currently exist and could result in the cofferdam area obstructing flow, contributing to a rise of base flood elevations and an increase in scour potential during construction. The east approaches are identical among the Short-span Alternatives (bascule and vertical) east of 2nd Avenue and would have the same impacts during construction.

Replacement Alternative with Long-Span Approach

The Long-span Alternative would use longer fixed bridge spans on both the east and west approaches. The principal advantage of the Long-span Alternative is the elimination of four intermediate bents as compared with the Short-span Alternative, including two from in the main channel. As a result, the Long-span Alternative reduces the potential risk for sediment mobilization associated with constructing foundations within areas of complex subsurface conditions. Another benefit of using a longer span approach is the elimination of the bent construction within Waterfront Park near the harbor wall. This would reduce construction impacts to the existing harbor wall and the attached sewage lines by eliminating ground improvements at the west approach, which could also be expected to reduce the potential for mobilization of contaminated sediments. Spanning the waterway and existing I-5 and I-84 structures on the east approach would eliminate one intermediate bent support within the waterway, and it would avoid cumulative impacts with the I-5 and I-84 structures for which associated scour patterns have been identified, which would reduce in-water construction activities and could reduce the mobilization of sediments. The tied-arch type would place one less bent along the west approach and two fewer bents along the east approach within the floodplain outside the floodway than the cable-stayed type would, which would have fewer associated impacts during construction.

Replacement Alternative with Couch Extension

The Couch Extension is identical on the west approach and main channel spans to the Short-span Alternative and could be expected to have the same construction-related impacts. The use of a seal course for cofferdam dewatering would be needed for the main channel bent locations and would have the same impacts as anticipated for the Short-span Alternative construction activities. The east approach would consist of two separate bridge structures to the east of Bent 9, with bents and spans denoted as north (N) and south (S). The structure would flare across Span 8 to accommodate the diverging horizontal alignments. The southeast structure configuration would follow the same logic as the Short-span Alternative and would have similar construction impacts. The northeast structure would be on a new alignment that does not exist today and could be supported on a reduced-column configuration due to the reduced bridge widths. The placement of additional footings and structures in the area between Pier 3 and the Eastbank Esplanade, where scour patterns have been identified, could increase local scour length potentials.

7.3.2 With Temporary Bridge

Impacts Common to All Alternatives

The impacts associated with the construction of the temporary bridge would include all the construction impacts described for the respective Alternatives without a temporary bridge, plus the impacts for placement of an additional temporary detour bridge in the main channel of the river. The estimated amount of floodway encroachment associated with the temporary bridge is presented in Table 5. The supporting calculations are detailed in Appendix A with a complete list of assumptions.

Table 5. Estimated Temporary Floodway Encroachment

Alternative	Floodway Cross-Sectional Area (sq ft)	Permanent Bridge		Temporary Bridge		Work Bridge		Total Percent of Floodway Occupied
		Total Lateral Surface Area (sq ft)[a]	Percent of Floodway Occupied	Total Lateral Surface Area (sq ft)	Percent of Floodway Occupied	Total Lateral Surface Area (sq ft)[a]	Percent of Floodway Occupied	
No Change								
No-Build (existing)	65,683	11,213	17	-	-	-	-	17
Lowest Impact								
Retrofit	65,683	11,394	17	3,000	5	3,920	6	28
Long-Span Alt.[(c)] – vertical lift (lowest impact)	65,683	11,105	17	3,000	5	3,640	6	28
Medium Impact								
Couch Extension – vertical lift	65,683	12,583	19	3,000	5	3,780	6	30
Short-Span Alt. – vertical lift	65,683	11,783	18	3,000	5	3,640	6	29
Highest Impact								
Couch Extension – bascule lift	65,683	15,349	23	3,000	5	3,780	6	34
Long-Span Alt.[(c)] – bascule lift	65,683	15,159	23	3,000	5	3,640	6	34
Short-Span Alt. – bascule lift (highest impact)	65,683	15,447	24	3,000	5	3,640	6	35

Source: Existing Base Flood Elevation of 32 feet (FEMA 2010).

[a] Total Lateral Surface Area: In contact with the flow of the water at base flood elevation

[b] Total Percent of Floodway Occupied: sum of proposed permanent and temporary lateral surface area floodway encroachments of floodway cross-sectional area.

[c] The Long-span Alternatives were analyzed using the tied-arch configuration. Cable-stayed support configurations would have similar impacts.

Alt. = Alternative

During construction, the base flood elevation could temporarily increase when cofferdams are placed to surround existing and proposed footprints for permanent piers and for construction of the temporary work bridge. These actions could result in impacts to the water surface elevation of the river which would likely rise in response during the stages of placement. The temporary water surface elevation impacts would then likely decrease when temporary construction features are removed. Hydraulic modeling would be conducted at a later phase to calculate base flood elevation impacts during construction.

7.3.3 Potential Off-Site Staging Areas

The construction contractor may use one or more off-site staging areas, outside the bridge study area to store and and/or assemble materials that would then be transported by barge to the construction site. Off-site staging could occur with any of the alternatives. Whether, where, and how to use such sites would be the choice of the contractor and therefore the actual site or sites cannot be known at this time. Given this uncertainty, detailed analysis of impacts is not possible at this time. To address this uncertainty, four possible sites have been identified that represent a much broader range of potential sites where off-site staging might occur. While the contractor could choose to use one of these or any other site, it is assumed that because of regulatory and time constraints on the contractor, any site they choose would need to be already developed with road and river access. It is also assumed that the contractor would be responsible for relevant permitting and/or mitigation that could be required for use of a chosen site. The Draft EIS evaluates hydraulic impacts that could occur from off-site staging, based on the above assumptions. This analysis is not intended to “clear” any specific site, but rather to disclose potential hydraulic impacts based on the possible sites.

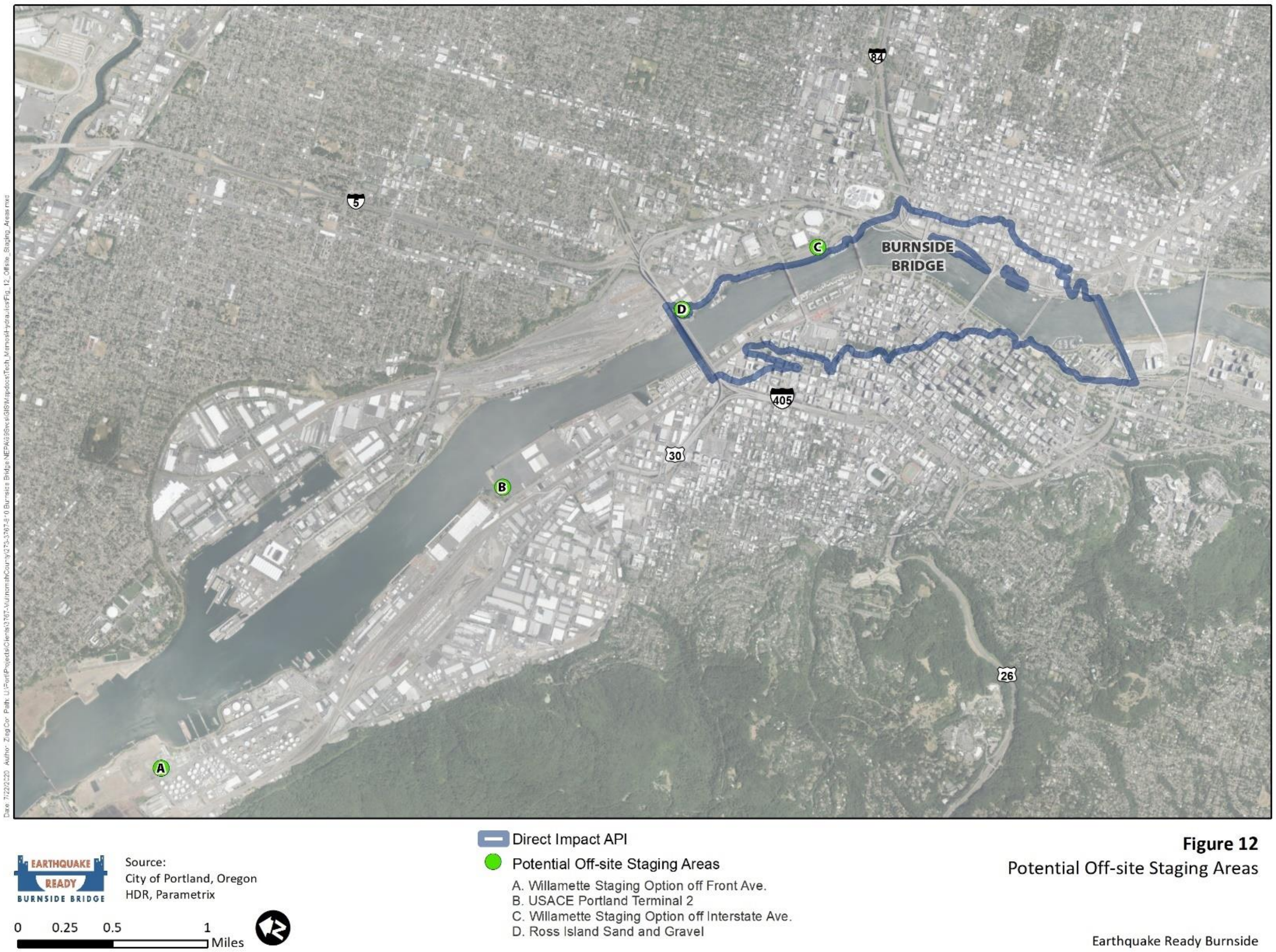
The four representative sites shown in Figure 12 include:

- A Willamette Staging Option off Front Avenue
- B USACE Portland Terminal 2
- C Willamette Staging Option off Interstate Avenue
- D Ross Island Sand and Gravel Site

As shown in Figure 12, all of the currently identified potential off-site staging areas would be located outside the hydraulic impacts API and the enclosed 100-year floodplain. However, even if a new location inside the API boundary were identified, if the assumptions hold that any potential off-site staging area would already be developed and no additional regrading or other fill would occur, no hydraulic impacts are expected.

If a contractor chooses to use an off-site staging area that is located within the 100-year floodplain, the regulations outlined in Section 4.1 of this report could apply.

Figure 12. Willamette River Depths and Scour Patterns



Source: City of Portland, Oregon, HDR, Parametrix

7.4 Cumulative Effects

7.4.1 No-Build Alternative

Development throughout the Willamette Valley Region has substantially altered the hydraulics of surface water resources, including construction of canals, locks, and a series of major dams in the Willamette River system. These activities evolved as the city experienced population growth and substantial urbanization, and the river channel has been modified to accommodate commercial and industrial traffic, control flooding, store water, and generate electrical power. Notable projects that have already completed construction in the present condition and have a cumulative effect on the river's hydrology include the Eastbank Esplanade, the Duckworth Memorial Dock, and the I-5 and I-84 waterway support structures. These projects contribute to an increase in obstruction and displacement of flow, potential scour length, and energy losses for the flow in the river's main channel. The river channel would continue to experience the cumulative hydraulic impacts from these structure modifications and other future development under the No-Build Alternative.

7.4.2 Build Alternatives

The river channel would continue to experience the cumulative hydraulic impacts from existing structure modifications under each of the Build Alternatives. The hydraulic impacts analysis discussed in Section 7.1 includes past and present impacts and shows the contribution of the Project Alternatives to the effects.

7.5 Compliance with Laws, Regulations, and Standards

Each of the Build Alternatives could potentially result in an increase in the base flood elevation. Following review of the EIS and selection of a Preferred Alternative, the bridge design would be advanced, detailed hydraulic modeling of the channel would be conducted to determine the precise base flood elevation impact, and results would be documented in a technical hydraulic design report that could support a no-rise certification.

Construction within the Special Flood Hazard Area requires a permit from the City of Portland to ensure floodplain protection requirements are met. Outside of the floodway, construction must balance cut and fill at or below the protected 100-year flood elevation. Within the floodway, if bridge piers are found to create a net rise, the pier design must be altered or conveyance mitigation must be included to bring the net rise back to zero. With any impact resulting in base flood elevation increase, the Project would either be required to provide conveyance offsets or could request approval from the City for revision to the regulated base flood elevation to accommodate the new bridge piers. A Conditional Letter of Map Revision would be required for FEMA flood insurance maps.

FHWA outlines procedures for compliance with Floodplain Management Presidential Executive Order 11988 through 23 Code of Federal Regulations (CFR) 650 – Bridges, Structures, and Hydraulics, which include the following requirements:

- 650.109 Public involvement – Provide opportunity for early public review and comment on alternatives which contain encroachments, also including procedures outlined at 23 CFR part 771.
- 650.111 Location hydraulic studies – Identify location of potential floodplain encroachment, evaluate and discuss practicability of alternatives and support of probable incompatible floodplain development commensurate with the significance of the risk or environmental impact, identify and evaluate measures to minimize floodplain impacts associated with the action. The studies required by 650.111must be summarized in environmental review documents and local, state, and federal agencies must be consulted to determine if the proposed highway action is consistent with existing floodplain management programs.
- 650.113 Only practicable alternative finding – A proposed action that includes a significant encroachment (such as construction of bridge piers in the floodway) will not be approved unless the FHWA finds that the proposed significant encroachment is the only practicable alternative. The FHWA finding must be included in the final environmental document (Final EIS) or finding of no significant impact, which must include reasons why the proposed action must be located in the floodplain, alternatives considered and why they were not practicable, and discussion of whether the action conforms to applicable state or local floodplain protection standards.
- 650.115 Design standards – The selected design must be supported by analyses of alternatives considering capital costs, risks, and other economic, engineering, social and environmental concerns.

For many of these elements complying with the National Environmental Policy Act would satisfy the process requirements; however, additional details will be presented in the Final EIS including modeling analysis of the floodplain and floodway impacts. The detailed analysis will be initiated sometime after a Preferred Alternative is identified.

7.6 Conclusion

All Build Alternatives' proposed pier designs are anticipated to create some degree of hydraulic encroachment and result in an increase in the base flood elevation as well as an increased scour potential which could result in the mobilization and transport of contaminated sediments present in the riverbed. Detailed modeling analysis would be initiated after a Preferred Alternative is selected to identify design changes that would avoid these impacts. If impacts could not be avoided through design, the Project would coordinate with the City to comply with floodplain impact regulations and scour prevention and monitoring measures and acquire federal approval of the impact.

8 Mitigation Measures

8.1 Measures Common to all Build Alternatives

The structural needs to create a seismically resilient bridge all include larger (wider and longer) in-water structures than the existing structure, which could result in an unavoidable increase in the base flood elevation, scour at the piers or related in-water structures, and the potential to mobilize contaminated sediments. The level of seismic resiliency incorporated into each Build Alternative is expected to produce bridge structures that are insensitive to effects from local scour (i.e., changes in scour are not expected to weaken any of the Build Alternatives); however, scour will be carefully assessed in the design and necessary countermeasures incorporated in the design as needed to minimize the resulting hydraulic impacts which could affect the surrounding environment.

There are limited opportunities to mitigate hydraulic encroachment impacts associated with the Project because encroachment offsets need to occur at the same location as the encroachment. The minimization measures would focus on limiting an increase in base flood elevation, and reducing scour potential that could impact habitat and mobilize contaminated sediment. This could be accomplished by minimizing the number of in-water piers and streamlining the pier shape. Appropriate countermeasures would be developed after a Preferred Alternative is selected and completion of hydraulic design, detailed modeling, and scour analyses. The following are potential measures under consideration to minimize hydraulic impacts:

- Size the bridge pier structures to minimize increase in water surface elevation for the 100-year peak flood discharge.
- Lengthen the bridge spans to reduce the number of piers in the floodplain.
- Design pier shaping to minimize energy losses.

Scour countermeasures would reduce localized scour to decrease flow separation and the formation of vortices around piers. Countermeasures could include streamlining the pier nose shape; orienting the pier within 5 degrees of the flow direction to decrease scour depth; or using partially grouted rock protection around piers to smooth flowpaths and minimize scour. Design modifications to pier type, span length, and pier location could also mitigate for the greatest effects from pier related flow constrictions. Longer spans and placement of solid piers outside the channel thalweg could also reduce flow obstruction, reducing the potential for debris to become lodged and exacerbate obstructions that cause scour (FHWA 2011).

One approach to mitigating the potential transport of contaminated sediments could include expanding in-water construction cofferdams to match the scour limits and remove and replace contaminated soils. Another possible approach could include underwater soil removal and replacement outside of the pier cofferdams within the extent of the anticipated scour. The use of techniques to curtain off and isolate the work area could be less costly than the use of extended cofferdams. Selection of any combination of these mitigation measures would be contingent upon detailed modeling and scour analysis to determine the footprint of the scour.

Detailed modeling and scour analysis would be conducted before final design of the preferred alternative or bridge type to evaluate the potential impact on base flood elevation and the scour footprint more precisely. If modeling shows that the Project would result in an unavoidable increase to the base flood elevation, the project team could request a variance to the Portland Municipal Code no-rise standard based on PMC 24.50.060(D) Floodways and PMC 24.50.070 Appeals and Variances and could supply the City with information to apply to FEMA for a Conditional Letter of Map Revision under the provisions of 44 CFR 60.3(d)(4), 44 CFR 65.6, 44 CFR 65.7, and 44 CFR 65.12.

Separately from flood rise impacts and mitigation, the City of Portland requires a balance of cut and fill within the 100-year floodplain or the 1996 flood extent, whichever is more expansive.

8.2 Temporary Detour Bridge Option

The temporary bridge would create an added obstruction in the river's flow for up to 78 months and would have a risk of increasing the base flood elevation during construction compared to options with no temporary bridge that would not pose this associated risk. Following selection of a Preferred Alternative, the bridge design would be advanced, detailed hydraulic modeling of the channel (including the temporary bridge, if selected as part of the Preferred Alternative) would be conducted to determine the precise base flood elevation impact and potential velocities that could contribute to scour. Efforts to minimize temporary hydraulic impacts during construction would include implementing appropriate construction techniques, such as modifying the design to minimize the footprint and limiting in-water work and construction equipment to tasks that can only occur in water (temporary pier construction).

9 Contacts and Coordination

Project work will include public involvement and agency coordination. During the hydraulic impact analysis, the following organizations were contacted for data and other information related to hydraulics, floodplains, and scour:

- City of Portland Bureau of Environmental Services
- National Marine Fisheries Service
- Oregon Department of Transportation
- Oregon State Marine Board

Agencies and organizations were notified through the Federal Register and Project website of the intent to prepare an EIS. Participating agencies were provided the opportunity to review and comment on the hydraulic impacts analysis through the course of the Project. All agencies and stakeholders will have the opportunity to review the technical reports during the public comment period for the Draft EIS.

10 Preparers

Name	Professional Affiliation	Education	Years of Experience
Julie Brandt, PE	Parametrix	BS, Civil Engineering	23
Jeff Coop, PE	Parametrix	BS, Civil Engineering	32

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Appendix A. Preliminary Hydraulic Impact Estimates

Lateral Surface Area (sq ft)	Pier 1		Pier 2			Pier 3			Pier 4	
Alternative	**Footing**	**Column**	**Footing**	**Column**	**Pier Protection**	**Footing**	**Column**	**Pier Protection**	**Footing**	**Column**
Existing	0	717	1,492	3,422	0	1,487	3,491	0	171	434
Retrofit	482	485	1,509	3,380	0	1,567	3,428	0	71	471
Short Span-Bascule	0	495	3,710	3,180	216	3,710	3,238	221	57	620
Short Span-Lift	0	495	2,800	2,258	203	2,800	2,319	231	57	620
Long Span-Cable/Bascule	0	495	3,710	3,282	223	3,710	3,309	219	0	0
Long Span-Arch/Bascule	0	495	3,710	3,406	244	3,710	3,369	225	0	0
Long Span-Cable/Lift	0	495	2,800	2,258	203	2,800	2,319	231	0	0
Long Span-Arch/Lift	0	495	2,800	2,258	203	2,800	2,319	231	0	0
Couch-Bascule	0	495	3,710	3,238	223	3,710	3,270	213	59	511
Couch-Vertical Lift	0	495	2,800	2,579	252	2,800	2,776	272	59	550

Assumptions:
*Existing structure pier 1 conservative estimate asssumes entire column exposed and footing buried
*Retrofit Pier 1 estimate assumes entire column and partial proposed reinforcement footing exposed
*All replacement alternatives assume Pier 1 structure remains in place for estimate of exposed surface.
*Piers 2 and 3 for all alternatives assume bathymetry with 15 feet of footing is buried into the ground.
*Piers 2 and 3 for all alternatives assume bathymetry with 15 feet of footing is buried into the ground.
*Pier 4 assumed half of the respective sized struts and the entire columns are exposed.
*Retrofit Pier 4 invloves relocating the pier west into the channel.
*Long Span Lift Combinations are assumed to have the same sized elements as the Short approach span/Lift Combination, and the same configuration/ # of piers in the main channelas the Long Span Bascule Combination.

Floodway Calculations

Cross Section	Distance (miles)	Width (ft)	Cross sectional Area (sq ft)
P	12.3	1,144	70,636
Q	12.6	849	60,729
Burnside Bridge	12.4	997	65,683

Assumptions:
* distance is miles above mouth
*computed without consideration of influence from the Columbia River
* Burnside=average area of FEMA designated crosss sections P and Q

Two Dimensional Floodway Encroachment

Alternative	Pier 1	Pier 2	Pier 3	Pier 4	Total Lateral Surface Area	Total Increase in LSA (sq. ft.)	Floodway Cross sectional area (sq ft)	Percent of floodway occupied by permanent structures %	Percent Increase of occupied floodway %
Existing	717	4,914	4,979	604	11,213	0	65,683	17	0
Retrofit	968	4,889	4,995	543	11,394	181	65,683	17	0
Short Span-Bascule	495	7,106	7,169	678	15,447	4,234	65,683	24	6
Short Span-Lift	495	5,261	5,350	678	11,783	570	65,683	18	1
Long Span-Cable/Bascule	495	7,215	7,238	0	14,948	3,735	65,683	23	6
Long Span-Arch/Bascule	495	7,360	7,304	0	15,159	3,946	65,683	23	6
Long Span-Cable/Lift	495	5,261	5,350	0	11,105	-107	65,683	17	0
Long Span-Arch/Lift	495	5,261	5,350	0	11,105	-107	65,683	17	0
Couch-Bascule	495	7,171	7,193	570	15,428	4,216	65,683	23	6
Couch-Vertical Lift	495	5,631	5,847	609	12,583	1,370	65,683	19	2

Assumptions:
*Assume 32 foot BFE from FEMA
*Assume width of Floodway from FEMA, averaging the channel areas at cross sections P and Q.
*Total Increase in LSA = Proposed Lateral Surface Area-Existing Lateral Surface Area
*Percent of floodway occupied= (Total LSA /FW CSA)*100

Footing Length

Alternative	Plan View (ft)	Pier 1 Length Footing	Pier 2 Length Footing	Pier 3 Length Footing	Pier 4 Length Footing
Existing		71	122	122	68
Retrofit		101	264	264	113
Short Span-Bascule		71	175	175	106
Short Span-Lift		71	140	140	106
Long Span-Bascule		71	175	175	0
Long Span-Lift		71	140	140	0
Couch-Bascule		71	175	175	142
Couch-Vertical Lift		71	140	140	142

Assumptions:
*Existing Structure lengths sourced form record drawings (1924-02-21_Burnside As-Bulits)
*Retrofit Structure lengths sourced from Substructure Retrofit Layout design sheets and measured in Bluebeam.
*Long Span Lift Alternative assumed to have same size footings as the short span & couch connection Alternatives
*Long Span Lift Alternative is assumed to have same footing placement/configuration as Long Span Bascule Alt.
*Long Span Lift Alternative plan set has not been developed, so assumptions have been made through consultation with the design team lead Mark Libbey.
*Couch Alternatives lengths sourced from Replacement Moveable Bridge with Couch Connection design sheets for respective lifts and measured in Bluebeam.
*Couch Extension alternatives assume Pier 1 substructure remains in place for estimate of potential footing scour.
*Pier 1 footing length assumed to be the existing footing, with partial pier column removed, as pictured.

Scour Impacts

		Pier 1 Increase (ft)	Pier 2 Increase (ft)	Pier 3 Increase (ft)	Pier 4 Increase (ft)	Pier 1 % Increase	Pier 2 % Increase	Pier 3 % Increase	Pier 4 % Increase
Alternative									
Existing		0	0	0	0	0	0	0	0
Retrofit		30	142	142	45	42	116	116	66
Short Span-Bascule		0	53	53	38	0	43	43	56
Short Span-Lift		0	18	18	38	0	15	15	56
Long Span-Bascule		0	53	53	-68	0	43	43	-100
Long Span- Lift		0	18	18	-68	0	15	15	-100
Couch-Bascule		0	53	53	74	0	43	43	109
Couch-Vertical Lift		0	18	18	74	0	15	15	109

Assumptions:
Increase=Proposed footing length - Existing footing length
%Increase=(Increase/Existing Footing)*100

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY[2] (FEET NAVD)	WITH FLOODWAY[2] (FEET NAVD)	INCREASE (FEET)
WILLAMETTE RIVER								
A	0.38	1,600 / 846[4]	85,130	3.1	30.8	29.4	30.2	0.8
B	1.52	1,700 / 756[4]	113,090	2.3	30.9	29.5	30.3	0.8
C	3.03	2,073 / 1,273[4]	110,545	2.4	30.9	29.6	30.4	0.8
D	3.50	1,896	110,822	3.4	30.9	29.6	30.4	0.8
E	4.54	1,710	116,277	3.2	31.0	29.7	30.5	0.8
F	5.00	1,716	103,773	3.6	31.2	29.7	30.5	0.8
G	6.00	1,420	85,079	4.4	31.2	29.8	30.6	0.8
H	6.70	1,417	80,505	4.7	31.2	29.9	30.7	0.8
I	7.00	1,440	82,091	4.5	31.3	30.0	30.8	0.8
J	7.68	1,870	123,102	3.0	31.4	30.3	31.1	0.8
K	8.40	2,045	122,118	3.1	31.4	30.4	31.2	0.8
L	9.66	1,697	98,255	3.8	31.5	30.5	31.2	0.7
M	11.00	1,023	68,973	5.4	31.6	30.6	31.4	0.8
N	11.72	928	54,397	6.9	31.7	30.6	31.4	0.8
O	11.94	740	53,452	7.0	31.7	30.8	31.5	0.7
P	12.30	1,144	70,636	5.3	32.0	31.3	32.1	0.8
Q	12.62	849	60,729	6.2	32.1	31.3	32.1	0.8
R	12.99	1,197	67,540	5.6	32.3	31.7	32.4	0.7
S	13.16	1,295	69,242	5.4	32.4	31.8	32.5	0.7
T	13.33	1,378	66,329	5.7	32.4	31.8	32.6	0.8
U	13.51	1,339	69,350	5.4	32.5	31.9	32.7	0.8
V	13.73	1,339	69,350	5.4	32.6	32.0	32.7	0.7
W	13.84	1,371	73,934	5.1	32.7	32.1	32.9	0.8
X	14.00	1,585	73,405	5.1	32.7	32.2	32.9	0.7
Y	14.90	1,611[3]	68,291	5.5	33.1	32.7	33.2	0.5
Z	15.66	2,948[3]	122,470	3.1	33.3	33.0	33.9	0.9

[1]Miles Above Mouth
[2]Elevations computed without consideration of influence from Columbia River
[3]Width does not include island
[4]Width/width within City of Portland

TABLE 4

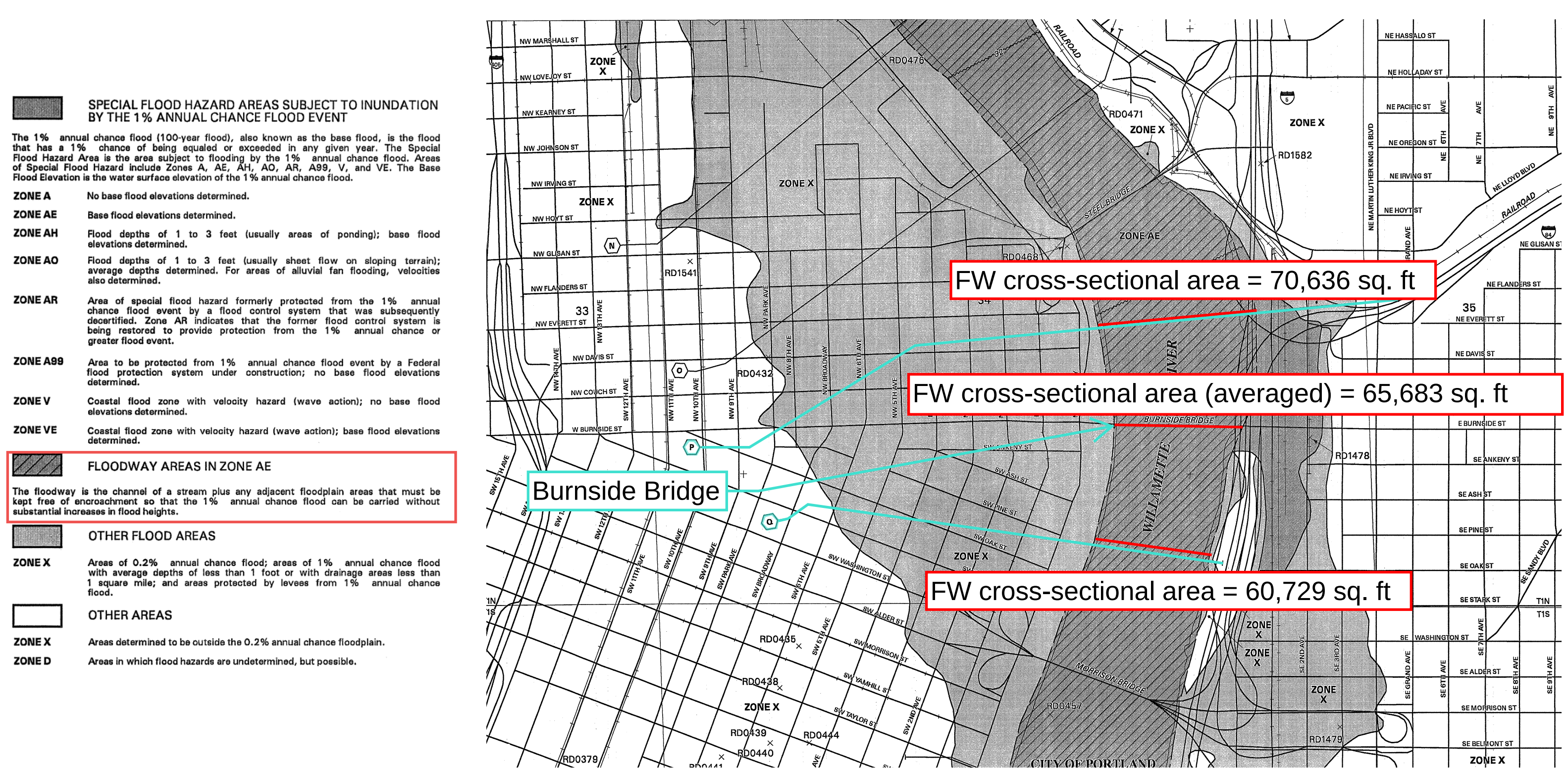
FEDERAL EMERGENCY MANAGEMENT AGENCY

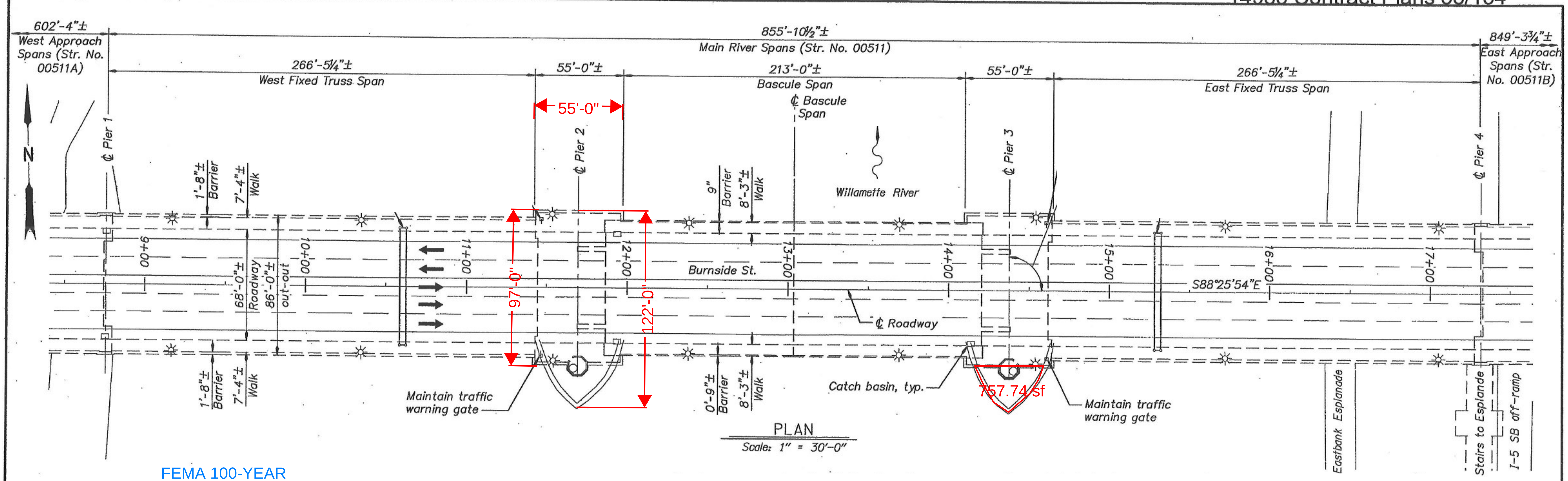
CITY OF PORTLAND, OR

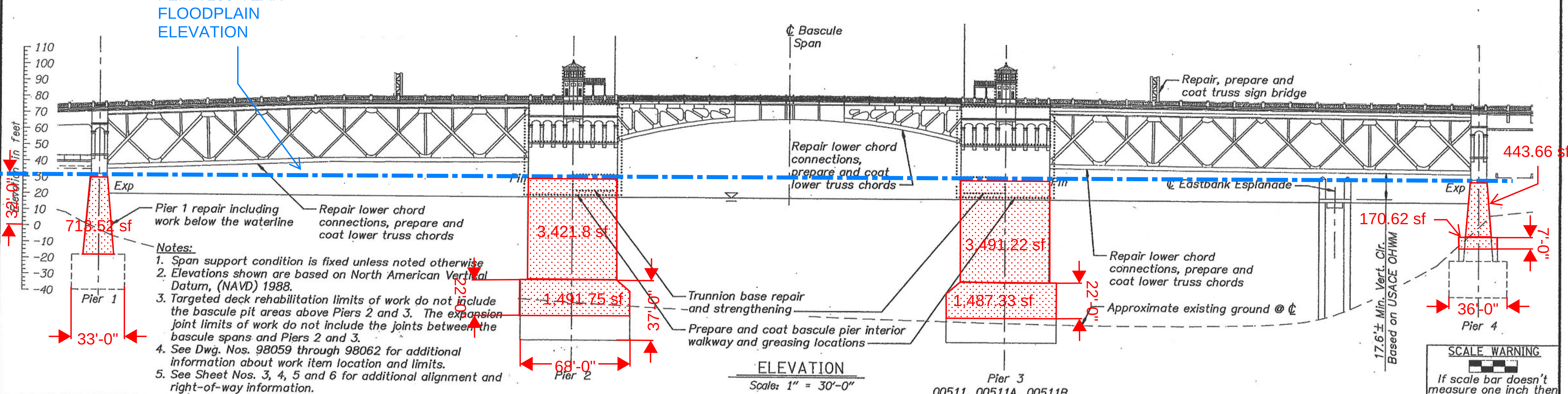
(MULTNOMAH, CLACKAMAS, AND WASHINGTON COS.)

FLOODWAY DATA

WILLAMETTE RIVER







Notes:

1. Span support condition is fixed unless noted otherwise.
2. Elevations shown are based on North American Vertical Datum, (NAVD) 1988.
3. Targeted deck rehabilitation limits of work do not include the bascule pit areas above Piers 2 and 3. The expansion joint limits of work do not include the joints between the bascule spans and Piers 2 and 3.
4. See Dwg. Nos. 98059 through 98062 for additional information about work item location and limits.
5. See Sheet Nos. 3, 4, 5 and 6 for additional alignment and right-of-way information.

SCALE WARNING

If scale bar doesn't measure one inch then drawing is not to scale

DATE	REVISION	BY

ACCOMPANIED BY DWGS. See Sheet 1 for this structure.

DRAFTER: Dustin Altenburg

DESIGNER: Douglas Lampkin

CHECKER: Matthew Harlan

REVIEWER: Terrence Stones

REGISTERED PROFESSIONAL ENGINEER 84352PE OREGON SEPTEMBER 14, 2010 DOUGLAS G. LAMPKIN

EXPIRES: 12-31-18

OREGON DEPARTMENT OF TRANSPORTATION

MULTNOMAH COUNTY BRIDGES — Connecting Commerce and Community

DAVID EVANS AND ASSOCIATES INC.

STRUCTURE NO. See above

DATE January – 2017

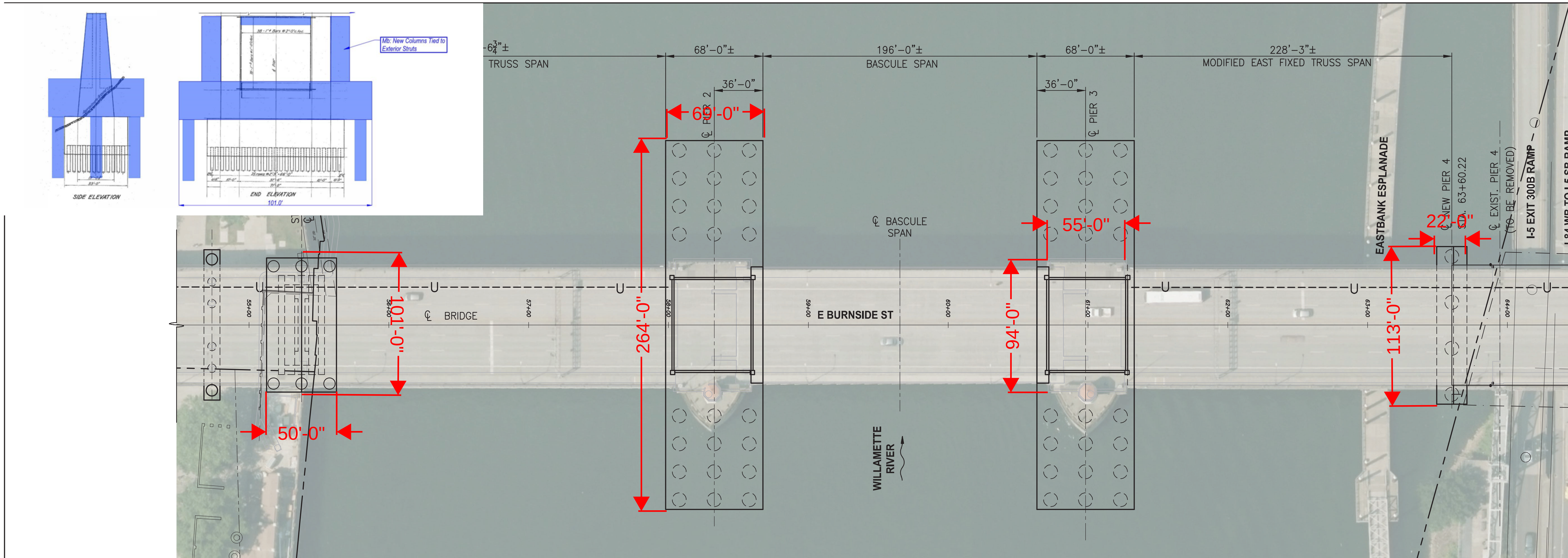
CALC. BOOK 6846-6848

BURNSIDE ST: WILLAMETTE RIVER BR
PAINT & REHAB PROJECT
BURNSIDE STREET
MULTNOMAH COUNTY

PLAN AND ELEVATION - 2

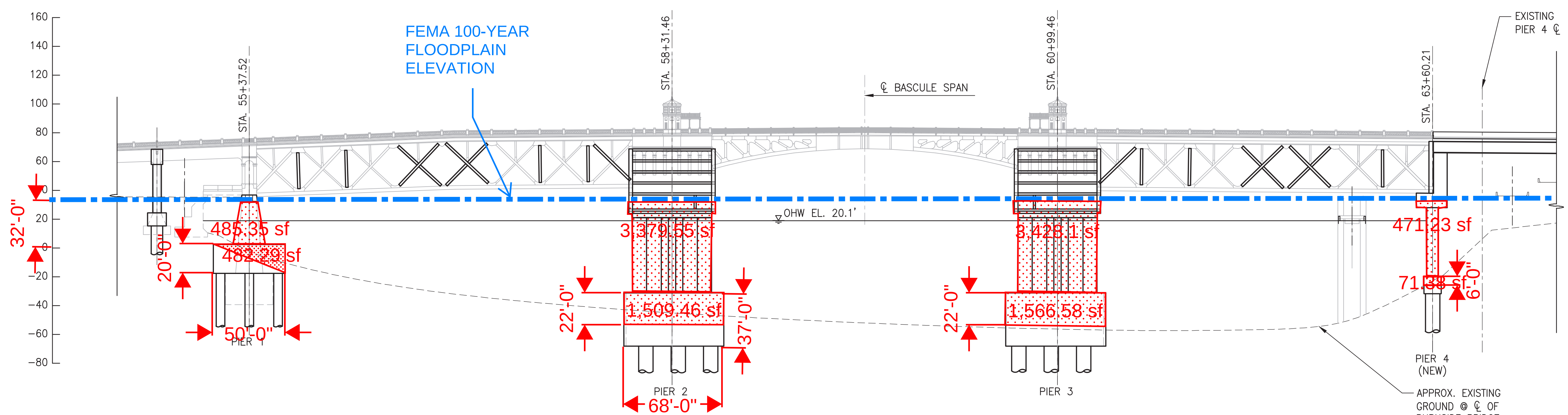
SHEET 2 OF 60

DRAWING NO. 98056



PLAN

SCALE: 1" = 40'



ELEVATION

SCALE: 1" = 40'

LEGEND:

EXISTING

RETROFIT

ROW

NOTES:

1. BASCULE LEAVES RETROFIT NOT SHOWN FOR CLARITY
2. GROUND IMPROVEMENT NOT SHOWN, SEE GEOTECHNICAL REPORT

CONCEPTUAL PLANS
JUNE 2020

EARTHQUAKE READY BURNSIDE BRIDGE

ENHANCED SEISMIC RETROFIT
SUBSTRUCTURE RETROFIT LAYOUT
RIVER SPANS

DATE: 1/31/20

PROJECT NO.: Proj No

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

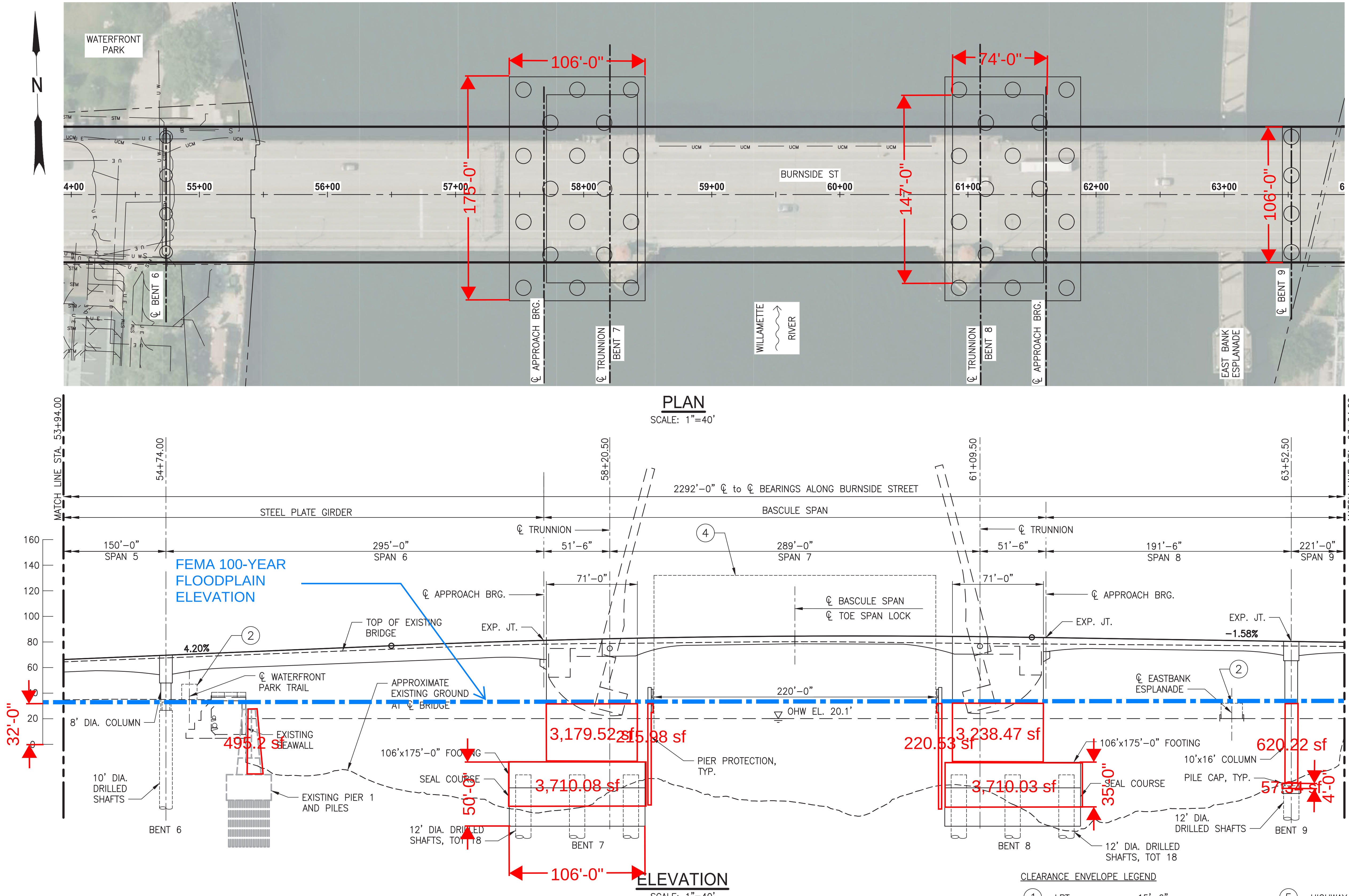
IAN B. CANNON P.E.
COUNTY ENGINEER

DESIGNED BY: BJS/CRK
DRAFTED BY: CRK/BRP
CHECKED BY: YY

REVISIONS

NO.	DATE:

Sheet No.
S05



CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x UNLIMITED H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Short-span Approach (Bascule)
MULTNOMAH COUNTY

PROJECT NO.:
DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

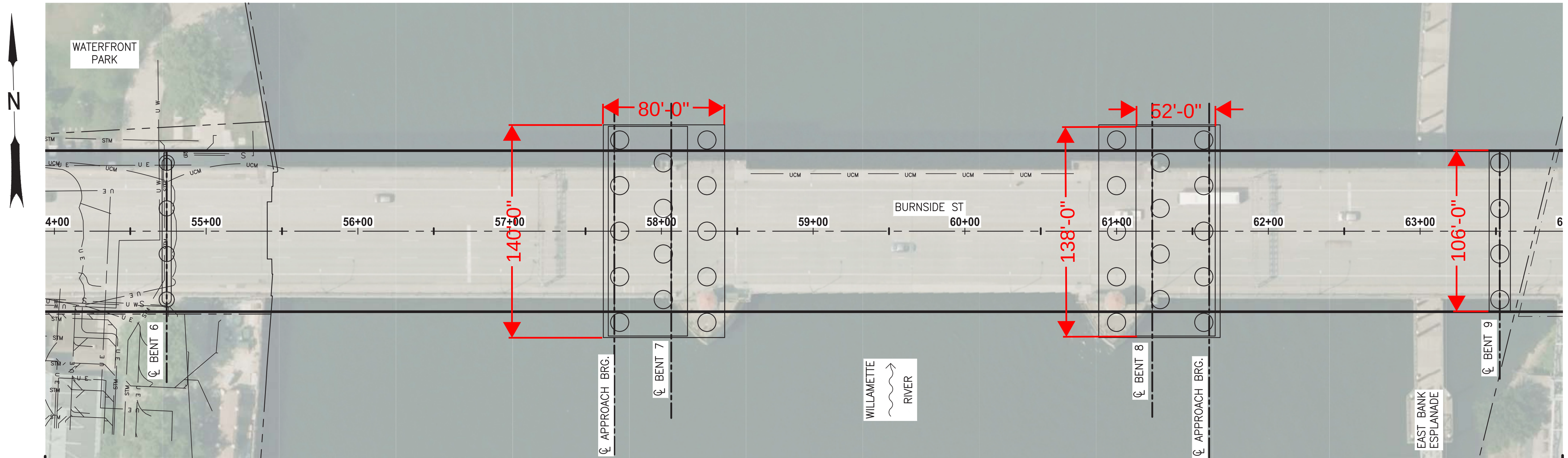
IAN B. CANNON P.E.
COUNTY ENGINEER

DESIGNED BY:
DRAFTED BY:
CHECKED BY:

REVISIONS

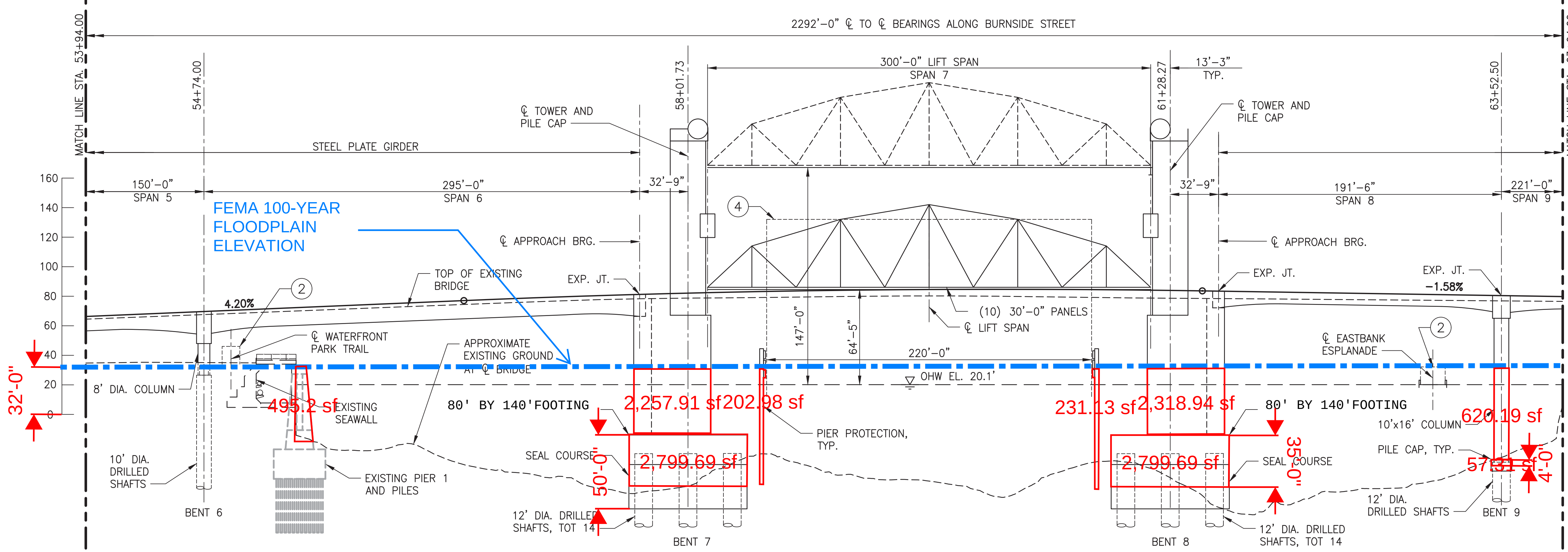
NO. DATE:

Sheet No. BR03



PLAN

SCALE: 1"=40'



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x 147'-0" H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge

Replacement Alternative with Short-span Approach (Lift)

MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E.
COUNTY ENGINEER

DESIGNED BY:

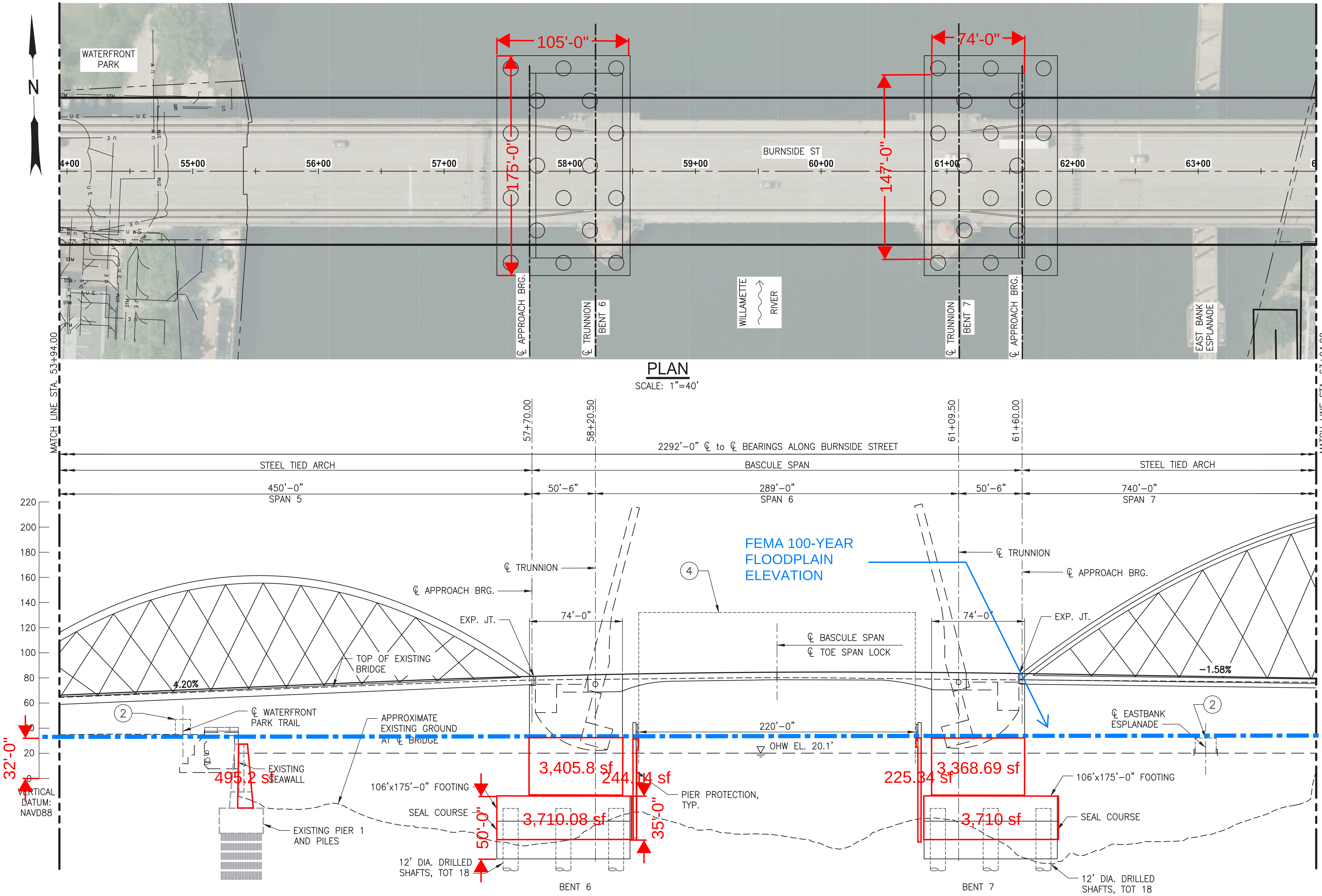
DRAFTED BY:

CHECKED BY:

REVISIONS

NO	DATE:	

Sheet No.
BR07



PLAN

SCALE: 1"=40'

ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x UNLIMITED H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Long-span Approach (Bascule)
MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

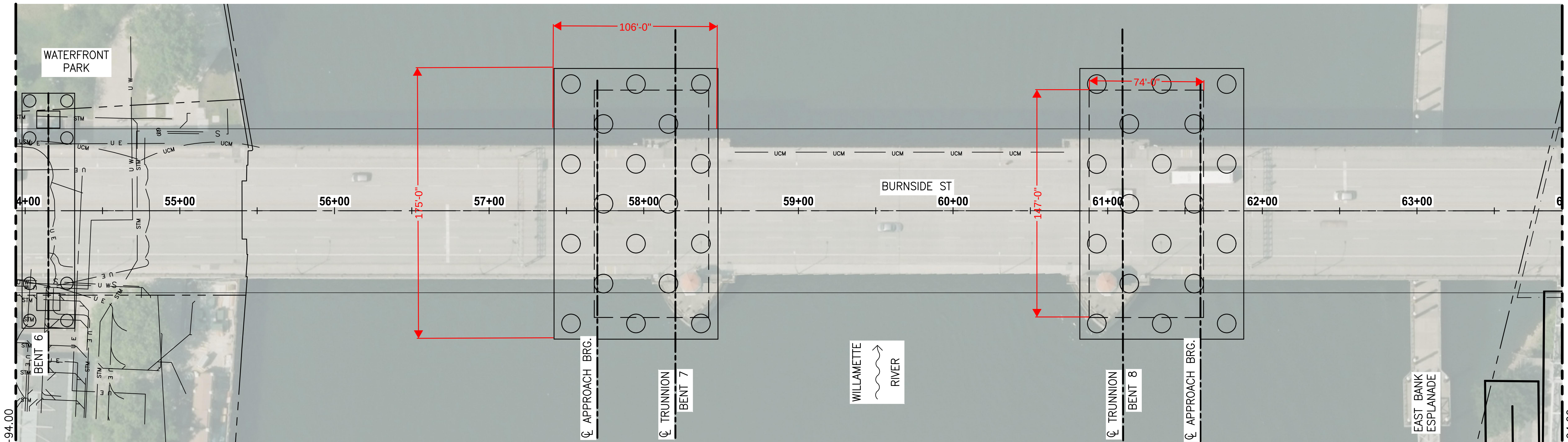
COUNTY ENGINEER
IAN B. CANNON P.E.

DESIGNED BY:
DRAFTED BY:
CHECKED BY:

REVISIONS

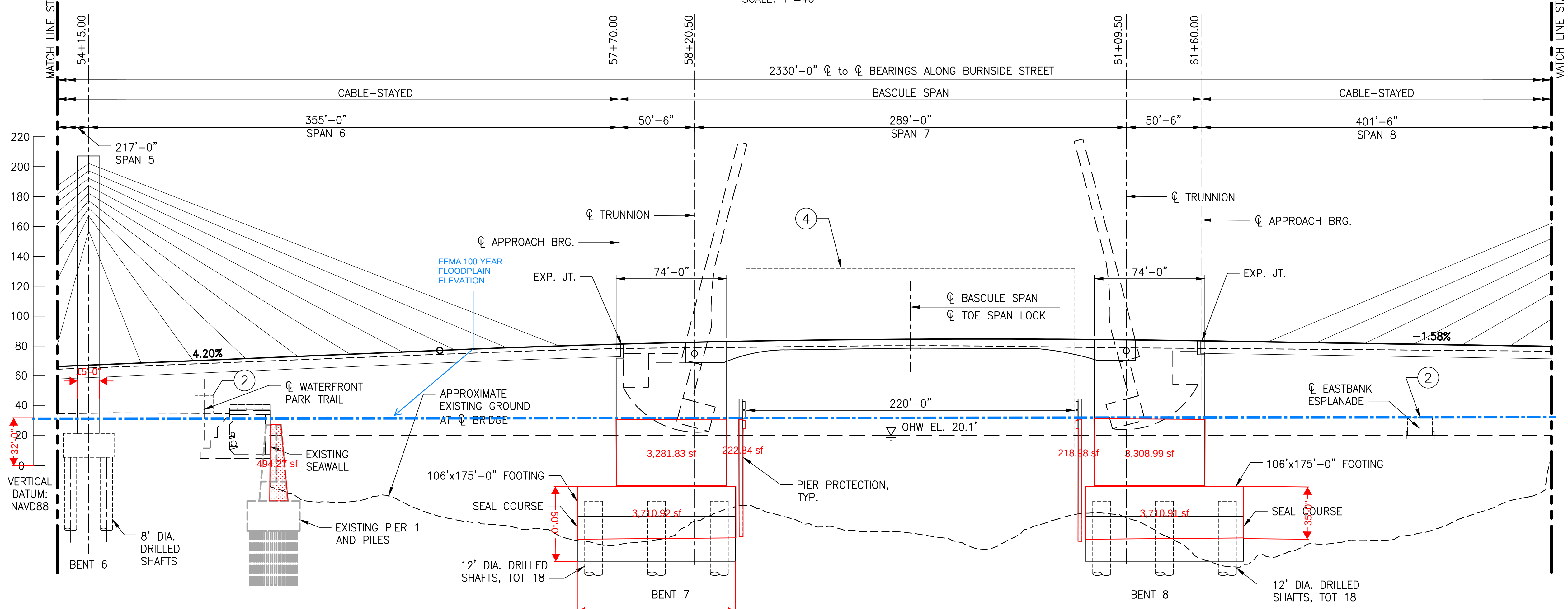
NO | DATE:

Sheet No.
BR11



PLAN

SCALE: 1"=40'



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x UNLIMITED H			

CONCEPTUAL PLANS
JANUARY 2020

Earthquake Ready Burnside Bridge
Replacement Movable Bridge (Bascule) With Long-Span Cable Approach on Existing Alignment
MULTNOMAH COUNTY

PROJECT NO.:
DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

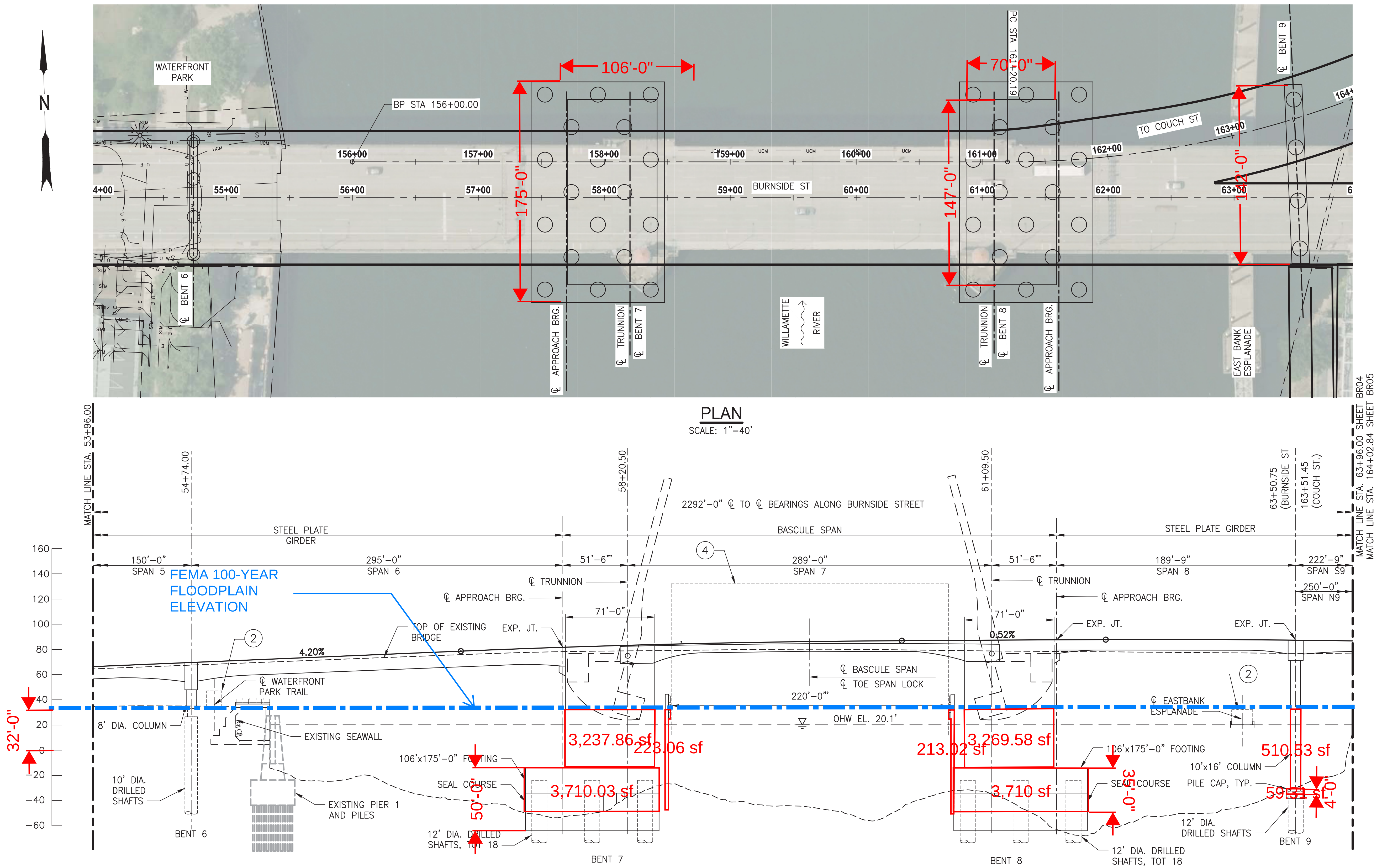
IAN B. CANNON P.E.
COUNTY ENGINEER

DESIGNED BY:
DRAFTED BY:
CHECKED BY:

REVISIONS

NO.	DATE:

Sheet No.
BR03



ELEVATION

SCALE: 1"=40'

NOTE:
EASTBOUND BRIDGE ELEVATION SHOWN, FOR WESTBOUND BRIDGE SEE SHEET BR05.

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"
2	PEDESTRIAN	12'-0"
3	CITY STREET	18'-0"
4	NAVIGATION	220'-0" W x UNLIMITED H
5	HIGHWAY	17'-4"
6	UPRR	23'-6"
7	CITY STREET @ 3rd AVE	13'-8"

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Couch Extension (Bascule)
MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

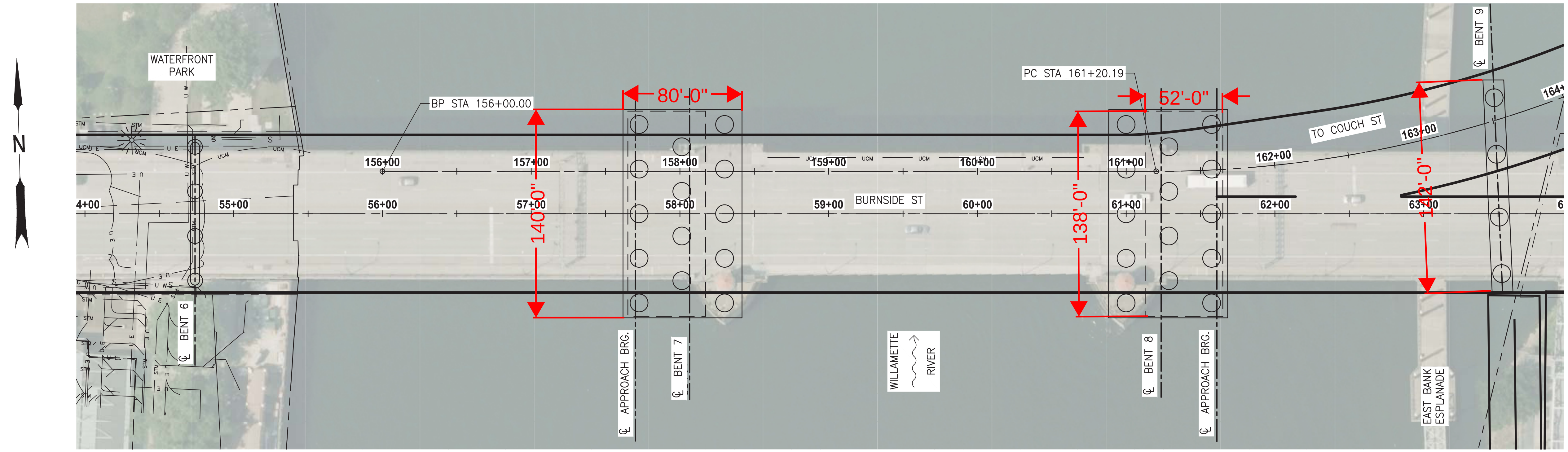
COUNTY ENGINEER
IAN B. CANNON P.E.

DESIGNED BY:
DRAFTED BY:
CHECKED BY:

REVISIONS

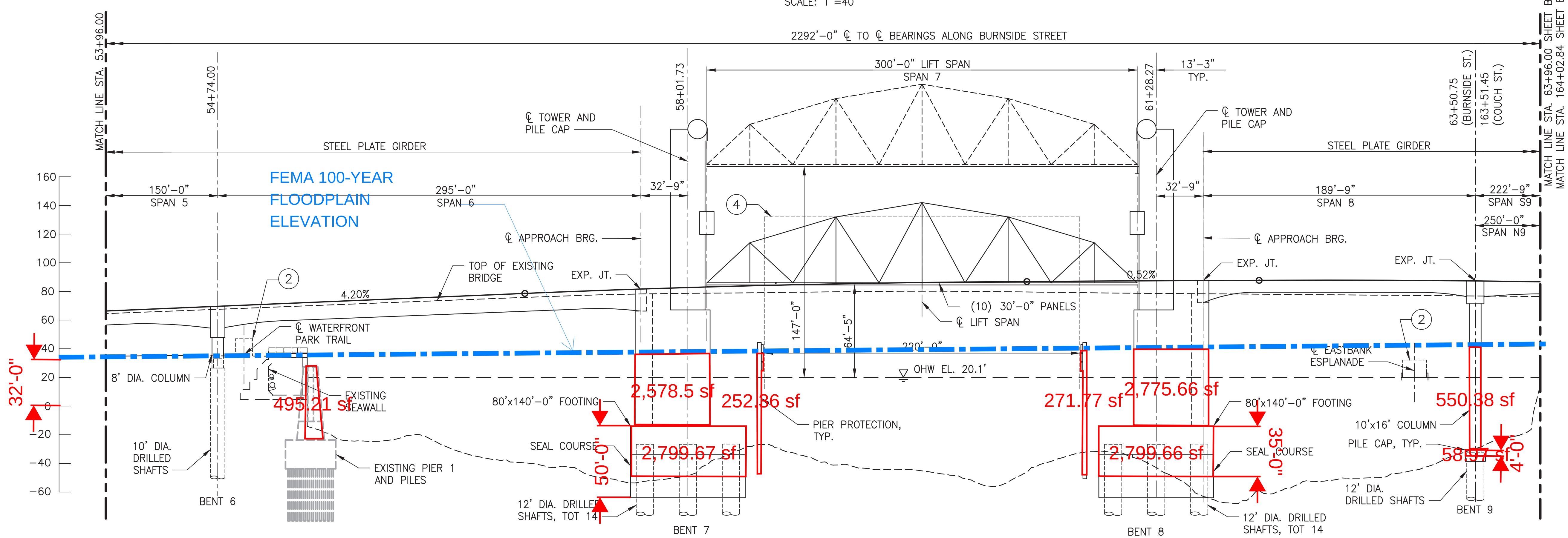
NO. | DATE:

Sheet No.
BR15



PLAN

SCALE: 1"=40'



ELEVATION

SCALE: 1"=40'

NOTE:
EASTBOUND BRIDGE ELEVATION SHOWN, FOR WESTBOUND BRIDGE SEE SHEET BR05.

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x 147'-0" H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Couch Extension (Lift)
MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

COUNTY ENGINEER
IAN B. CANNON P.E.

DESIGNED BY:
DRAFTED BY:
CHECKED BY:

REVISIONS

NO	DATE:

Sheet No.
BR20

Floodplain Impacts Outside of the Floodway

Existing West Approach | **Existing** East Approach

Support Locations	Number of Shafts	Shaft Diamter (feet)	Column Diamter (feet)	Total Bent width parallel to river (feet)	Support Locations	Number of Shafts	Shaft Diamter (feet)	Column Diamter (feet)	Total Bent width parallel to river (feet)	Alternative Total Bent width parallel to River (feet)	
										241	
Bent 1	Abutment				Bent 21	2	NA	2	4		
Bent 2	4	NA	2	8	Bent 22	2	NA	2	4		
Bent 3	4	NA	2	8	Bent 23	2	NA	2	4		
Bent 4	4	NA	2	8	Bent 24	2	NA	2	4		
Bent 5	4	NA	2	8	Bent 25	2	NA	2	4		
Bent 6	4	NA	2	8	Bent 26	2	NA	2	4		
Bent 7	4	NA	2	8	Bent 27	3	NA	2	6		
Bent 8	4	NA	2	8	Bent 28	3	NA	5	15		
Bent 9	4	NA	2	8	Bent 29	4	NA	2	8		
Bent 10	4	NA	2	8	Bent 30	4	NA	2	8		
Bent 11	4	NA	2	8	Bent 31	4	NA	2	8		*outside boundaries of the API
Bent 12	4	NA	2	8	Bent 32	4	NA	2	8		and excluded from totals
Bent 13	4	NA	2	8	Bent 33	4	NA	3	12		
Bent 14	4	NA	3	12	Bent 34	4	NA	3	12		
Bent 15	4	NA	3	12	Bent 35	Abutment					
Bent 16	4	NA	3	12	**Totals:**	**26**		**23**	**61**		
Bent 17	4	NA	4	16							
Bent 18	4	NA	4	16							
Bent 19	4	NA	4	16							
Totals:	**72**		**45**	**180**							

Assumptions/Sources:
*Measured bent widths from elevation view of Paint and Rehab project plan sets (2017) using Bluebeam.
* Number of shafts from Plan View of As Builts (1924)
*Assume all footings in West Aproach are fully buried in the ground
*Assume all footings in East Aproach are fully buried in the ground
*Measured the distance from the centerline of 2nd Ave to the boundary extent of the 500 year floodplain to be 190 ft.
Then marked that on the alignments to eliminate bents outside the floodplain.

Floodplain Impacts Outside of the Floodway

Retrofit

West Approach

Support Locations	Number of Shafts	Shaft Diamter (feet)	Column Diamter (feet)	Total Bent width parallel to river (feet)
Bent 1	Abutment			
Bent 2	4	NA	3	12
Bent 3	4	NA	3	12
Bent 4	4	NA	3	12
Bent 5	4	NA	3	12
Bent 6	4	NA	3	12
Bent 7	4	NA	3	12
Bent 8	4	NA	3	12
Bent 9	4	NA	3	12
Bent 10	4	NA	3	12
Bent 11	4	NA	3	12
Bent 12	4	NA	3	12
Bent 13	4	NA	3	12
Bent 14	4	NA	3.75	15
Bent 15	4	NA	3.75	15
Bent 16	4	NA	3.75	15
Bent 17	6	NA	5.75	34.5
Bent 18	6	NA	6.25	37.5
Bent 19	6	NA	6.25	37.5
Totals:	**78**		**65.5**	**298.5**

Retrofit

East Approach

Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Alternative Total Bent width parallel to River (feet)
					423.5
Bent 21	removed	-	-	-	
Bent 22	removed	-	-	-	
Bent 23	4	NA	4	16	
Bent 24	4	NA	4	16	
Bent 25	4	NA	4	16	
Bent 26	4	NA	4	16	
Bent 27	4	NA	4	16	
Bent 28	3	NA	7	21	
Bent 29	4	NA	3	12	
Bent 30	4	NA	3	12	
Bent 31	4	NA	3	12	*outside boundaries of the API and excluded from totals
Bent 32	4	NA	3	12	
Bent 33	4	NA	3.75	15	
Bent 34	4	NA	3.75	15	
Bent 35	Abutment				
Totals:	**31**		**33**	**125**	

Assumptions/Sources:
*table values from the Enhanced Seismic Retrofit Plan Set
*Assume all footings in West Aproach are fully buried in the ground
*Assume all footings in East Aproach are fully buried in the ground

Floodplain Impacts Outside of the Floodway

Short Span Approaches

West Approach

West Approach East Approach

Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Alternative Total Bent width parallel to River (feet)
Bent 1	10	3	3	30	Bent 10	4	10	8	32	254
Bent 2	4	7	5	20	Bent 11	4	10	8	32	
Bent 3	4	7	5	20	Bent 12	4	10	8	32	
Bent 4	4	8	6	24	Bent 13	4	7	5	20	*outside boundaries of the API and excluded from totals
Bent 5	4	10	8	32	Bent 14	13	3	3	39	
Bent 6	4	10	8	32						
Total:	**30**		**35**	**158**	**Total:**	**12**		**24**	**96**	

Assumptions/Sources:
*tables values from the Bridge Replacement Technical Report (Appendix B)
* note that bent 6 is depicted on the main channel plan sheet, but was included in the floodplain analysis because it is behind the seawall.
*Assume all footings in West Aproach are fully buried in the ground
*Assume all footings in East Aproach are fully buried in the ground

Long Span Approaches- Tied Arch

West Approach

West Approach East Approach

Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Alternative Total Bent width parallel to River (feet)
Bent 1	10	3	3	30	Bent 8	8	10	12	12	118
Bent 2	4	7	5	20	Bent 9	4	7	5	20	*outside boundaries of the API
Bent 3	4	7	5	20	Bent 10	13	3	3	39	and excluded from totals
Bent 4	4	8	6	24	**Total:**	**8**		**12**	**12**	
Bent 5	8	10	12	12						
Total:	**30**		**31**	**106**						

Assumptions/Sources:
*tables values from the Bridge Replacement Technical Report (Appendix B)
*Assume all footings in West Aproach are fully buried in the ground
*Assume all footings in East Aproach are fully buried in the ground

Long Span Approaches- Cable Stay

West Approach

West Approach East Approach

Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Alternative Total Bent width parallel to River (feet)
Bent 1	10	3	3	30	Bent 9	8	8	15	15	158
Bent 2	4	7	5	20	Bent 10	4	10	8	32	
Bent 3	4	7	5	20	Bent 11	4	6	4	16	
Bent 4	4	7	5	20	Bent 12	13	3	3	39	*outside boundaries of the API
Bent 5	8	8	6	6	**Total:**	12		23	47	and excluded from totals
Bent 6	8	8	15	15						
Total:	**38**		**39**	**111**						

Assumptions/Sources:
*table values from the MBEAL Long Span Cable Stay Plan Set
*Assume all footings in West Aproach are fully buried in the ground
*Assume all footings in East Aproach are fully buried in the ground

Floodplain Impacts Outside of the Floodway

Couch Alternatives

West Approach

Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)
Bent 1	10	3	3	30
Bent 2	4	7	5	20
Bent 3	4	7	5	20
Bent 4	4	8	6	24
Bent 5	4	10	8	32
Bent 6	4	10	8	32
Total:	**30**		**35**	**158**

Couch Alternatives

East Approach-North

Couch Alternatives

East Approach-South

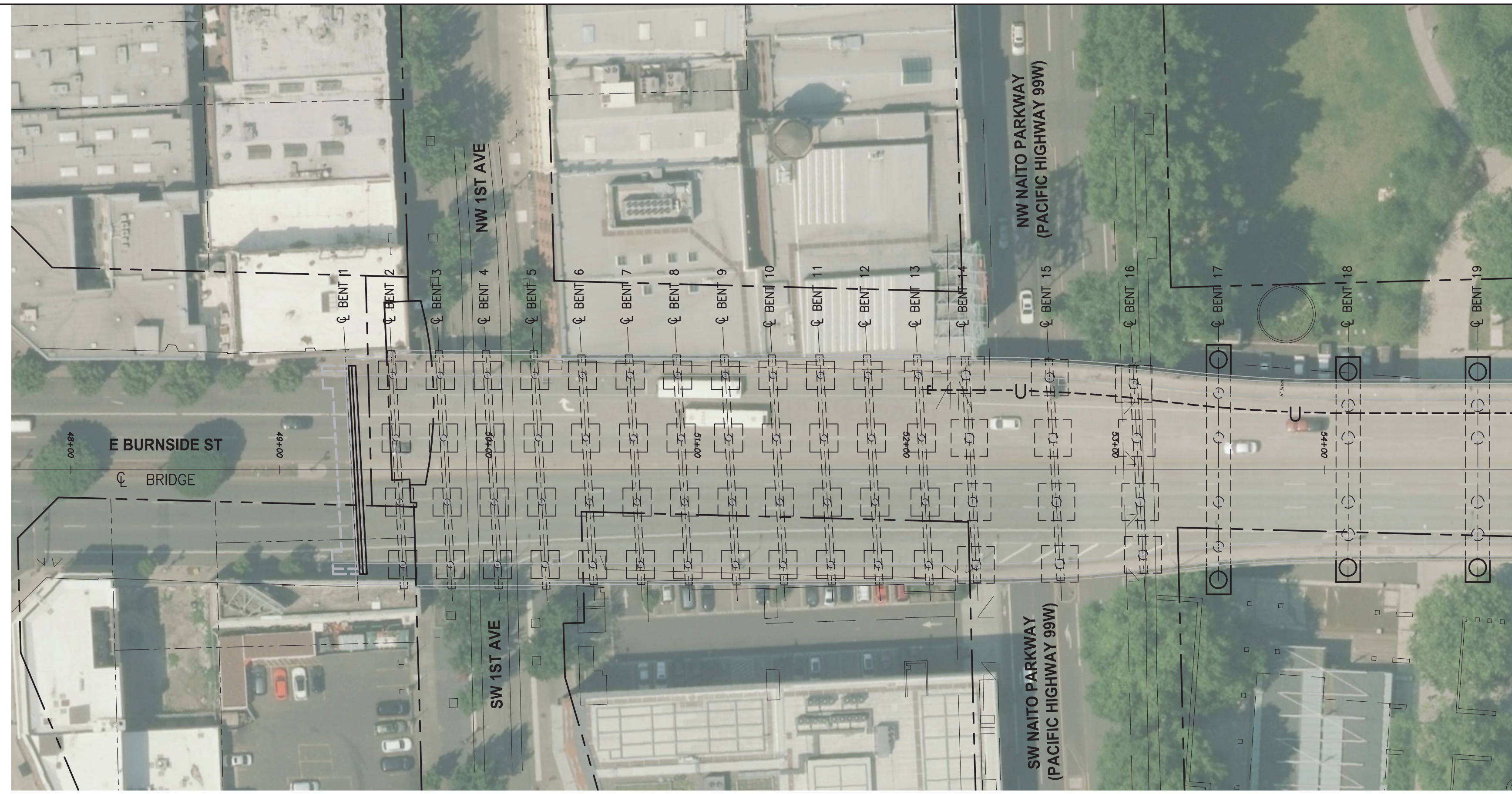
Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Support Locations	Number of Shafts	Shaft Diameter (feet)	Column Diameter (feet)	Total Bent width parallel to river (feet)	Alternative Total Bent width parallel to River (feet)
Bent N10	2	10	8	16	Bent S10	3	10	8	24	286
Bent N11	2	10	8	16	Bent S11	3	10	8	24	
Bent N12	2	8	6	12	Bent S12	3	10	8	24	
Bent N13	2	8	6	12	Bent S13	3	7	5	15	*outside boundaries of the API and excluded from totals
Bent N14	2	6	4	8	Bent S14	8	3	3	24	
Bent N15	6	3	3	18	-	-	-	-	-	
Total:	**8**		**28**	**56**	**Total:**	**9**		**24**	**72**	

Assumptions/Sources:
*table values from the Bridge Replacement Technical Report (Appendix B)
* note that bent 6 is depicted on the main channel plan sheet, but was included in the floodplain analysis because it is behind the seawall.

500 year Floodplain Impacts

Results Summary

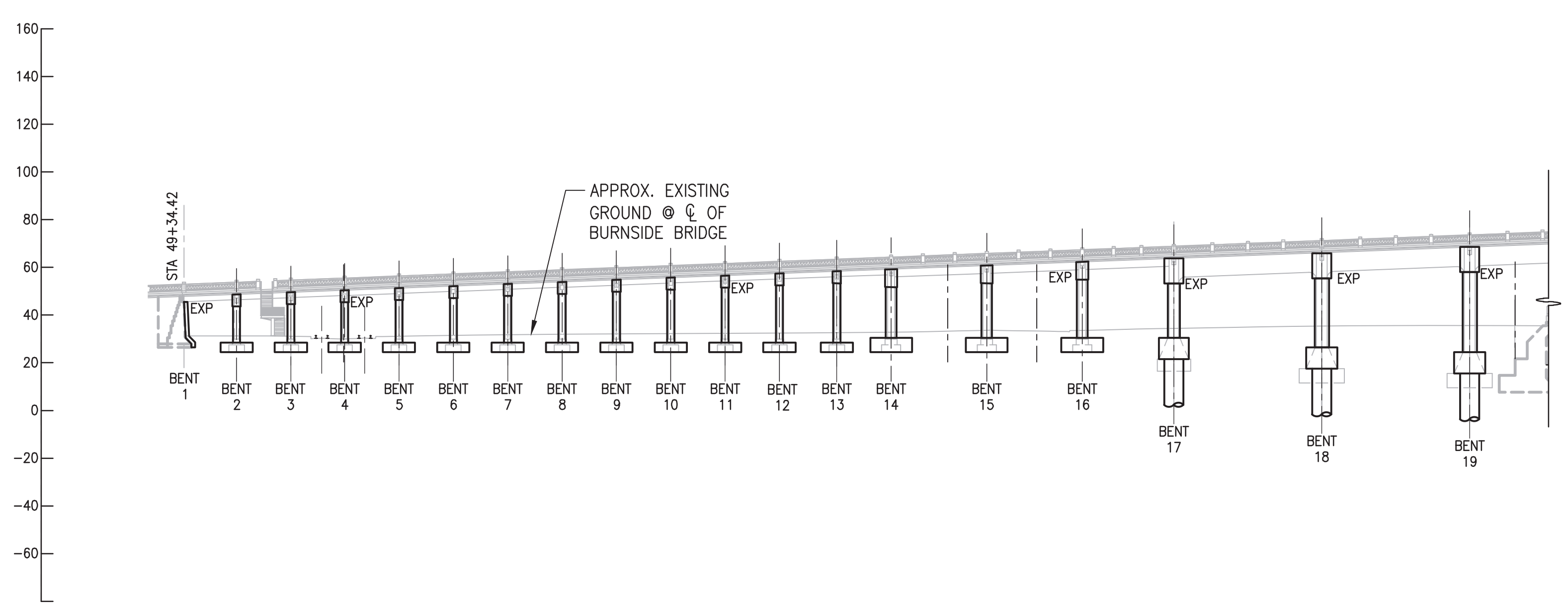
	West			East-(North and South for Couch)						
	Total # of Shafts	Total Width of Bents (ft)	Total Bent width parallel to river (feet)	Total # of Shafts	Total Width of Bents (ft)	Total Bent width parallel to river (feet)	Total # of Shafts	Total Width of Bents (ft)	Total Bent width parallel to river (feet)	Alternative Total Bent width parallel to River (feet)
Alternative										
Existing	72	45	180	26	23	61	-	-	-	241
Retrofit	78	65.5	299	31	33	125	-	-	-	424
Short Span	30	35	158	12	24	96	-	-	-	254
Long Span-TA	30	31	106	8	12	12	-	-	-	118
Long Span-CS	38	39	111	12	23	47	-	-	-	158
Couch	30	35	158	8	28	56	9	24	72	286



PLAN

SCALE: 1" = 40'

COLUMN RETROFIT DATA	
BENT NUMBER	"A"
2	3'-0"
3	3'-0"
4	3'-0"
5	3'-0"
6	3'-0"
7	3'-0"
8	3'-0"
9	3'-0"
10	3'-0"
11	3'-0"
12	3'-0"
13	3'-0"
14	3'-9"
15	3'-9"
16	3'-9"
17	5'-9"
18	6'-3"
19	6'-3"
28	7'-0"
29	3'-0"
30	3'-0"
31	3'-0"
32	3'-0"
33	3'-9"
34	3'-9"



ELEVATION

SCALE: 1" = 40'

LEGEND:

- EXISTING
- RETROFIT
- ROW

NOTES:

1. SUPERSTRUCTURE RETROFITS NOT SHOWN FOR CLARITY
2. GROUND IMPROVEMENT NOT SHOWN, SEE GEOTECHNICAL REPORT

CONCEPTUAL PLANS
JUNE 2020

EARTHQUAKE READY BURNSIDE BRIDGE

ENHANCED SEISMIC RETROFIT
SUBSTRUCTURE RETROFIT LAYOUT
WEST APPROACH

DATE: 1/31/20 PROJECT NO.: Proj No

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

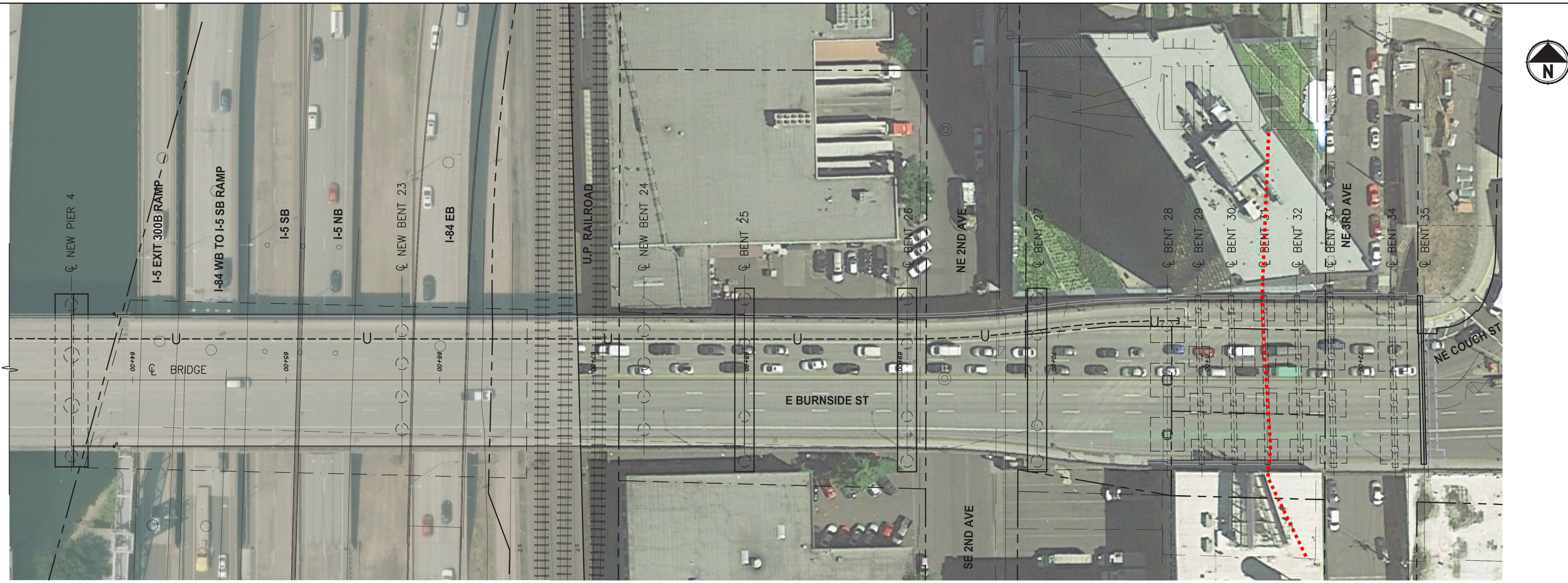
IAN B. CANNON P.E. COUNTY ENGINEER

DESIGNED BY: BJS/CRK
DRAFTED BY: CRK/BRP
CHECKED BY: YY

REVISIONS

NO.	DATE:

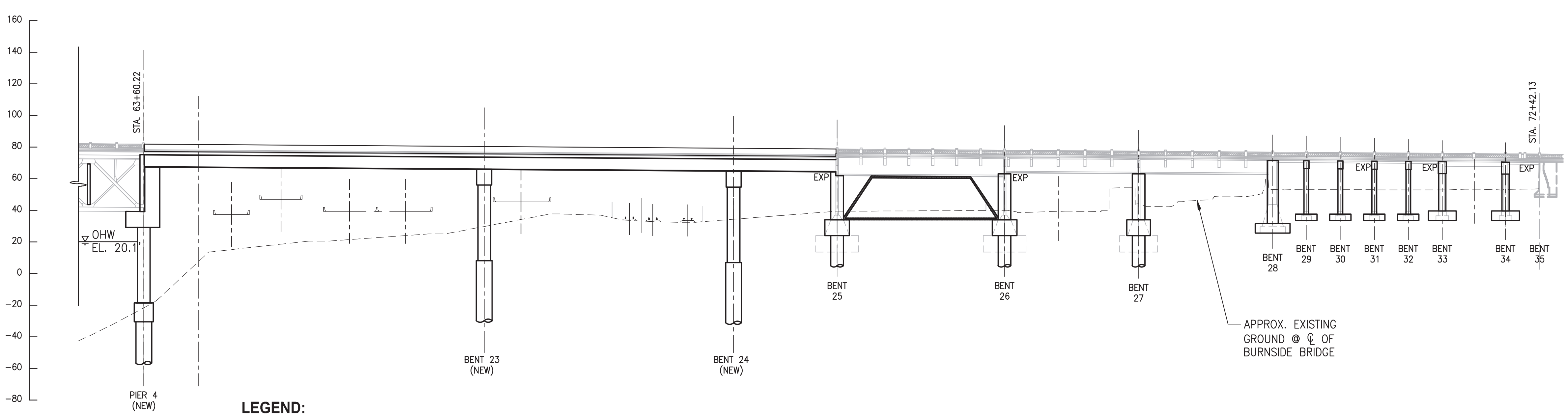
Sheet No. S04



PLAN

SCALE: 1" = 40'

Approximate limits of 500 year floodplain



LEGEND:

EXISTING

RETROFIT

ROW

ELEVATION

SCALE: 1" = 40'

NOTES:

1. BASCULE LEAVES RETROFIT NOT SHOWN FOR CLARITY
2. GROUND IMPROVEMENT NOT SHOWN, SEE GEOTECHNICAL REPORT

CONCEPTUAL PLANS
JUNE 2020

EARTHQUAKE READY BURNSIDE BRIDGE

ENHANCED SEISMIC RETROFIT
SUBSTRUCTURE RETROFIT LAYOUT
EAST APPROACH

DATE: *1/31/20* PROJECT NO.: *Proj No*

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

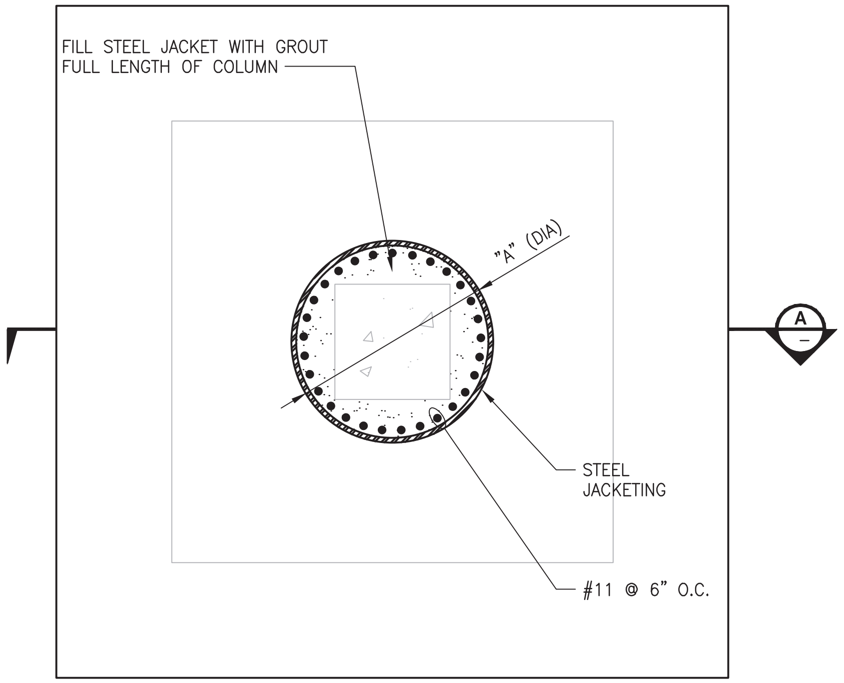
IAN B. CANNON P.E. COUNTY ENGINEER

DESIGNED BY: *BJS/CRK*
DRAFTED BY: *CRK/BRP*
CHECKED BY: *YY*

REVISIONS

NO.	DATE:			

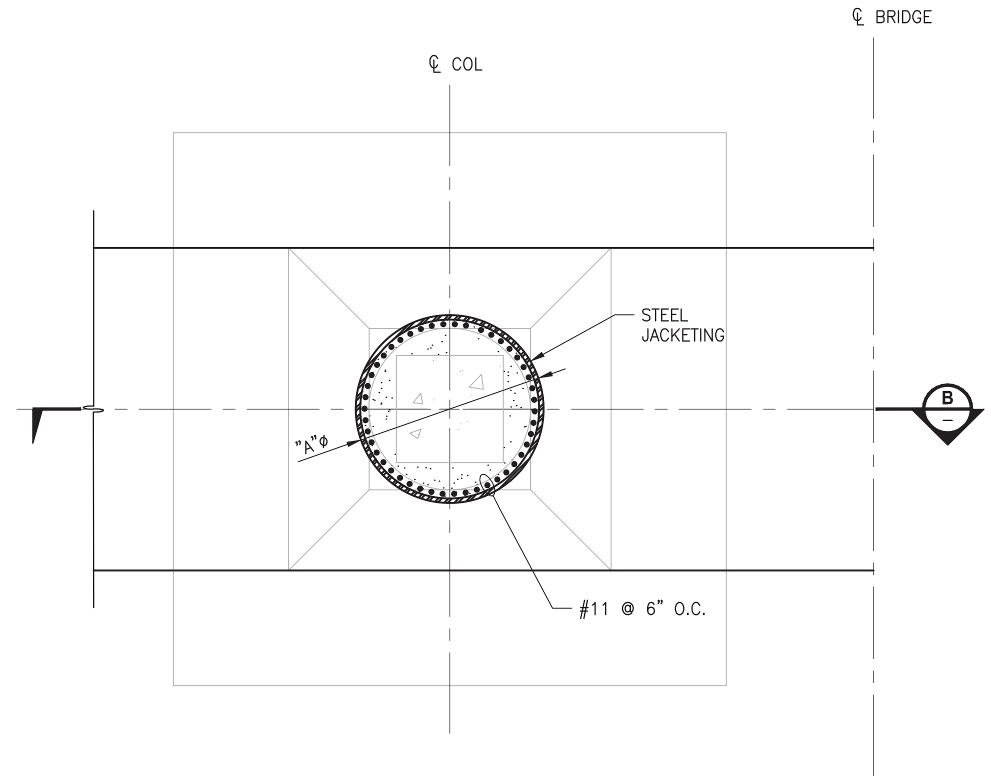
Sheet No. *S06*



COLUMN RETROFIT BENT 2-16 & 28-34

DETAIL 1 / S08

NOT TO SCALE

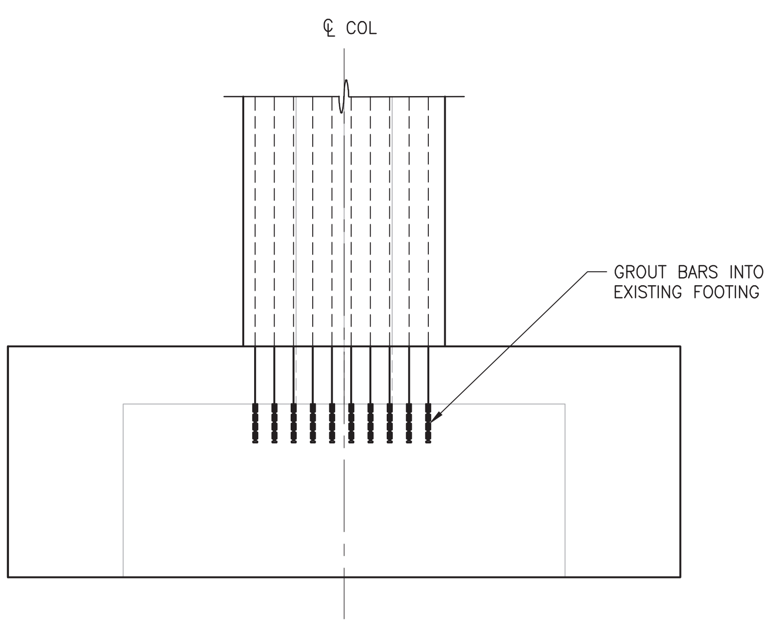


COLUMN RETROFIT BENT 17-19

PLAN

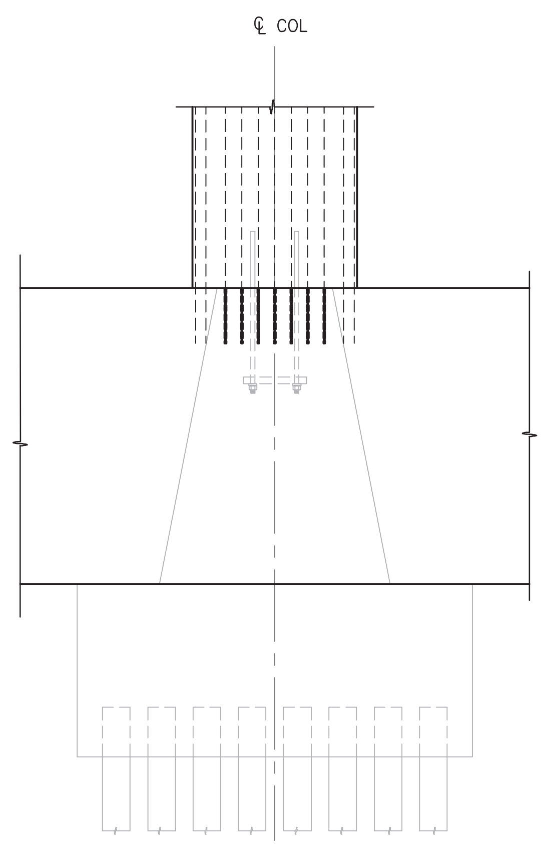
NOT TO SCALE

COLUMN RETROFIT DATA	
BENT NUMBER	"A"
2	3'-0"
3	3'-0"
4	3'-0"
5	3'-0"
6	3'-0"
7	3'-0"
8	3'-0"
9	3'-0"
10	3'-0"
11	3'-0"
12	3'-0"
13	3'-0"
14	3'-9"
15	3'-9"
16	3'-9"
17	5'-9"
18	6'-3"
19	6'-3"
28	7'-0"
29	3'-0"
30	3'-0"
31	3'-0"
32	3'-0"
33	3'-9"
34	3'-9"



SECTION A / –

NOT TO SCALE



SECTION B / –

NOT TO SCALE

CONCEPTUAL PLANS
JUNE 2020

EARTHQUAKE READY BURNSIDE BRIDGE

ENHANCED SEISMIC RETROFIT
COLUMN RETROFIT
BENT 2-19 & 28-34

DATE: *1/31/20* PROJECT NO.: *Proj No*

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E. COUNTY ENGINEER

DESIGNED BY: BJS/CRK
DRAFTED BY: CRK/BRP
CHECKED BY: YY

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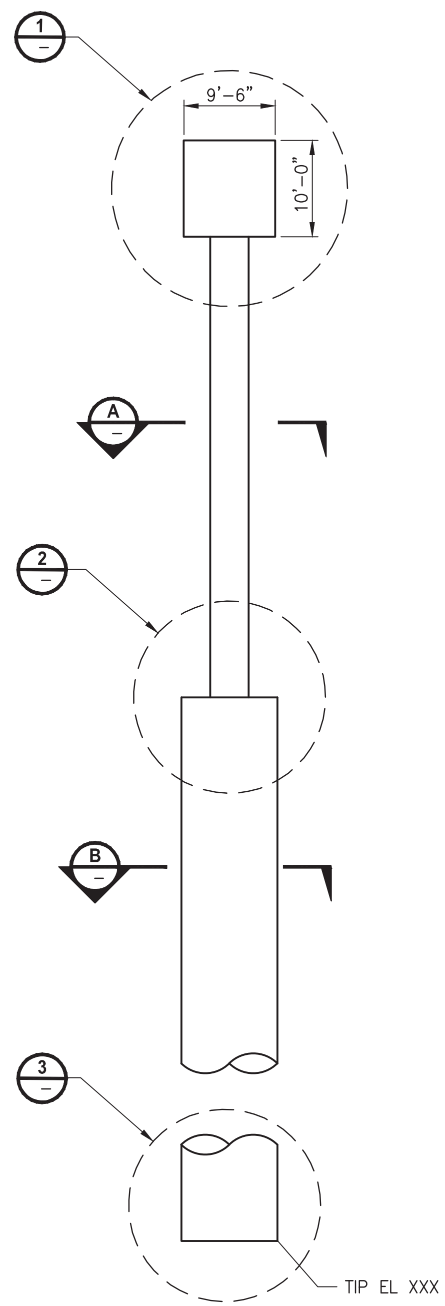
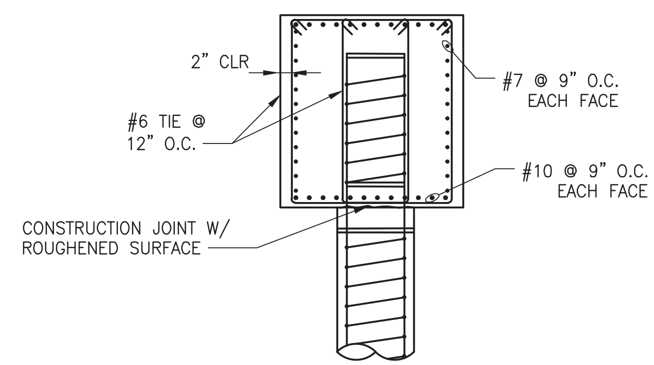
NO.	DATE:

Sheet No. *S14*



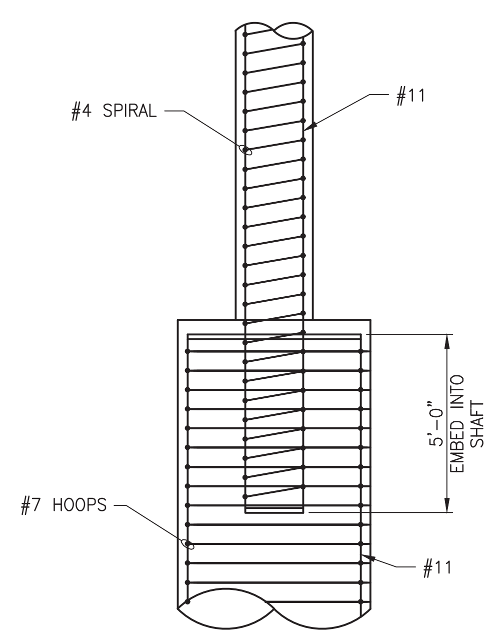
ELEVATION

SCALE: 1"=10'



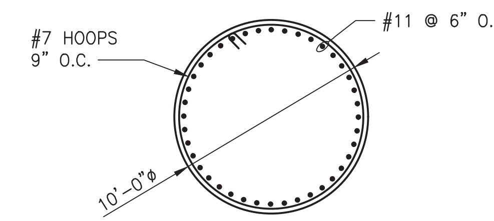
DETAIL 1

SCALE: 1"=5'



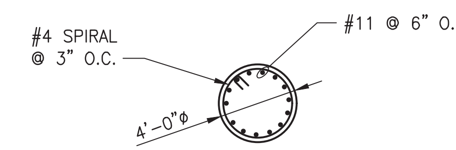
DETAIL 2

SCALE: 1"=5'



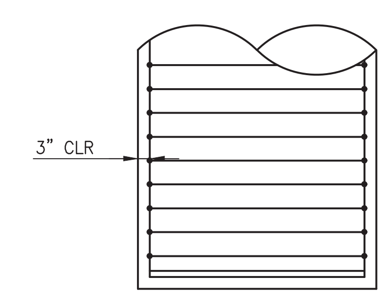
SECTION B

SCALE: 1"=5'



SECTION A

SCALE: 1"=5'



DETAIL 3

SCALE: 1"=5'

CONCEPTUAL PLANS
JUNE 2020

EARTHQUAKE READY BURNSIDE BRIDGE

ENHANCED SEISMIC RETROFIT
BENT AND FOOTING REPLACEMENT
NEW BENTS 23-24

DATE: *1/31/20* | PROJECT NO.: *Proj No*

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E. COUNTY ENGINEER

DESIGNED BY: BJS/CRK
DRAFTED BY: CRK/BRP
CHECKED BY: YY

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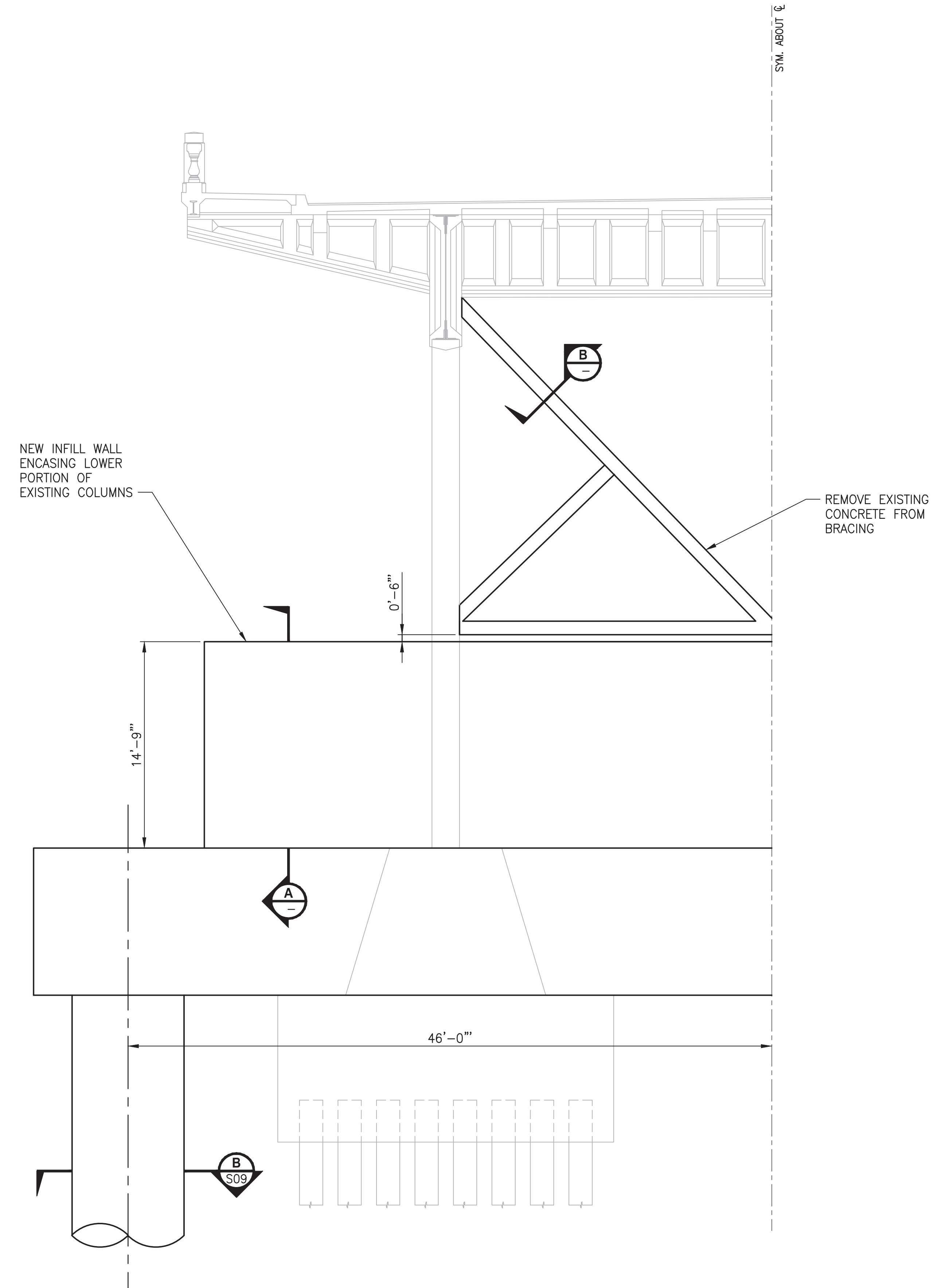
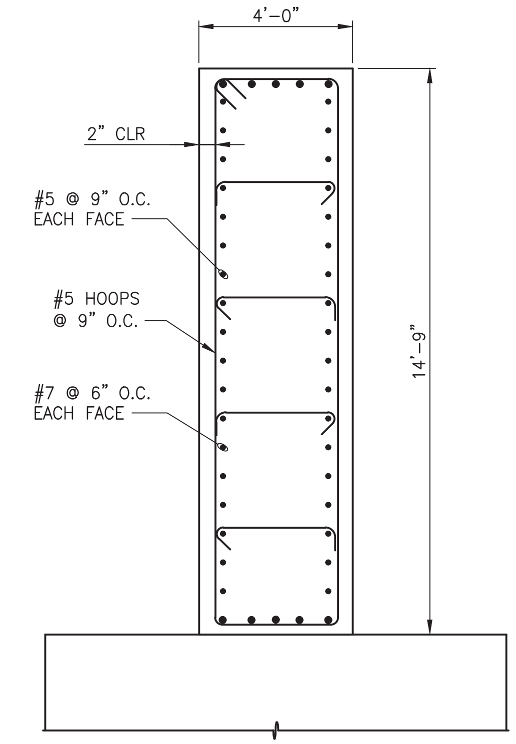
NO.	DATE:			

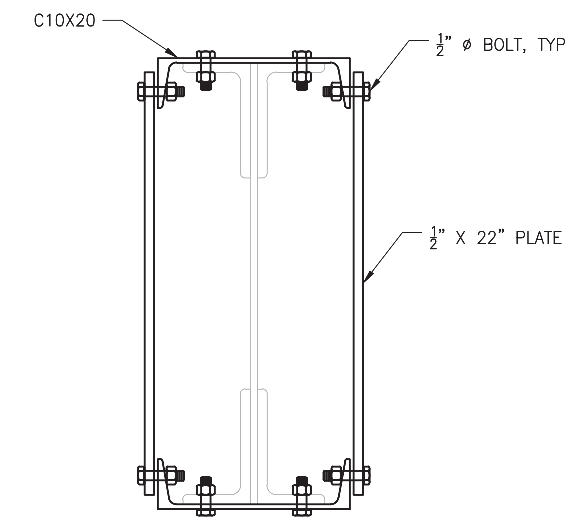
Sheet No. *S11*



TYPICAL SECTION 1
NOT TO SCALE



SECTION A
NOT TO SCALE



SECTION B
NOT TO SCALE

CONCEPTUAL PLANS
JUNE 2020

EARTHQUAKE READY BURNSIDE BRIDGE
ENHANCED SEISMIC RETROFIT
BENT RETROFIT
BENT 25-27

DATE: 1/31/20 | PROJECT NO.: Proj No

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

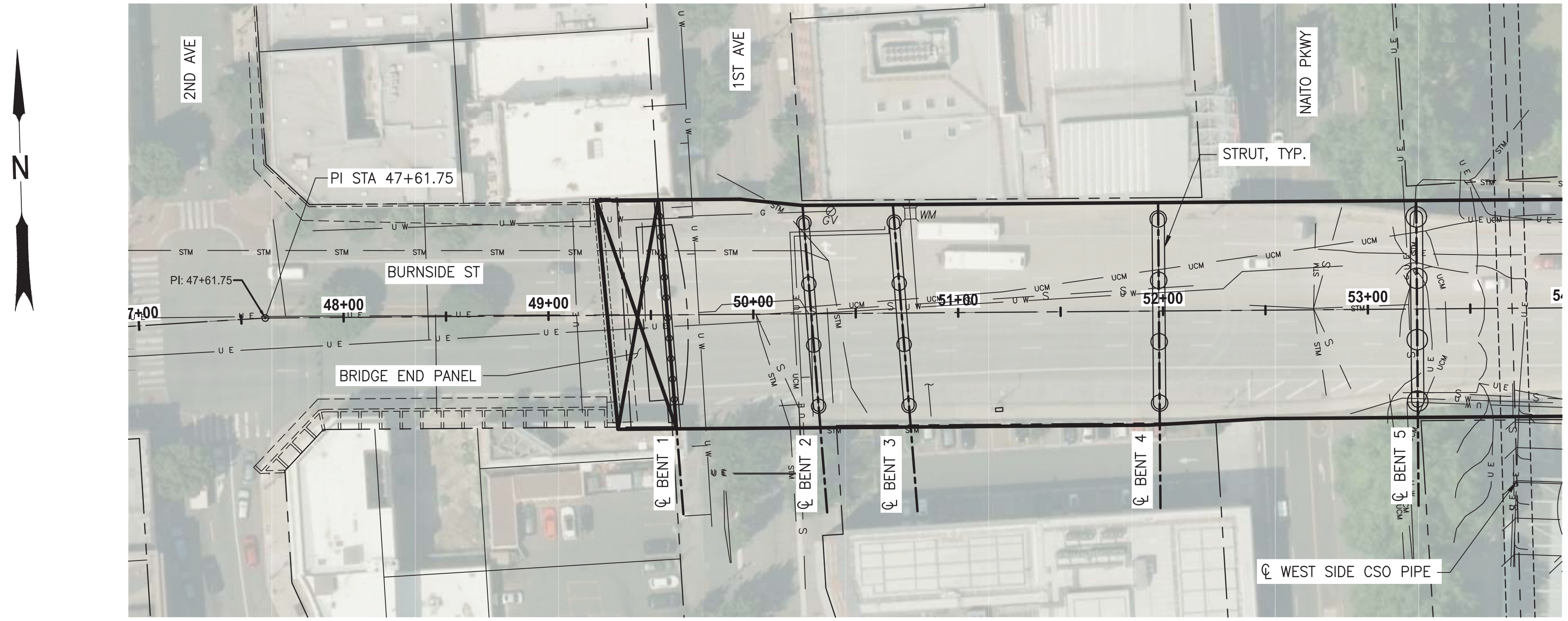
IAN B. CANNON P.E. | COUNTY ENGINEER

DESIGNED BY: BJS/CRK
DRAFTED BY: CRK/BRP
CHECKED BY: YY

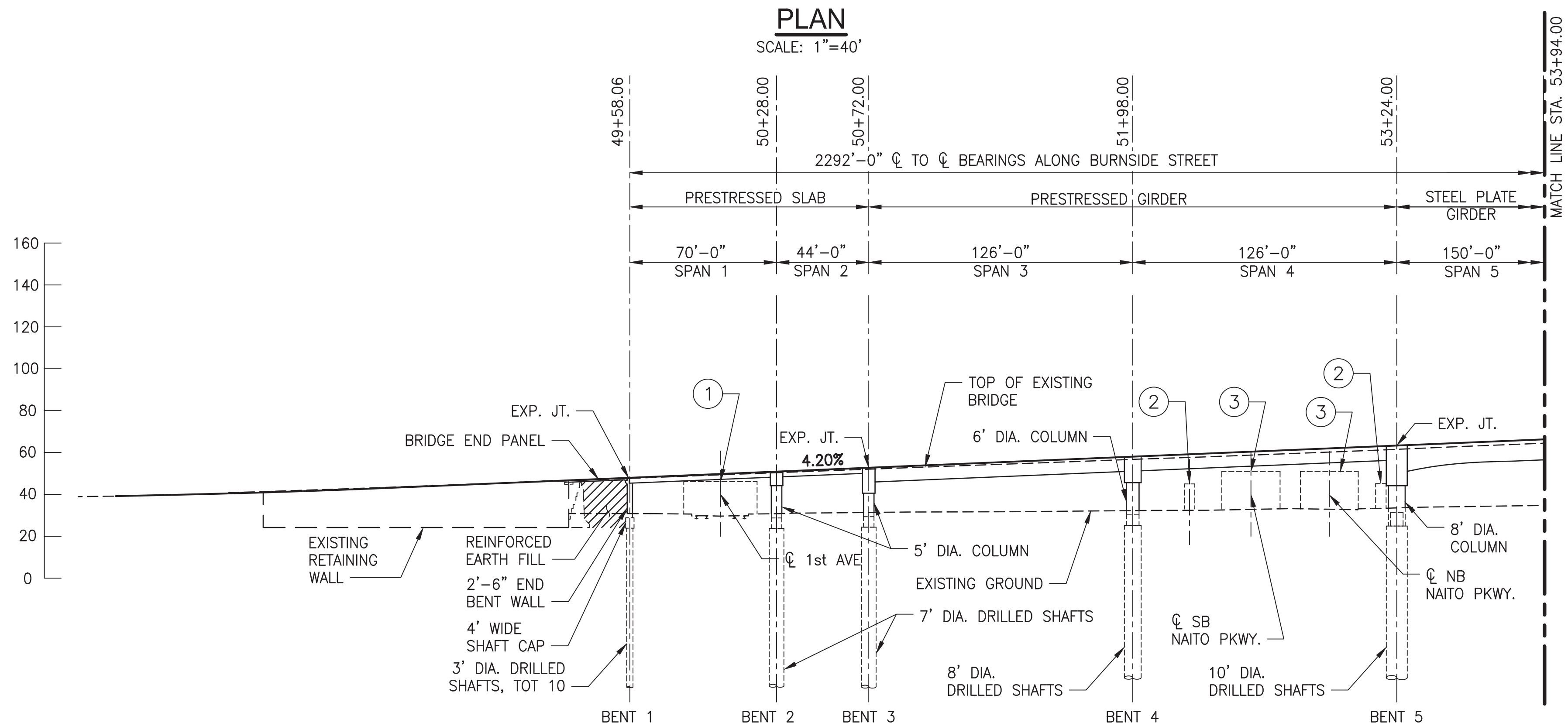
REVISIONS

NO.	DATE:			

Sheet No.
S15



PLAN
SCALE: 1"=40'



ELEVATION
SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"
2	PEDESTRIAN	12'-0"
3	CITY STREET	18'-0"
4	NAVIGATION	220'-0" W x 147'-0" H
5	HIGHWAY	17'-4"
6	UPRR	23'-6"
7	CITY STREET @ 3rd AVE	13'-8"

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge

Replacement Alternative with Short-span Approach (Lift)

MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E. COUNTY ENGINEER

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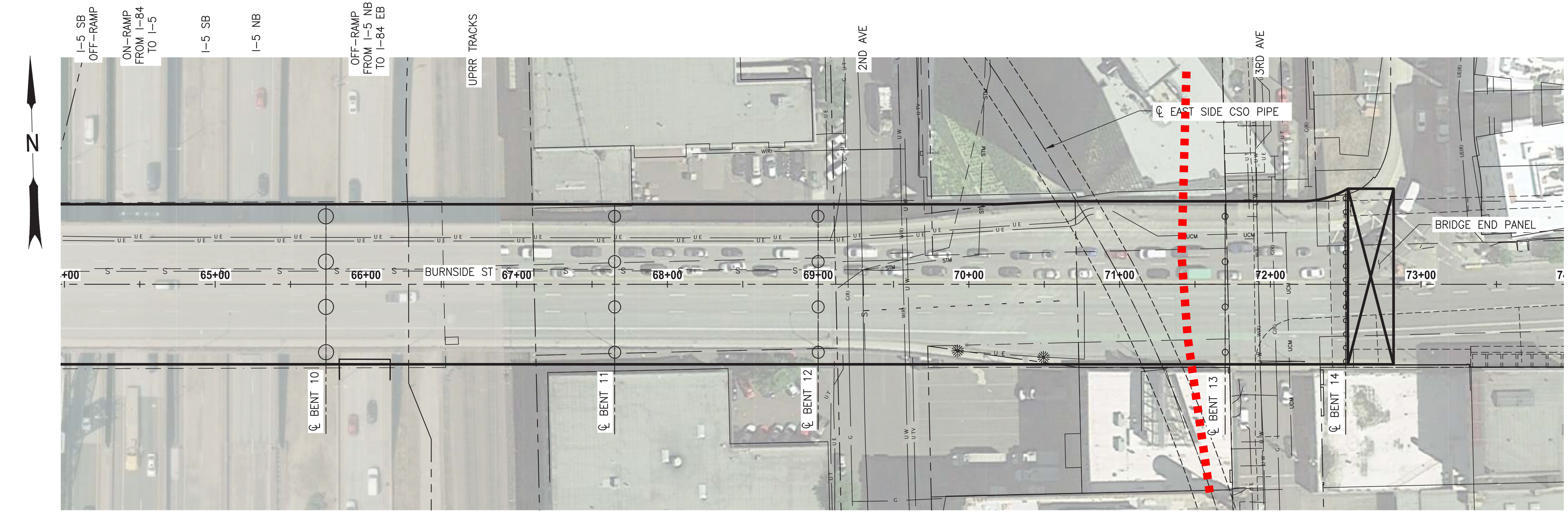
REVISIONS

NO DATE:

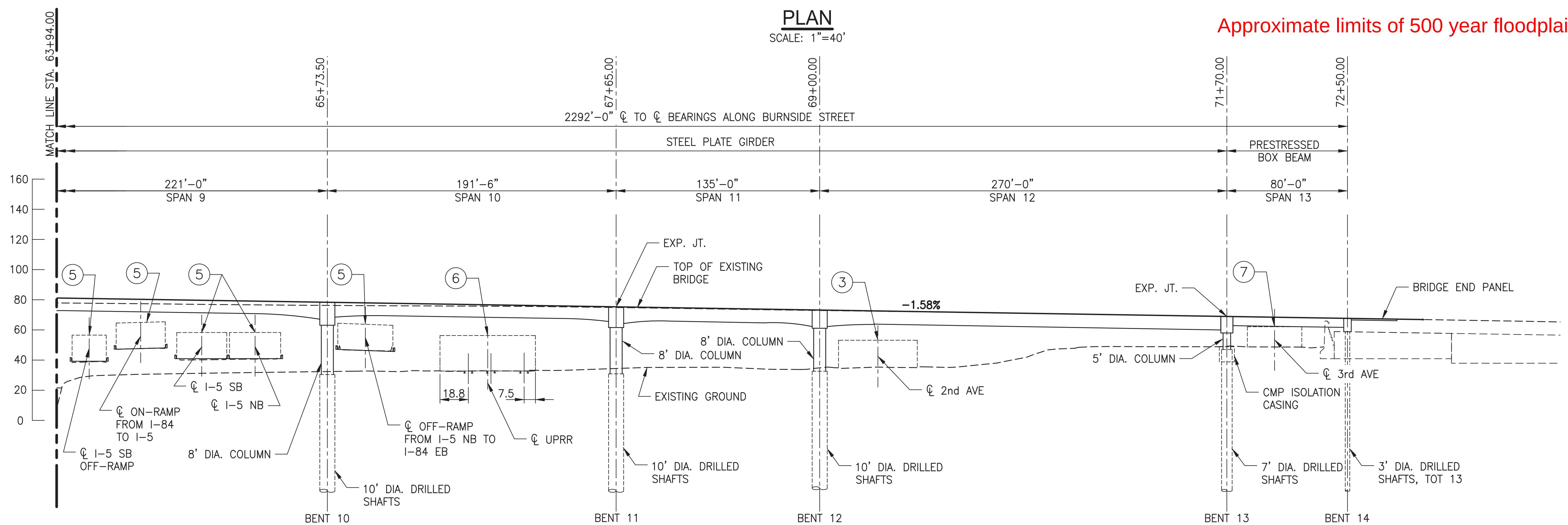
Sheet No.
BR06



PLAN

SCALE: 1"=40'

Approximate limits of 500 year floodplain



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x 147'-0" H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge

Replacement Alternative with Short-span Approach (Lift)

MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

COUNTY ENGINEER
IAN B. CANNON P.E.

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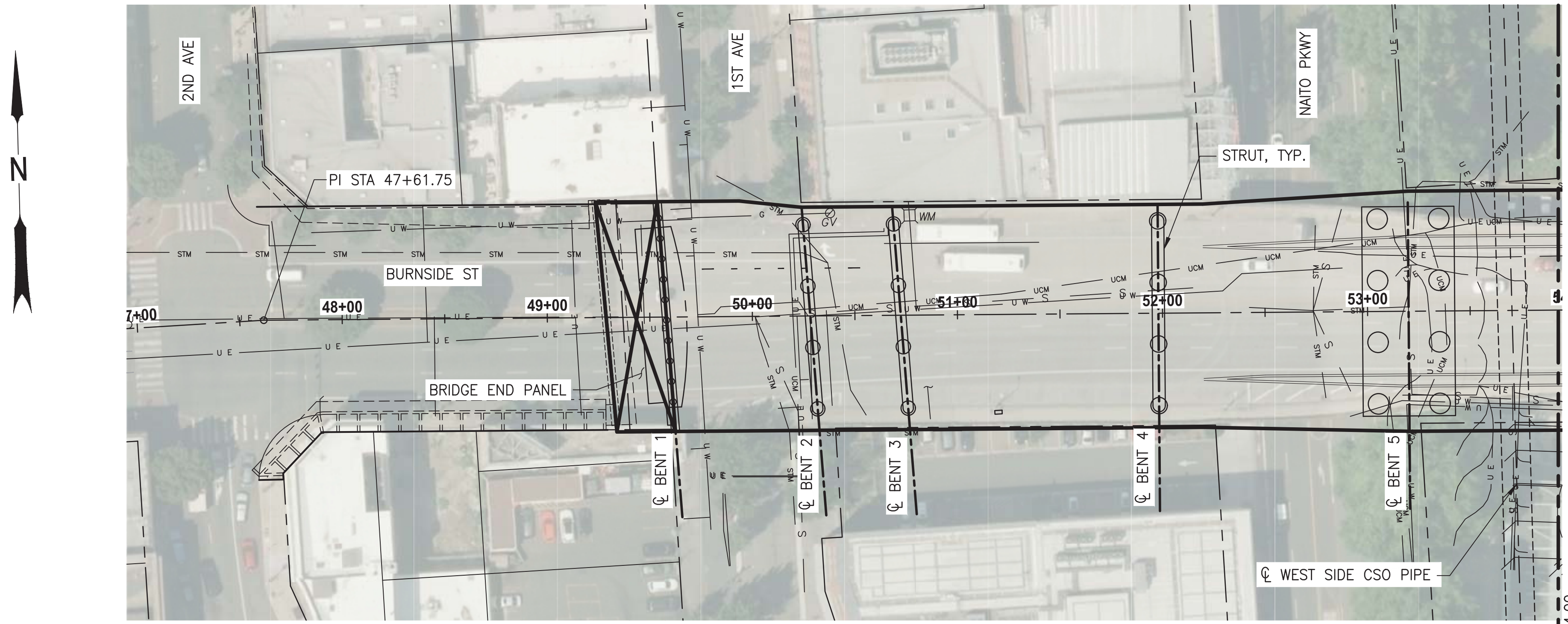
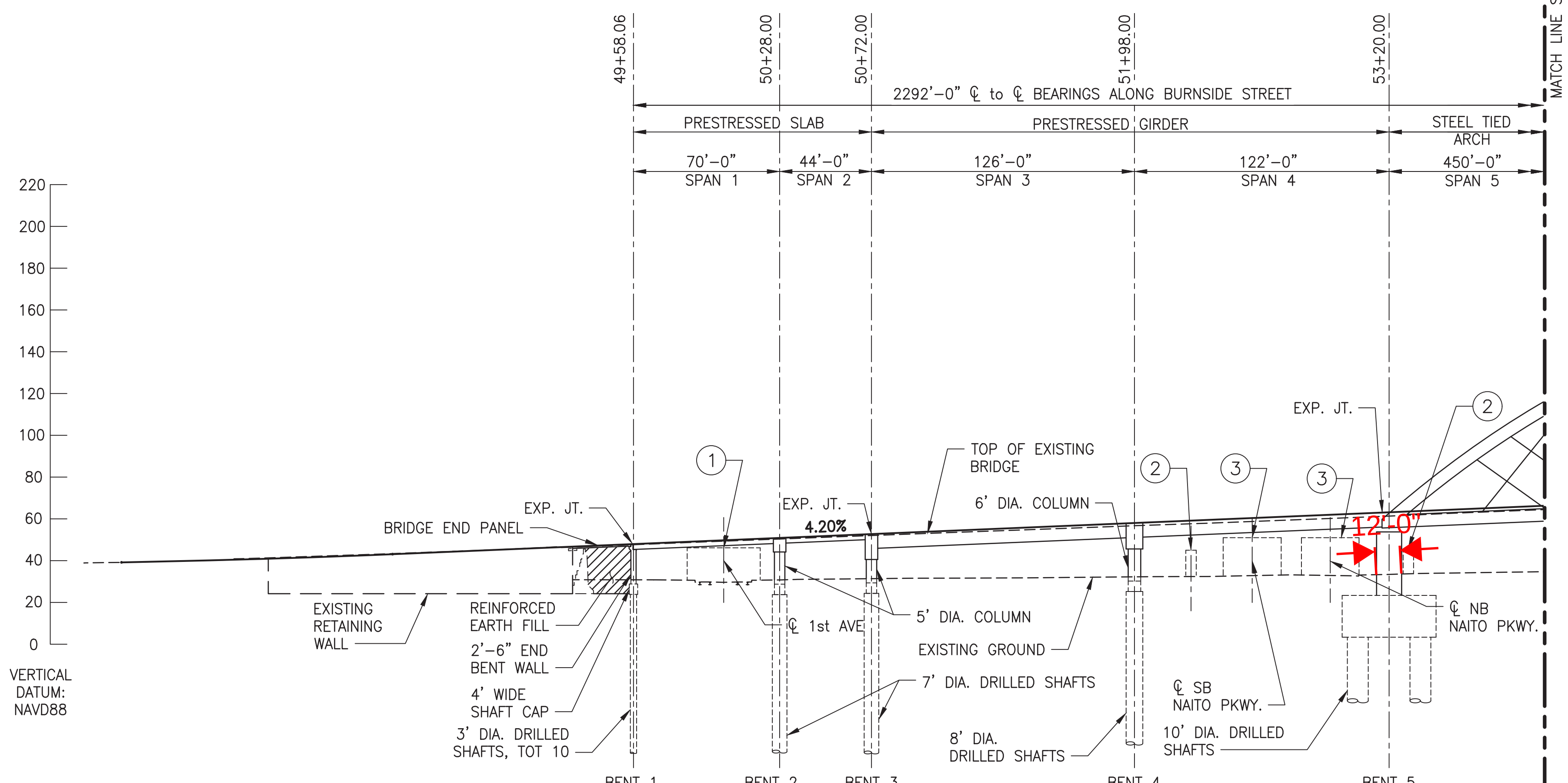
Sheet No.
BR08



PLAN

SCALE: 1"=40'



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"
2	PEDESTRIAN	12'-0"
3	CITY STREET	18'-0"
4	NAVIGATION	220'-0" W x UNLIMITED H
5	HIGHWAY	17'-4"
6	UPRR	23'-6"
7	CITY STREET @ 3rd AVE	13'-8"

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Long-span Approach (Bascule)
MULTNOMAH COUNTY
PROJECT NO.:
DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E.
COUNTY ENGINEER

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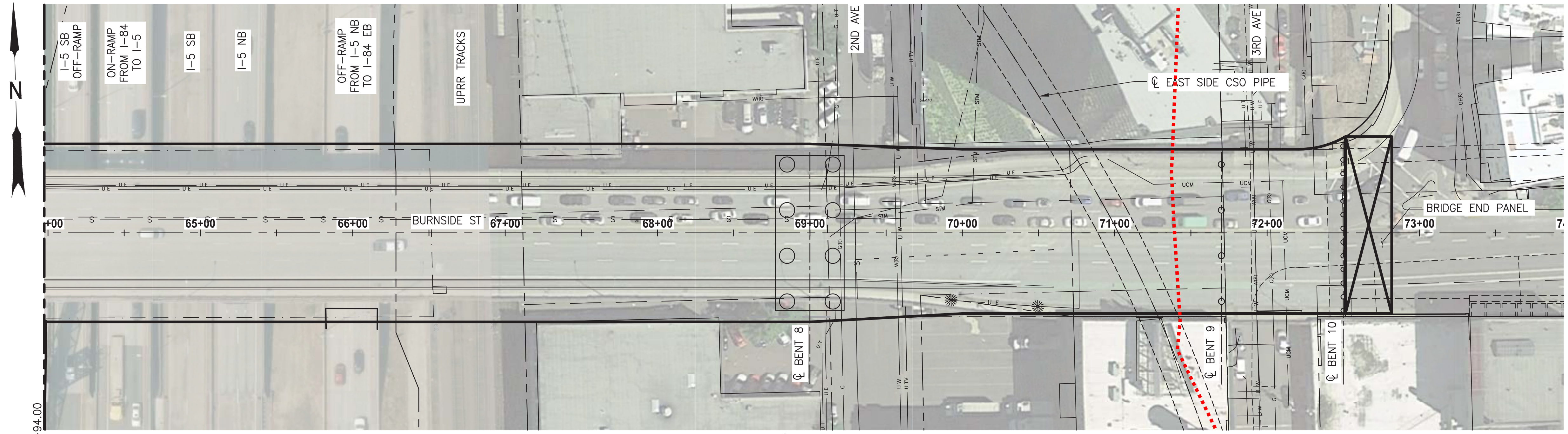
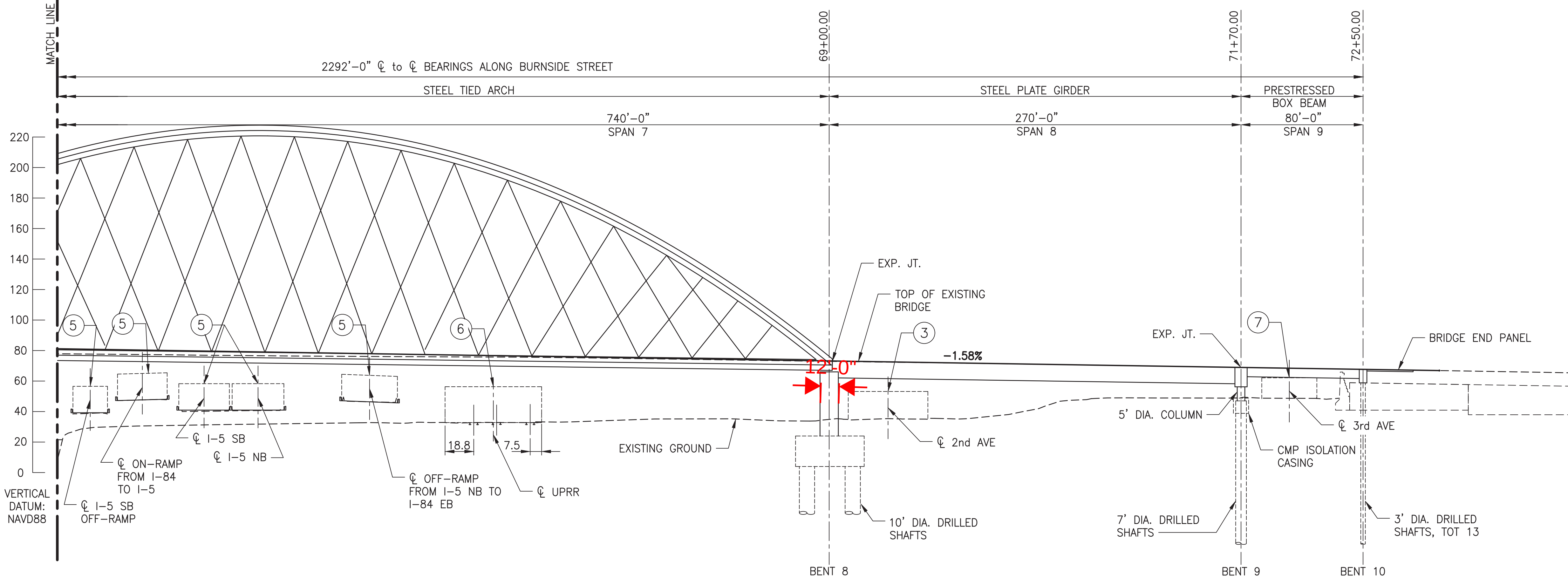
Sheet No.
BR10



PLAN

SCALE: 1"=40'

Approximate limits of 500 year floodplain



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x UNLIMITED H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Long-span Approach (Bascule)
MULTNOMAH COUNTY

PROJECT NO.:
DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E.
COUNTY ENGINEER

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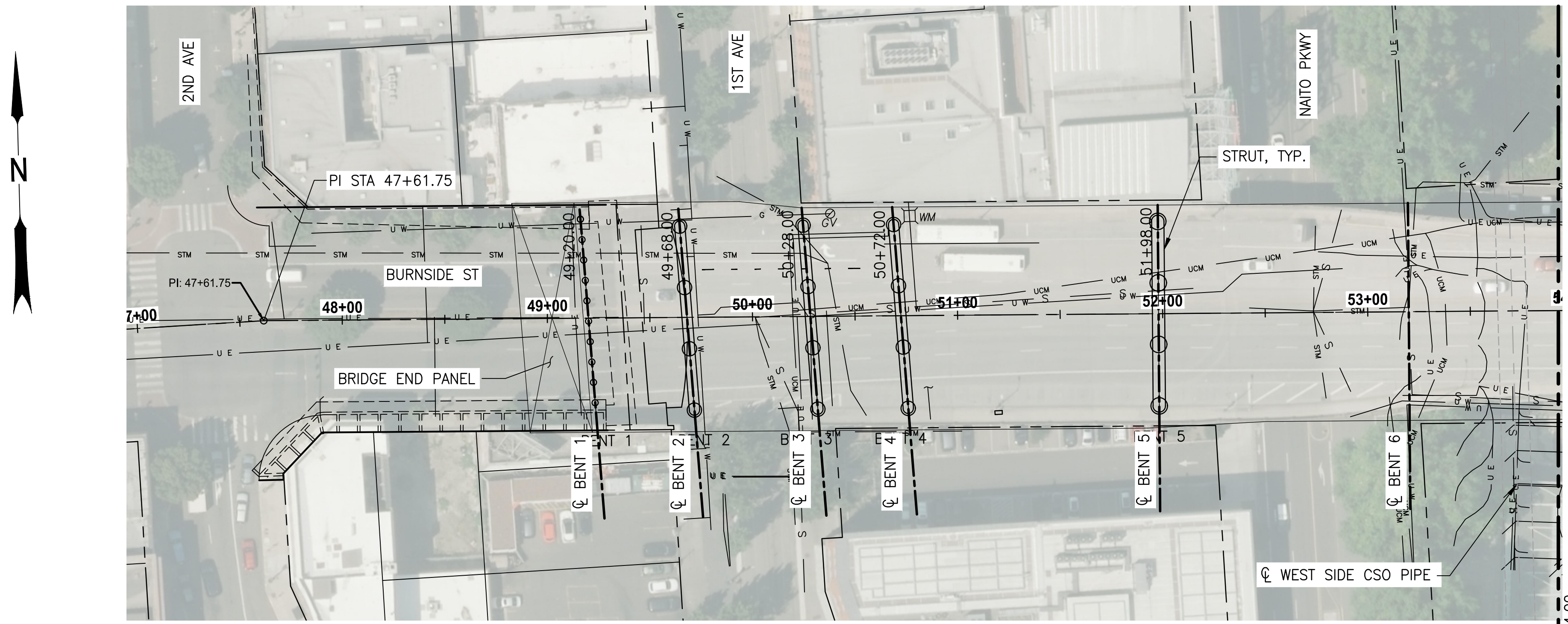
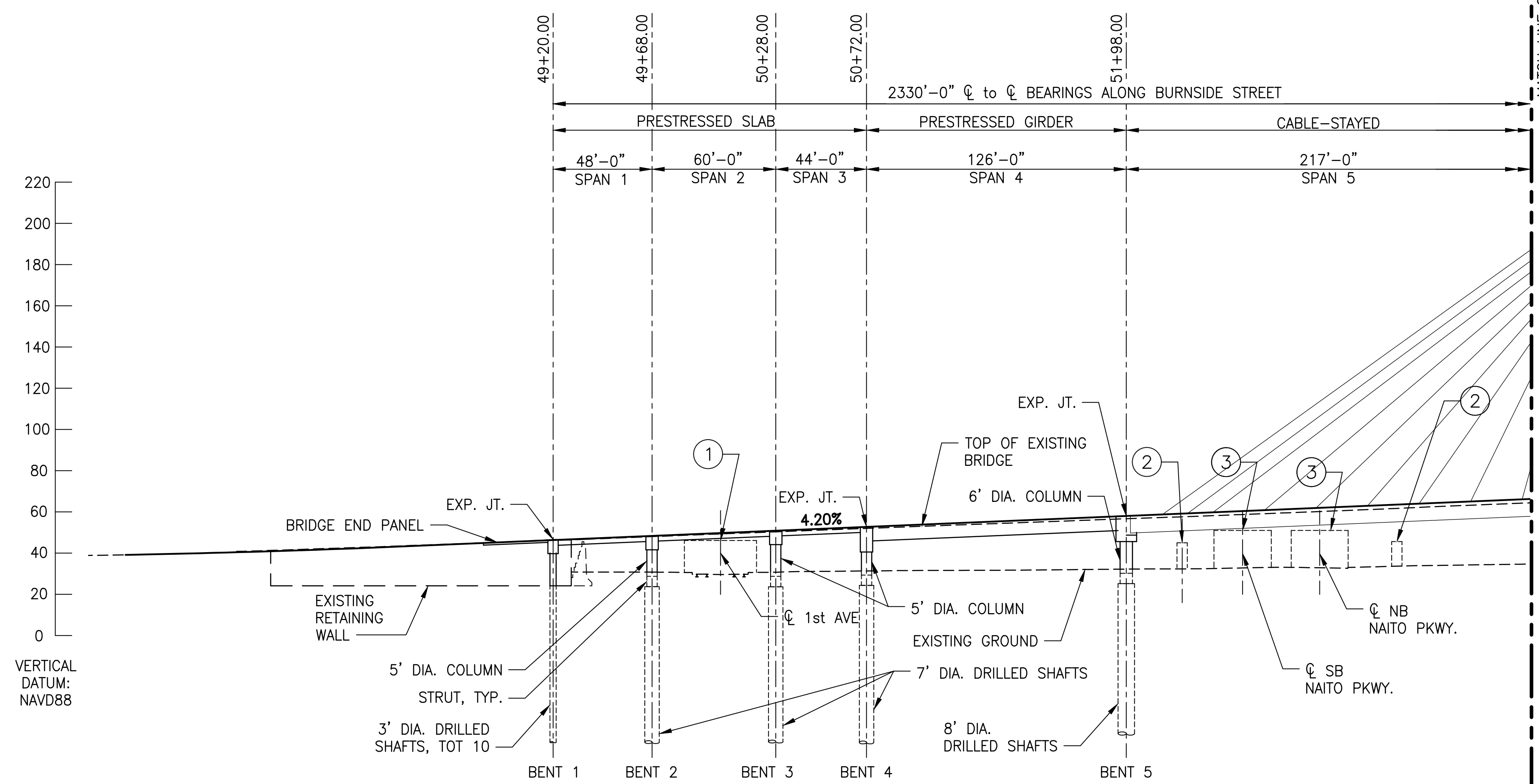
REVISIONS
NO. DATE:

Sheet No. *BR12*



PLAN

SCALE: 1"=40'



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

(1)	LRT	15'-6"
(2)	PEDESTRIAN	12'-0"
(3)	CITY STREET	18'-0"
(4)	NAVIGATION	220'-0" W x UNLIMITED H
(5)	HIGHWAY	17'-4"
(6)	UPRR	23'-6"
(7)	CITY STREET @ 3rd AVE	13'-8"

CONCEPTUAL PLANS
JANUARY 2020

Earthquake Ready Burnside Bridge

Replacement Movable Bridge (Bascule) With Long-Span Cable Approach on Existing Alignment

MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E. COUNTY ENGINEER

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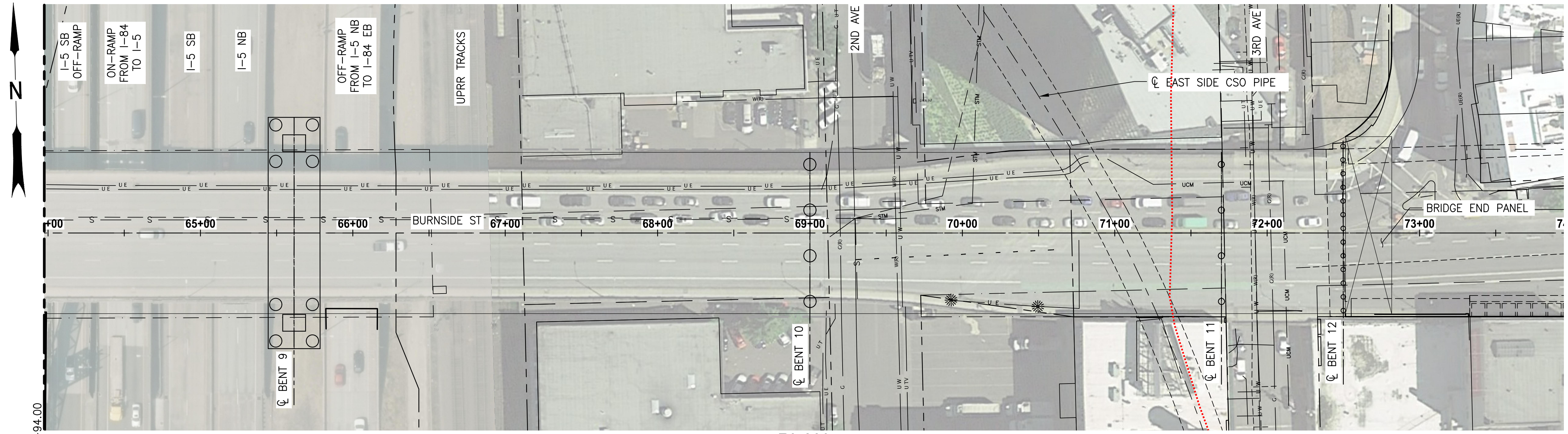
REVISIONS

NO. DATE:

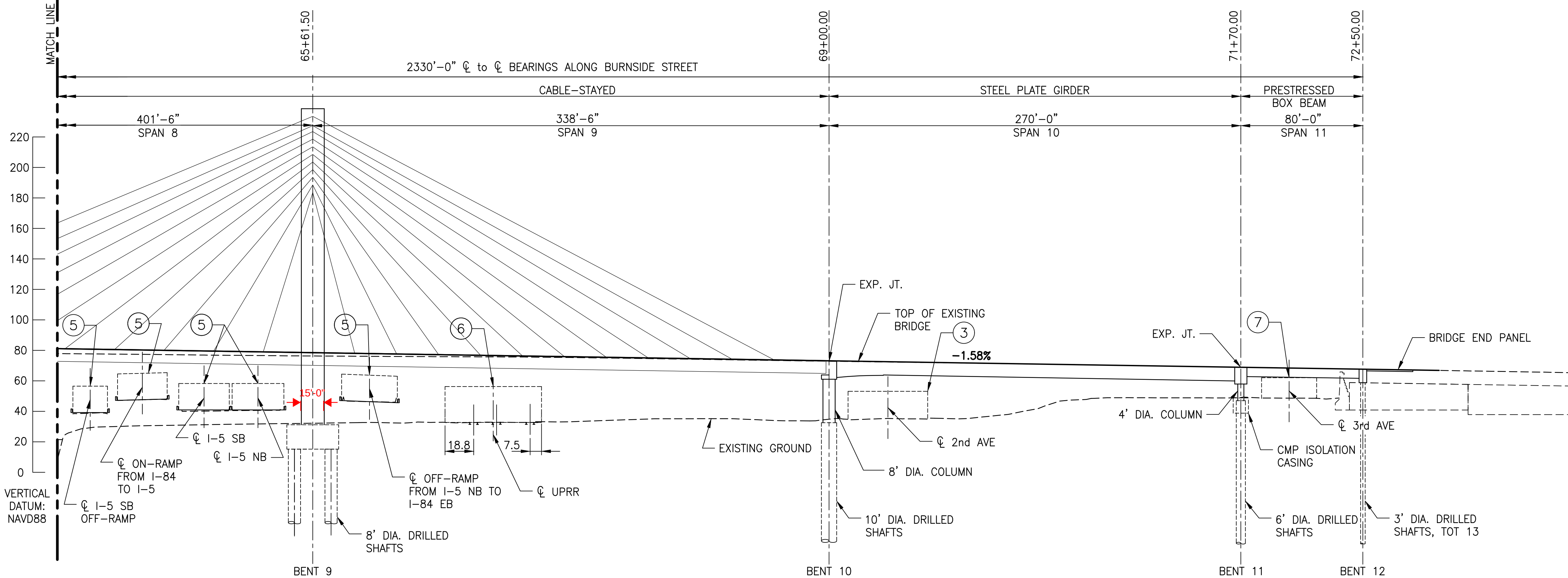
Sheet No. BR02



PLAN

SCALE: 1"=40'

Boundary of the 500 year Floopl ain



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x UNLIMITED H			

CONCEPTUAL PLANS
JANUARY 2020

Earthquake Ready Burnside Bridge

Replacement Movable Bridge (Bascule) With Long-Span Cable Approach on Existing Alignment

MULTNOMAH COUNTY

PROJECT NO.:

DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E.
COUNTY ENGINEER

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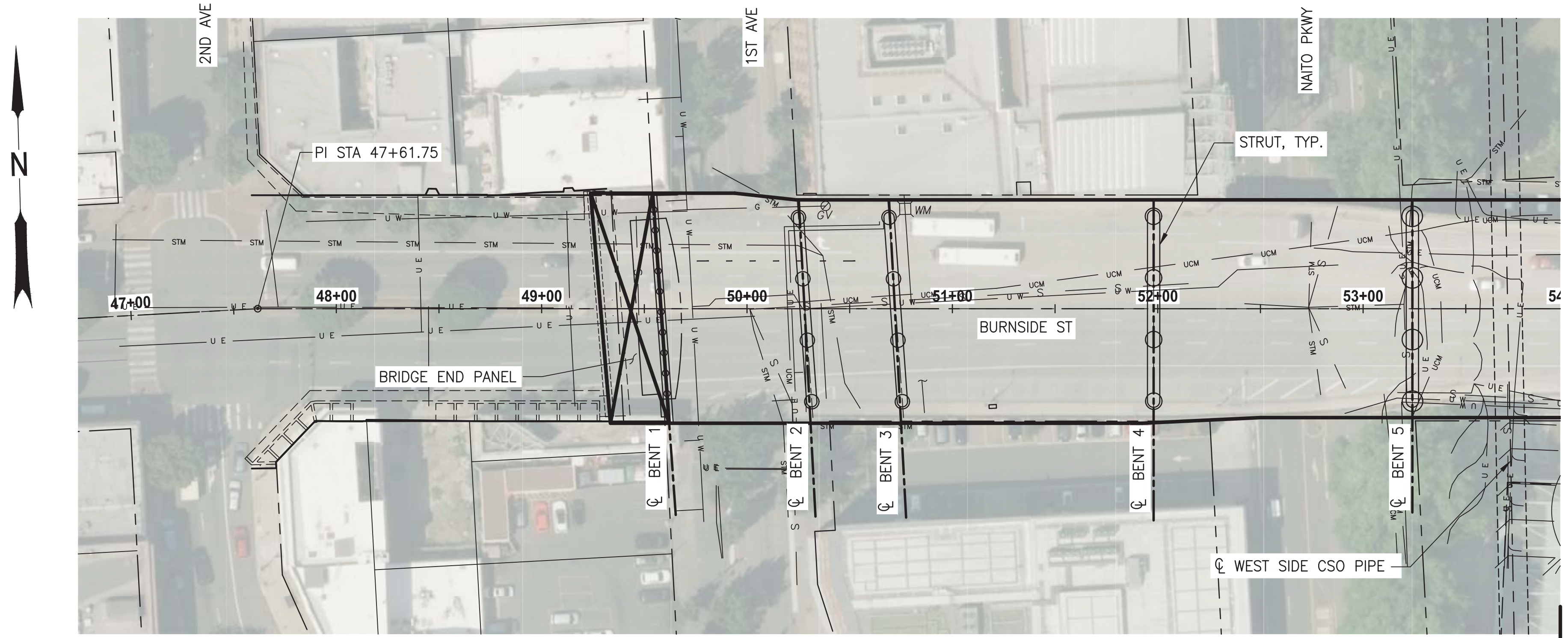
REVISIONS

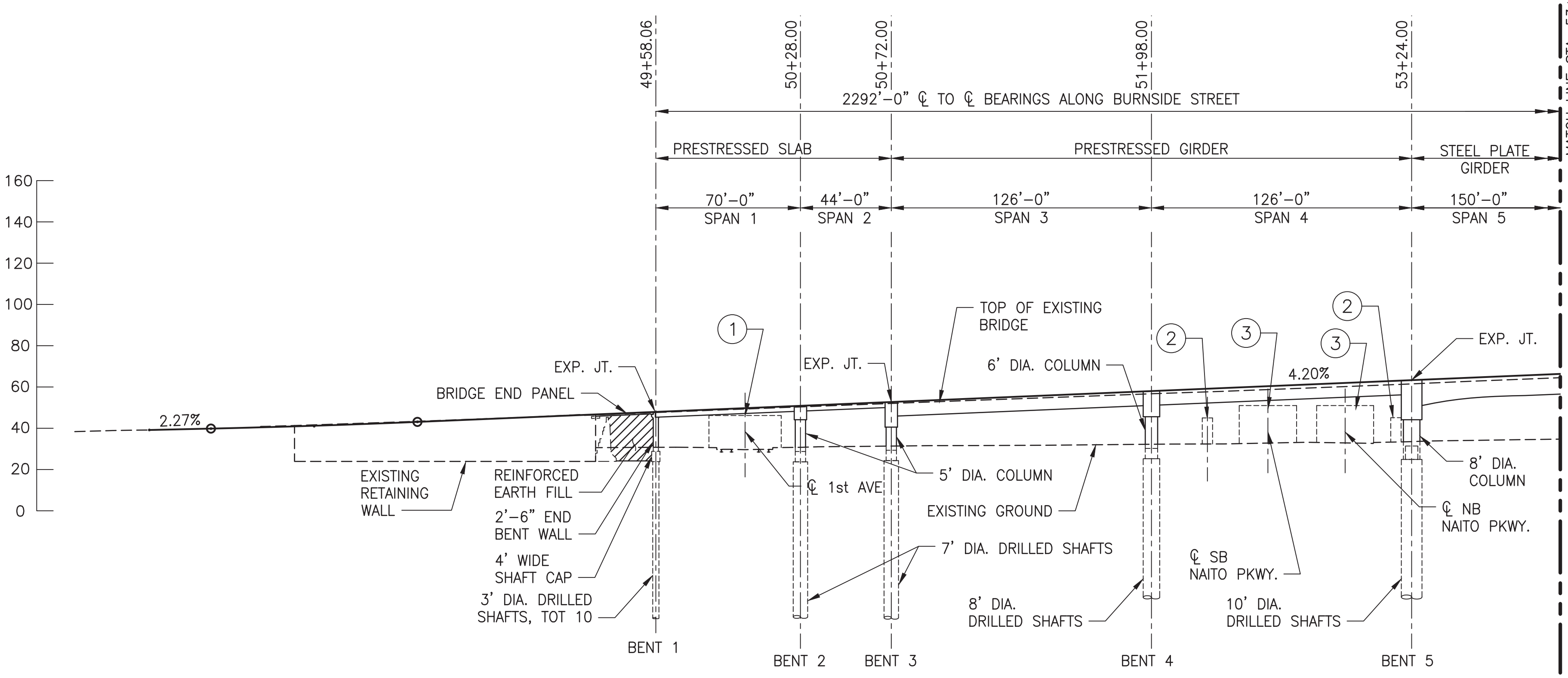
NO. DATE:

Sheet No.
BR04



PLAN

SCALE: 1"=40'



ELEVATION

SCALE: 1"=40'

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"
2	PEDESTRIAN	12'-0"
3	CITY STREET	18'-0"
4	NAVIGATION	220'-0" W x 147'-0" H
5	HIGHWAY	17'-4"
6	UPRR	23'-6"
7	CITY STREET @ 3rd AVE	13'-8"

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Couch Extension (Lift)
MULTNOMAH COUNTY

PROJECT NO.:
DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E.
COUNTY ENGINEER

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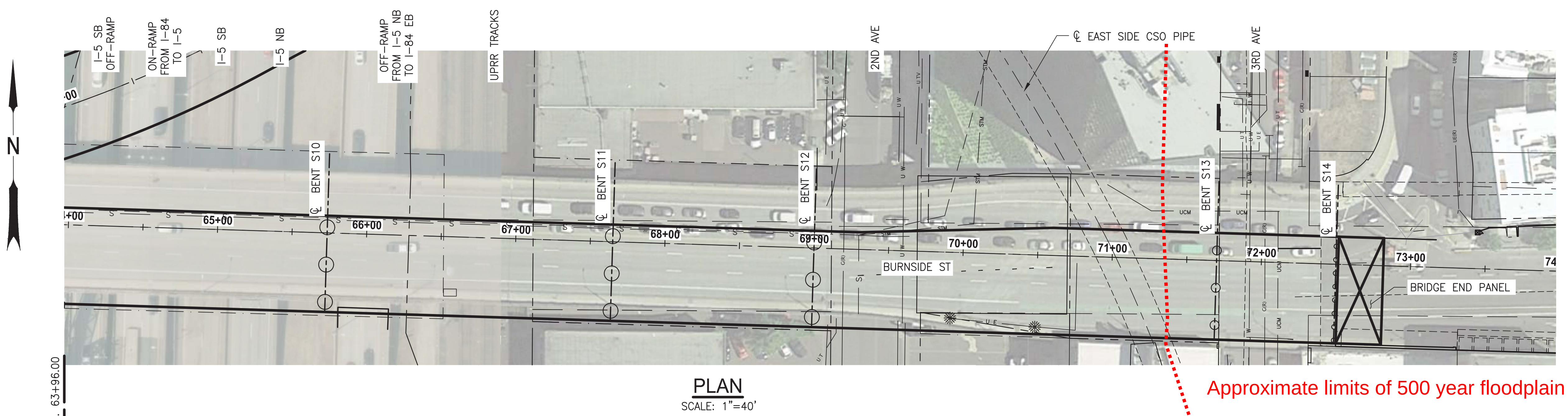
REVISIONS

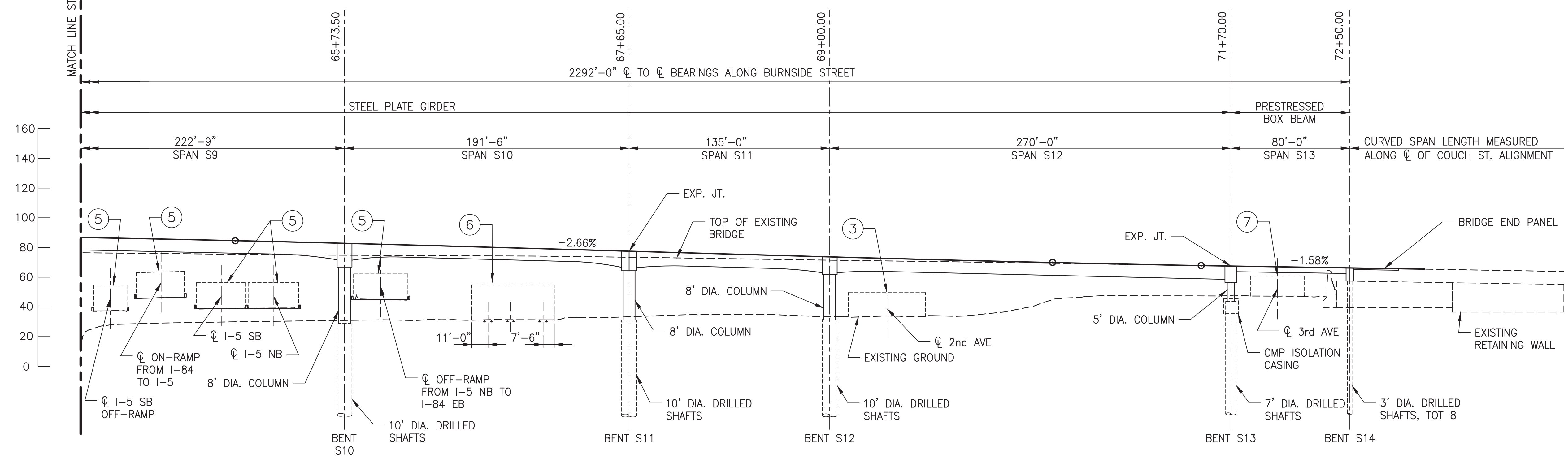
NO	DATE:

Sheet No.
BR19



PLAN

SCALE: 1"=40'



ELEVATION

SCALE: 1"=40'

NOTE:
EASTBOUND BRIDGE ELEVATION SHOWN,
FOR WESTBOUND BRIDGE SEE BR05.

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x 147'-0" H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Couch Extension (Lift)
MULTNOMAH COUNTY

PROJECT NO.:
DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E.
COUNTY ENGINEER

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REVISIONS

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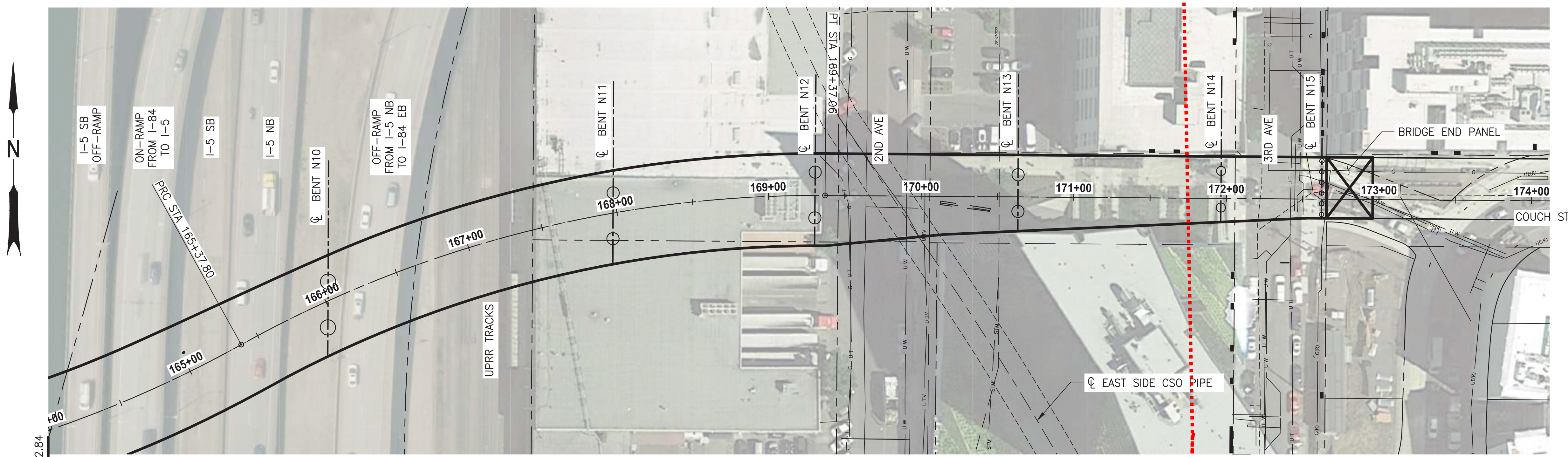
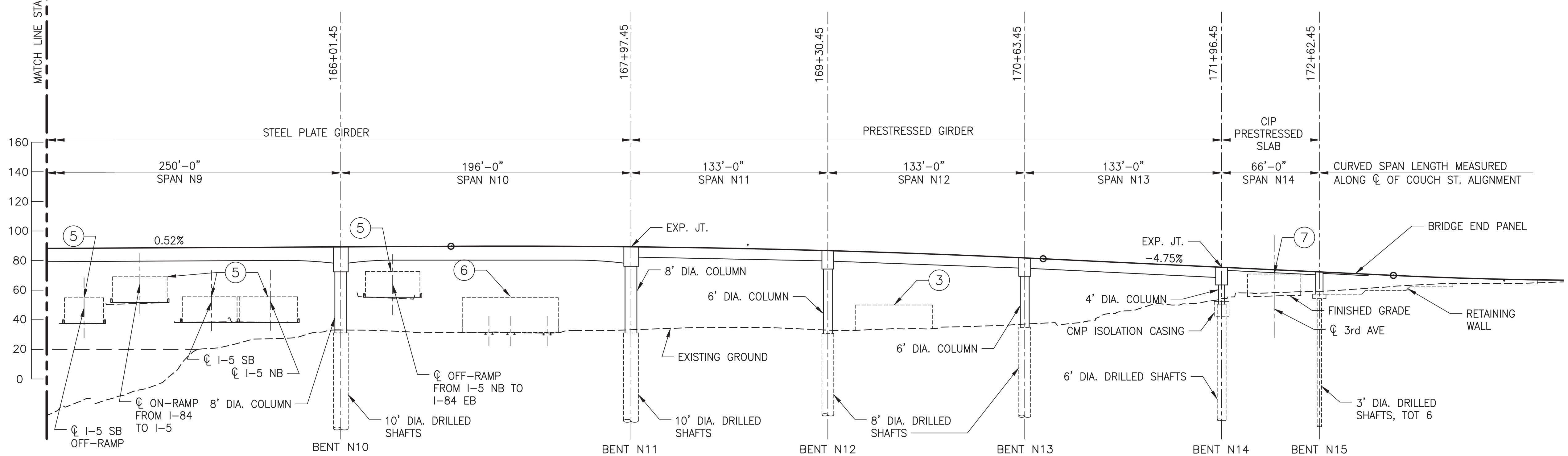
Sheet No.
BR21



PLAN

SCALE: 1"=40'



DEVELOPED ELEVATION

SCALE: 1"=40'

NOTE:
WESTBOUND BRIDGE ELEVATION SHOWN, FOR EASTBOUND BRIDGE, SEE BR04.

CLEARANCE ENVELOPE LEGEND

1	LRT	15'-6"	5	HIGHWAY	17'-4"
2	PEDESTRIAN	12'-0"	6	UPRR	23'-6"
3	CITY STREET	18'-0"	7	CITY STREET @ 3rd AVE	13'-8"
4	NAVIGATION	220'-0" W x 147'-0" H			

CONCEPTUAL PLANS
JUNE 2020

Earthquake Ready Burnside Bridge
Replacement Alternative with Couch Extension (Lift)
MULTNOMAH COUNTY
PROJECT NO.:
DATE:

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

COUNTY ENGINEER
IAN B. CANNON P.E.

DESIGNED BY:
DRAFTED BY:
CHECKED BY:

REVISIONS
NO. DATE:

Sheet No.
BR22

Temporary Bridge Flooplain Impacts - All Modes

Structural Element	Number of element	Width (ft)	Exposed element depth at BFE (ft)	Total Surface Area (sq ft)
Shaft Rows	10	2	70	1400
Temporary Pier Shafts	8	2	80	1280
Temporary Pier Protection	2	2	80	320
Total				**3000**

Temporary Bridge Floodplain Impacts - Pedestrian and Bike Only

Structural Element	Number of element	Width (ft)	Exposed element depth at BFE (ft)	Total Surface Area (sq ft)
Shaft Rows	10	2	70	1400
Temporary Pier Shafts	8	2	80	1280
Temporary Pier Protection	2	2	80	320
Total				**3000**

Assumptions:
*Assume 2 ft width of each shaft (dots) with no shaft cap extending from river bottom to bridge
*Assume shafts are exposed from assumed bathymetry of main channel analysis up to 100 year flood elevation.
*Assume East and West portion of main channel depth of 70ft
(channel depth measured at the centerpoint of the approaches using figures for floodway encroachment calculations)
*Assume Pier has a solid cap of width of 20 ft, that does not make contact with flow at BFE
*Assume center of main channel depth is 80ft
(channel depth measured at the centerpoint of the approaches using figures for floodway encroachment calculations)
*Assume presence of pier protection elements on the main channel side to protect the temporary piers.
*The pedestrian and bike configuration assumes 60% of the all modes width, (4 rows of 6 piles supporting the main piers.)
*Figures were created using the In Kind Replacement Alternative Construction Impacts sheet
*ADA Ramp Impacts will be narratively discussed and not quantified at this stage.
*Coffer Dam impacts will be narratively discussed in the construction impacts and not quantified at this stage.

Floodway Encroachment associated with Permanent Bridge or Temporary Bridge

		Permanent Bridge			Temporary Bridge		
Alternative	**Floodway Cross sectional area (sq. ft)**	**Total Lateral Surface Area (sq. ft)**	**Total Increase in LSA (sq. ft.)**	**Percent of floodway occupied**	**Total Lateral Surface Area (sq. ft)**	**Percent of floodway occupied**	**Combined Effect %**
Existing	65,683	11,213	0	17	0	0	18
Retrofit	65,683	11,394	181	17	3,000	5	22
Short Span-Bascule	65,683	15,447	4,234	24	3,000	5	29
Short Span-Lift	65,683	11,783	571	18	3,000	5	23
Long Span-Cable/Bascule	65,683	14,948	3,735	23	3,000	5	28
Long Span-Arch/Bascule	65,683	15,159	3,946	23	3,000	5	28
Long Span-Cable/Lift	65,683	11,105	17	17	3,000	5	22
Long Span-Arch/Lift	65,683	11,105	17	17	3,000	5	22
Couch-Bascule	65,683	15,428	4,216	23	3,000	5	28
Couch-Vertical Lift	65,683	12,583	1,370	19	3,000	5	24

*Total Increase in LSA = Proposed Lateral Surface Area-Existing Lateral Surface Area
*Percent of floodway occupied= (Total LSA /FW CSA)*100
Combined Effect % = permanent structures + temporary bridge

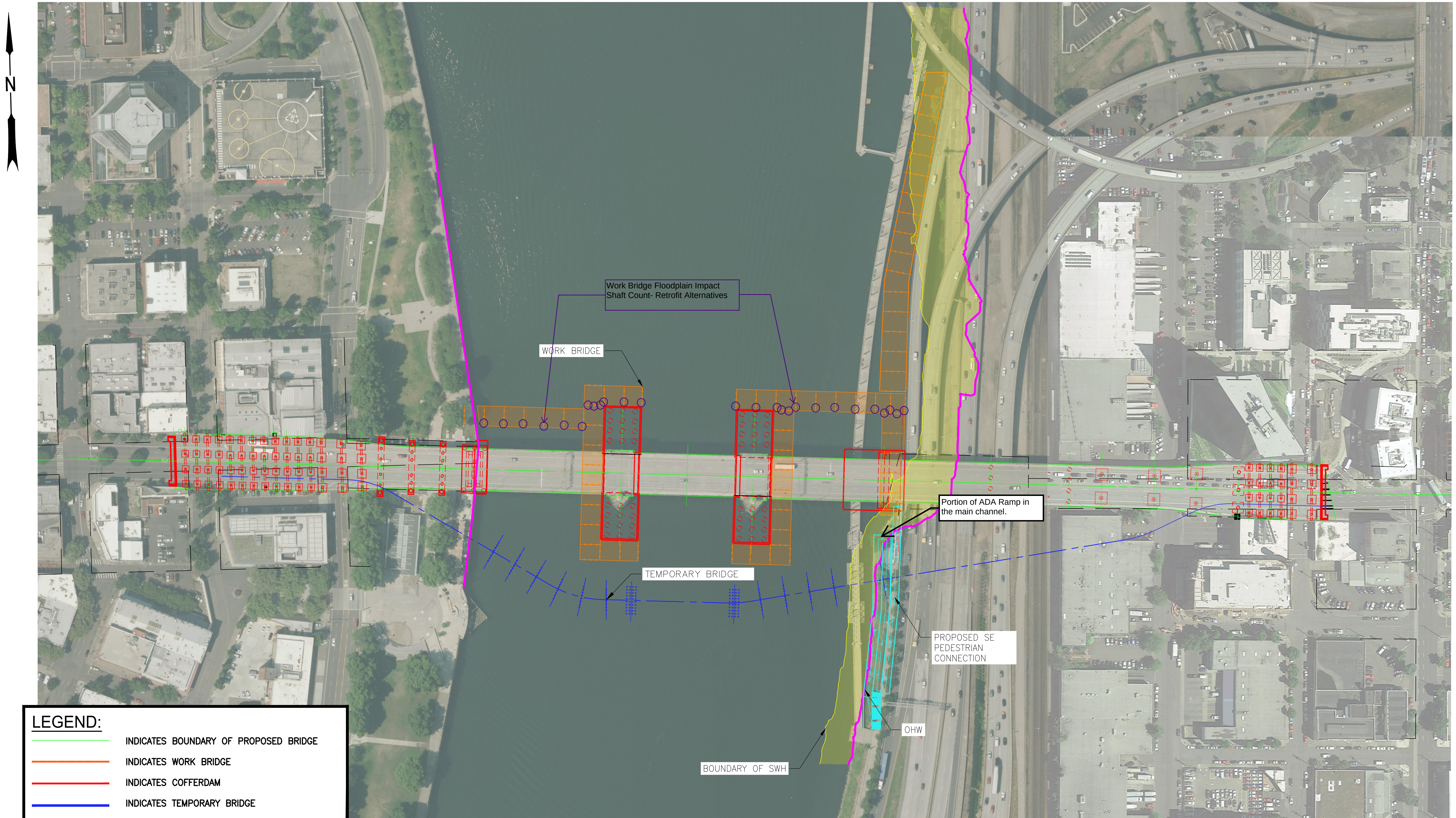
Temporary Element Impacts

		Work Bridge				
Alternative	**Floodway Cross sectional area (sq. ft)**	**Total # of piles at cross section of highest impact**	**width of piles (ft)**	**Depth of piles (ft)**	**Total Lateral Surface Area (sq. ft)**	**Percent of floodway occupied**
Existing	65,683	0	2	70	0	0
Retrofit	65,683	26	2	70	3,640	6
In Kind (Short and Long Span)	65,683	28	2	70	3,920	6
Couch (Bascule and Lift)	65,683	27	2	70	3,780	6

Assumptions:
*assume all piles have 2 foot diameter
*assume all piles are at 70 foot depth

Floodway Encroachment associated with Work Bridge Configurations and resulting combinations

		Permanent Bridge			Temporary Bridge		Work Bridge			
Alternative	**Floodway Cross sectional area (sq. ft)**	**Total Lateral Surface Area (sq. ft)**	**Total Increase in LSA (sq. ft.)**	**Percent of floodway occupied**	**Total Lateral Surface Area (sq. ft)**	**Percent of floodway occupied**	**Total Lateral Surface Area (sq. ft)**	**Percent of floodway occupied**	**Permanent and Work Bridge Combined Effect %**	**Permanent, Temporary and Work Bridge Combined Effect %**
Existing	65,683	11,213	0	17	0	0	0	0	17	17
Retrofit	65,683	11,394	181	17	3,000	5	3,920	6	23	28
Short Span-Bascule	65,683	15,447	4,234	24	3,000	5	3,640	6	30	35
Short Span-Lift	65,683	11,783	571	18	3,000	5	3,640	6	24	29
Long Span-Cable/Bascule	65,683	14,948	3,735	23	3,000	5	3,640	6	29	34
Long Span-Arch/Bascule	65,683	15,159	3,946	23	3,000	5	3,640	6	29	34
Long Span-Cable/Lift	65,683	11,105	-107	17	3,000	5	3,640	6	23	28
Long Span-Arch/Lift	65,683	11,105	-107	17	3,000	5	3,640	6	23	28
Couch-Bascule	65,683	15,349	4,136	23	3,000	5	3,780	6	29	34
Couch-Vertical Lift	65,683	12,583	1,370	19	3,000	5	3,780	6	25	30



LEGEND:

- INDICATES BOUNDARY OF PROPOSED BRIDGE
- INDICATES WORK BRIDGE
- INDICATES COFFERDAM
- INDICATES TEMPORARY BRIDGE
- INDICATES ORDINARY HIGH WATER (OHW)
- INDICATES SHALLOW WATER HABITAT (SWH)
- INDICATES PEDESTRIAN CONNECTION

CONCEPTUAL PLANS
FEBRUARY 2020

EarthQuake Ready Burnside Bridge

Environmental Impacts Enhanced Retrofit

MULTNOMAH COUNTY

Proj No

Date

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

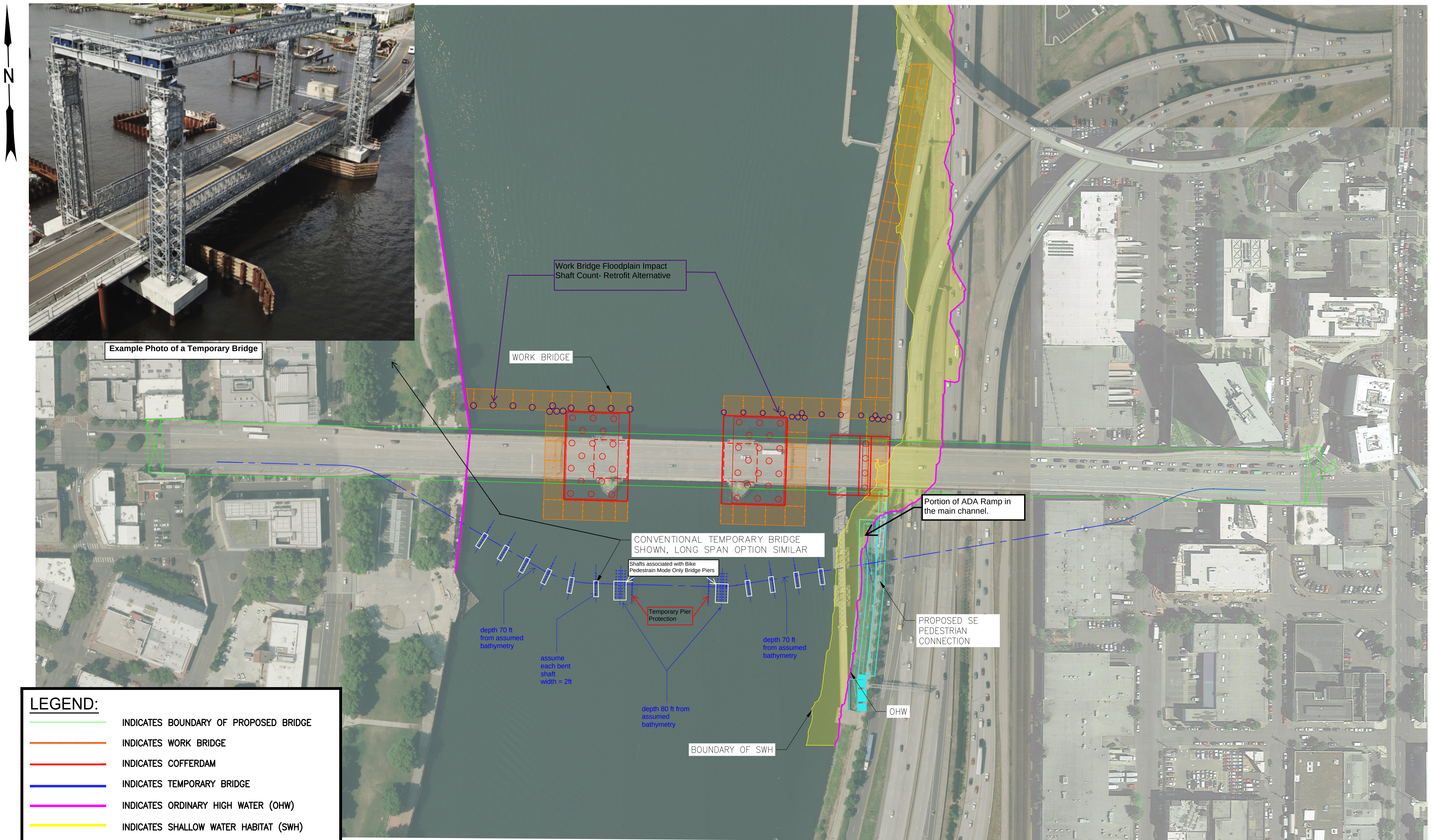
IAN B. CANNON P.E.
COUNTY ENGINEER

DESIGNED BY:
DRAFTED BY:
CHECKED BY:

REVISIONS

NO.	DATE:			

Sheet No.



LEGEND:

- INDICATES BOUNDARY OF PROPOSED BRIDGE
- INDICATES WORK BRIDGE
- INDICATES COFFERDAM
- INDICATES TEMPORARY BRIDGE
- INDICATES ORDINARY HIGH WATER (OHW)
- INDICATES SHALLOW WATER HABITAT (SWH)
- INDICATES PEDESTRIAN CONNECTION

CONCEPTUAL PLANS
FEBRUARY 2020

EarthQuake Ready Burnside Bridge

Environmental Impacts Replacement In Kind

MULTNOMAH COUNTY

Proj No

Date

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

IAN B. CANNON P.E.
COUNTY ENGINEER

DESIGNED BY:

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REVISIONS

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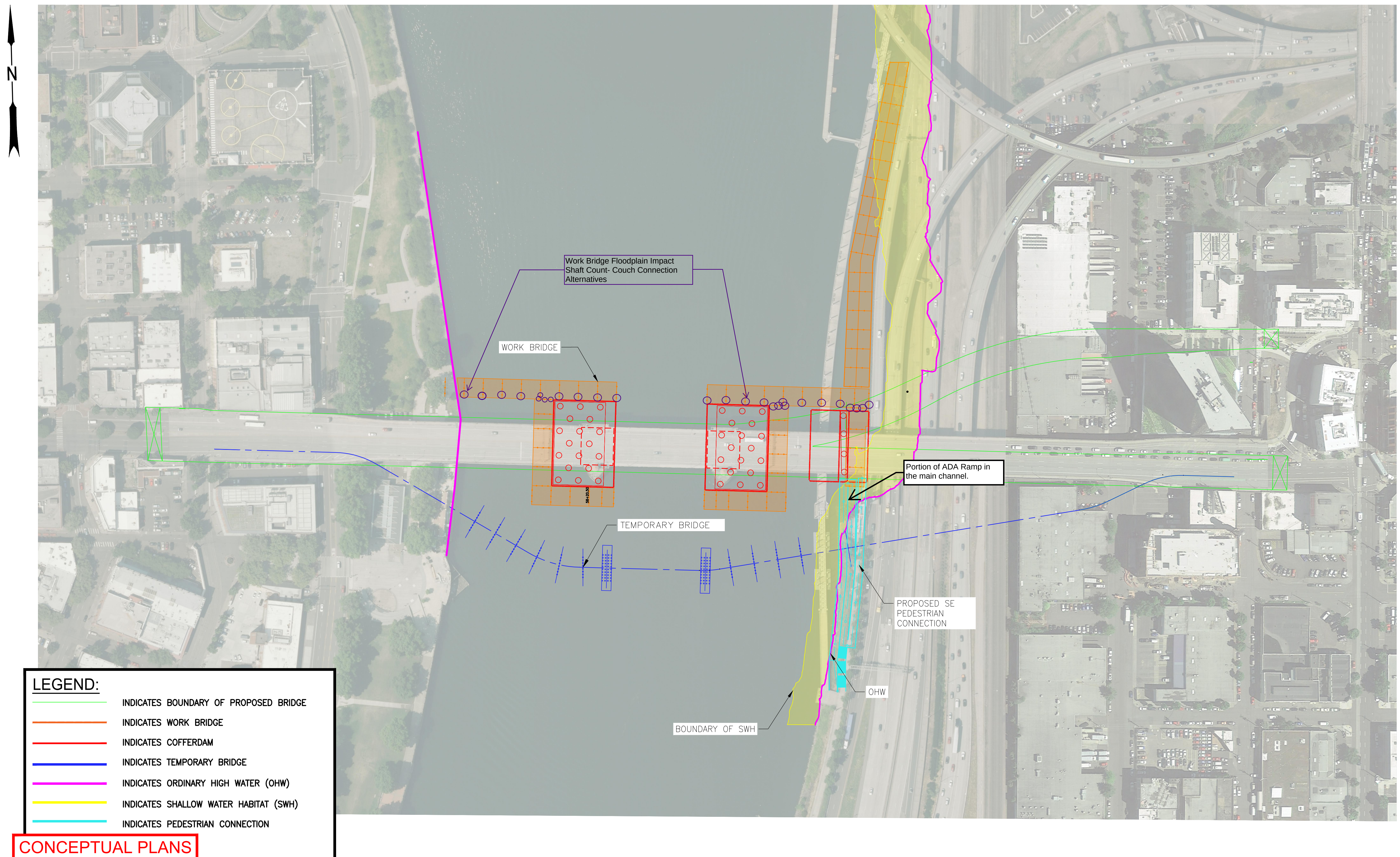

CONCEPTUAL PLANS
FEBRUARY 2020

EarthQuake Ready Burnside Bridge

Environmental Impacts Replacement with Couch Connection

MULTNOMAH COUNTY

Proj No

Date

MULTNOMAH COUNTY
DEPARTMENT OF COMMUNITY SERVICES
TRANSPORTATION DIVISION
1620 S.E. 190th AVE. PORTLAND, ORE. 97233-5999

COUNTY ENGINEER

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