Climate Change Technical Report

Multnomah County | Earthquake Ready Burnside Bridge Project

Portland, OR

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Earthquake Ready Burnside Bridge Climate Change Technical Report

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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, as a professional environmental planner.

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Acronyms, Initialisms, and Abbreviations

API	Area of Potential Impact
CO_2e	Carbon Dioxide Equivalent
CSZ	Cascadia Subduction Zone
DEQ	Oregon Department of Environmental Quality
DLCD	Oregon Department of Land Conservation and Development
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EQRB	Earthquake Ready Burnside Bridge
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Maps
GHG	greenhouse gas
ICE	Infrastructure Carbon Estimator
MOVES	Motor Vehicle Emissions Simulator
NEPA	National Environmental Policy Act of 1969
ODOE	Oregon Department of Energy
ODOT	Oregon Department of Transportation
OSTI	Oregon Sustainable Transportation Initiative
SEPA	Washington State Environmental Policy Act
STS	Statewide Transportation Strategy
UNFCCC	United Nations Framework Convention on Climate Change
USACE	U.S. Army Corps of Engineers
USC	United States Code
USGS	U.S. Geological Survey
WSDOT	Washington State Department of Transportation

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Executive Summary

As a part of the Draft Environmental Impact Statement (EIS) for the Earthquake Ready Burnside Bridge (EQRB) Project (Project), this Climate Change Technical Report has been prepared to analyze impacts from the Project that would contribute to climate change and to discuss potential impacts to the Project from future climate change conditions.

Burnside Street in Portland, Oregon, is a regionally established emergency transportation route across the Willamette River. The Earthquake Ready Burnside Bridge Project is the Multnomah County effort to build a seismically resilient Burnside Street lifeline crossing over the river that would remain fully operational and accessible for vehicles and other modes of transportation following a major Cascadia Subduction Zone (CSZ) earthquake. 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.

Based on the on-road (operational) emissions analysis for the No-Build Alternative and all of the Build Alternatives, the Project will not increase global or regional greenhouse gas emissions in a meaningful way because traffic patterns are not expected to change based on the Project design. The construction emissions resulting from the Project, as well as emissions resulting from the maintenance and operations of the Project, were analyzed for each Build Alternative, including the No-Build Alternative using project-level appropriate methods. Delays and detours resulting from construction, as well as the construction of a temporary bridge, were also considered in the analysis. The Retrofit Alternative without a temporary bridge would result in the fewest GHG emissions of the Build Alternatives because this Alternative would require less construction material, fewer construction activities, and less time to construct resulting in fewer detours and delays. Over the lifetime of the Project, construction and operations and maintenance of the Build Alternatives would likely result in fewer GHG emissions than the No-Build Alternative because of the ultimate need for a replacement bridge within the next 50 years.

The report also addresses the impact of future climate change-related conditions that could affect the Project and the Project Area, including the Willamette River and the preparedness and ability of local jurisdictions to effectively respond to extreme and catastrophic weather event. However, the degree to which these future impacts of climate change may be experienced remains uncertain, as well as the extent to which they will occur in the Project Area. All of the Build Alternatives would be designed with climate change in mind and are anticipated to be less severely affected by climate change than the No-Build Alternative.

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 greenhouse gas (GHG) emissions and climate change impacts within the Project's Area of Potential Impact (API).

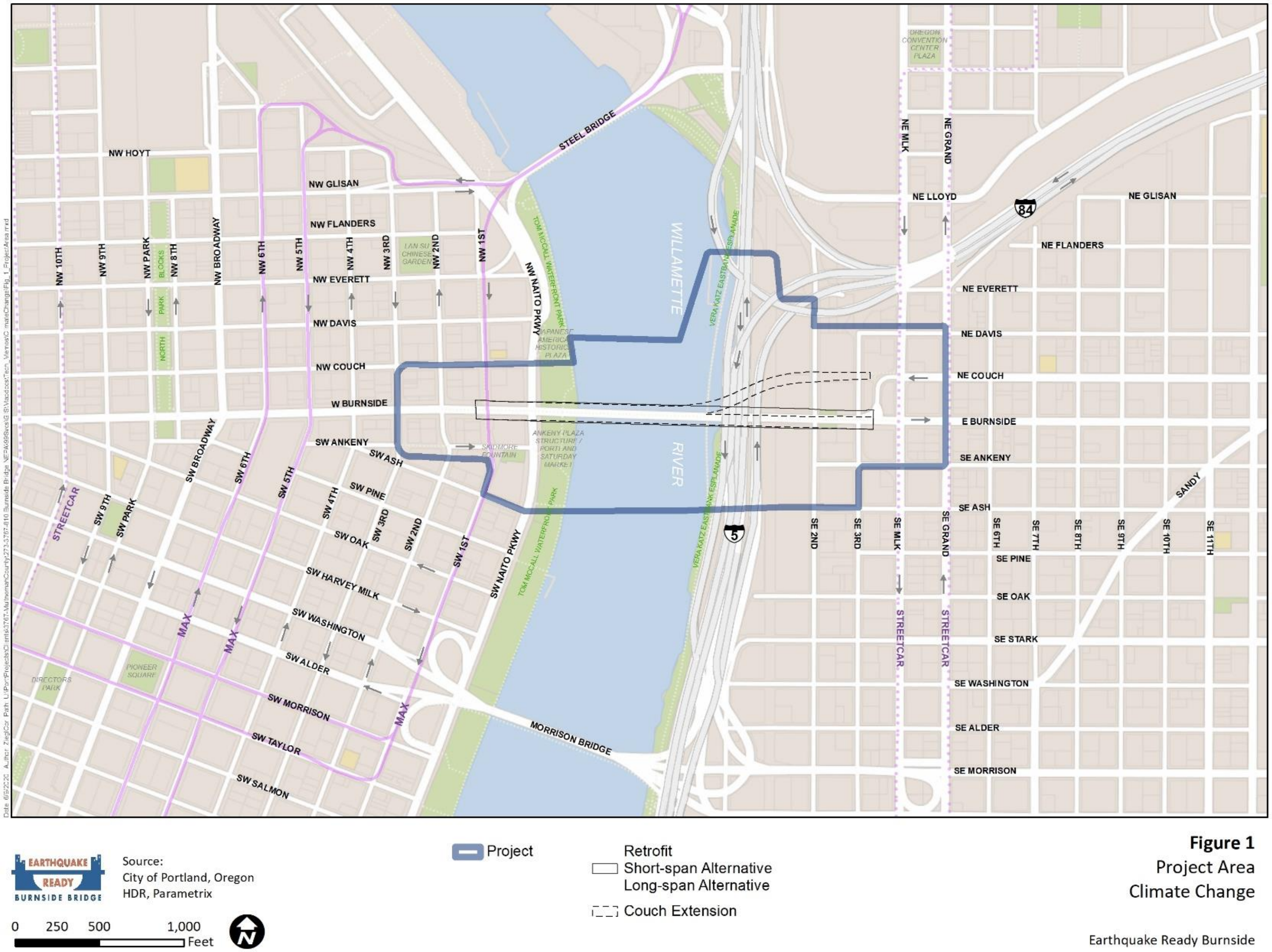
1.1 Project Location

The Project Area is located within the Central 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. The specific Area of Potential Impact (API) for climate change and greenhouse gas emissions is discussed in Section 5.1.

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 Burnside Bridge would provide a reliable crossing for emergency response, evacuation, and economic recovery after an earthquake. Additionally, the bridge would provide a long-term safe crossing with low maintenance needs.

Figure 1. Project Area



Source: City of Portland, Oregon, 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 2021a). 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 is:

- No-Build Alternative
- Build Alternatives
  - Enhanced Seismic Retrofit (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

3.1 Project Geography

The following terminology is used when discussing geographic areas:

- **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. For all topics, the API encompasses the Project Area, and for some topics (such as for utilities), the geographic extent of the API is the same as that for the Project Area; for other topics (such as for transportation effects) the API is substantially larger to account for impacts that could occur outside of the Project Area. The API for climate change 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.

3.2 Key Terms Used in this Analysis

Climate Change – The United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." Although the UNFCCC makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes, this analysis focuses on GHG emissions and climate change effects attributed primarily to human activity (IPCC 2018).

The term *climate change*, as used in this analysis, refers to a global effect whereby GHG emissions trap extra heat in the atmosphere which leads to increases in average global temperatures, extreme weather events, and other changes in the global climate. According to scientists, retained heat affects global climate in ways that adversely impact humans and natural ecosystems, with effects that can last millennia. Global climate change can lead to extended warm spells and drought, as well as more frequent flooding and sea-level rise. These changes are not evenly distributed geographically, and some regions will experience greater consequences and more frequent extreme weather events than others. In Oregon, agriculture, hydropower, public health, and infrastructure are vulnerable to climate change, as is watershed and forest health (ODOT 2013).

Greenhouse Gas Emissions are GHGs that are naturally and anthropogenically produced and discharged into the global atmosphere. The GHGs absorb heat and radiate it back toward the Earth's surface. The principal GHGs emitted by human activities are carbon dioxide, methane, nitrous oxide, and fluorinated gases. These GHG emissions result in large part from the combustion of fossil fuels such as petroleum, coal, and natural gas. In Oregon and nationwide, the transportation sector is the largest contributor to GHG emissions, followed by the residential and commercial electricity sector, industrial sector, and lastly the agricultural sector.

Base Flood is the regulatory standard also referred to as the 100-year flood. The base flood is the standard used by the National Flood Insurance Program and all federal agencies for the purposes of requiring the purchase of flood insurance and regulating new development (FEMA n.d.a).

Base Flood Elevation is the computed elevation to which floodwater is anticipated to rise during the base flood. Base flood elevations are shown on Flood Insurance Rate Maps (FIRM) and on the flood profiles. The base flood elevation is the regulatory minimum requirement for the elevation or flood-proofing of structures. The relationship between the base flood elevation and a structure's elevation determines the flood insurance premium (FEMA n.d.b).

4 Legal Framework and Standards

4.1 Laws, Plans, Policies, and Programs

The following is a list of federal, state, and local laws , programs, plans, and policies that guide or inform the assessment of climate change impacts on the Project:

4.1.1 Federal

- **Federal Highway Administration (FHWA) –** Multiple programs. There are many federal policies related to quantifying and reducing GHG emissions, such as those related to solar energy development or energy efficiency in buildings. FHWA programs (in conjunction with the National Highway Traffic Safety Administration) generally focus on reducing emissions by increasing the fuel economy of vehicles, promoting alternative fuel vehicles, encouraging transportation alternatives to driving, and improving the efficiency of the overall transportation system. This analysis and Project address FHWA policies that function to reduce transportation emissions, including programs focused on the following:
    - Improving system performance, efficiency, and Project delivery
    - Expanding transportation mode choices and safety for non-motorized modes

  Specific FHWA guidance documents include:
    - U.S. Department of Transportation Climate Adaptation Plan (USDOT 2014)
    - FHWA Order 5520, Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events
    - Integration of Resilient Infrastructure in the Emergency Relief Program (FHWA 2019). This memorandum provides clarity on how states can incorporate resilience info their emergency relief program funded projects.
- **Federal Emergency Management Agency (FEMA)** – This agency provides federal flood maps and estimates flood elevations during flood events. Locally, climate change has the potential to cause floodplain elevations to rise from increased precipitation and rising river levels. While FEMA does not regulate or prepare plans for addressing climate change, it does administer the National Flood Insurance Program and sets policy for construction within floodplains.

4.1.2 State

- **Oregon Department of Transportation (ODOT) –** The ODOT Air Quality Manual contains guidance on and methods for GHG analysis. The Oregon Sustainable

Transportation Initiative (OSTI) is an integrated statewide effort to reduce transportation GHG emissions. As part of OSTI, ODOT develops and implements the *Statewide Transportation Strategy* (STS), a state-level scenario planning effort that examines all aspects of the transportation system and identifies a combination of strategies to reduce GHG emissions. Relevant strategies outlined in the STS include the following (ODOT 2013):

- Cleaner Fuels – Support the development and use of cleaner fuels, including reduction of the carbon intensity of fuels.
- Operations and Technology – Enhance fuel efficiency and system investments and reduce emissions by fully optimizing the transportation system through operations and technology.
- Road System Growth – Design road expansions to be consistent with the objectives for reducing future GHG emissions by light-duty vehicles.
- Bicycle and Pedestrian Network Growth – Encourage local trips, totaling 20 miles or less round-trip, to shift from single-occupant vehicle to bicycling, walking, or other zero emission modes.

- **Oregon Department of Energy (ODOE), Oregon Department of Land Conservation and Development (DLCD) and Oregon Department of Environmental Quality (DEQ) –** ODOE, DLCD, and DEQ (among other agency partners) track GHG emissions and develop ways to reduce these emissions. ODOE and DLCD provide data to the Oregon Global Warming Commission, which in turn offers policy recommendations to the legislature and state agencies for meeting state GHG emission-reduction goals. The Oregon State Legislature passed House Bill 3543, setting the following specific GHG-reduction goals:
  - By 2010, arrest the growth of Oregon's GHG emissions and begin to reduce GHG emissions.
  - By 2020, achieve GHG levels that are 10 percent below 1990 levels.
  - By 2050, achieve GHG levels that are at least 75 percent below 1990 levels (see Executive Order 20-04 below for changes to this goal).

  GHG emissions recorded in Oregon in 1990 totaled 56.4 million metric tons of CO_2 equivalent (a measure used to compare the emissions from various GHGs based upon their global warming potential). If House Bill 3543 goals are met, Oregon's CO_2 equivalent should be 14 million metric tons or lower by 2050 (Oregon Global Warming Commission 2018).

- **Executive Order 20-04 (EO 20-04), Office of the Governor of the State of Oregon –** Governor Kate Brown issued an executive on March 10, 2020, that set the following specific GHG-reduction goals that exceeded goals of House Bill 3543:
  - By 2035, achieve GHG emissions levels that are 45 percent below 1990 levels.
  - By 2050, achieve GHG emissions levels that are 80 percent below 1990 levels.

  Additional provisions in EO 20-04 include stronger fuel standards, additional regulations for utility companies to reduce GHG emissions and wildfire risk, building energy-efficiency goals that aim for a 60 percent reduction in annual energy consumption compared to 2006 building codes, and the expansion of electric vehicle use and GHG impact evaluations for all transportation projects.

- **Washington State Department of Transportation (WSDOT) –** *WSDOT Guidance – Project-Level Greenhouse Gas Evaluations under NEPA and SEPA*[1] and WSDOT *Guidance for NEPA and SEPA Project-Level Climate Change Evaluations*. While not applicable to projects in Oregon, these guidance documents provide a standard analytical process and template for addressing GHG emissions in environmental documentation such as the analysis for this climate change technical report.

4.1.3 Local

- **City of Portland and Multnomah County *Climate Action Plan* (2015)**. In 1993, Portland became the first city in the U.S. to create a local action plan for reducing carbon emissions. The City of Portland and Multnomah County now collaborate to prepare updated climate plans to help guide the design and implementation of efforts to reduce carbon emissions in the city and county. The current update is the 2015 Climate Action Plan (CoP and MC 2015). The following are applicable objectives to be completed by 2030:
    - Create vibrant neighborhoods where 80 percent of residents can easily walk or bicycle to meet all basic daily, non-work needs and have safe pedestrian or bicycle access to transit. Reduce daily per capita vehicle miles traveled by 30 percent from 2008 levels.
    - Improve the efficiency of freight movement within and through the Portland metropolitan area.
    - Increase the fuel efficiency of passenger vehicles to 40 miles per gallon and manage the road system to minimize emissions.
    - Reduce lifecycle carbon emissions of transportation fuels by 20 percent from 2015 levels.
    - Reduce risks and impacts from flooding and landslides by preparing for warmer winters with the potential for more intense rain events.
    - Build City and County staff and community capacity to prepare for and respond to the impacts of climate change.
- **City of Portland and Multnomah County *Climate Change Preparation Strategy* (2014)**. This document (CoP and MC 2014) identifies actions to prepare for the changing climate including reducing climate-related vulnerabilities for residents and businesses and responding to impacts when they do occur. Applicable actions to be completed by 2030 include the following:
    - Work with FEMA to update the floodplain-mapping program to reflect potential variances due to climate change in the 100-year floodplain maps.

[1] NEPA = National Environmental Policy Act; SEPA = Washington State Environmental Policy Act

- Address floodplain hazards through the Comprehensive Plan update and provide guidance to regulate or manage development in the floodplain.
- Use updated floodplain data to inform city and county land use (e.g., ensure space below the base flood elevation is not converted to habitable space), transportation, and other infrastructure-planning processes.
- Participate in federal flood protection efforts and policy decisions on the Columbia and Willamette Rivers, such as the Columbia River Treaty renegotiation and the process for Columbia River levee recertification.
- Improve Portland's rating under the National Flood Insurance Program Community Rating System and minimize flood insurance rate impacts by working with FEMA, DLCD, neighboring communities, and landowners to (1) develop and implement actions that minimize flood damage to structures, and (2) protect, restore and enhance natural floodplain function.
- Develop the stormwater *System Plan* and update the *Stormwater Management Manual* and the drainage rules to better manage increased winter precipitation, including reevaluating the modeled 24-hour storm event design standard.
- Incorporate landslide hazard-reduction techniques into public infrastructure projects.

- **City of Portland *Central City 2035* (2018).** Provides recommendations for supporting transportation alternatives that lower the city's carbon footprint and promote human health. Policies in *Central City 2035* (CoP 2018) addressing climate change include (but are not limited to) the following:
  - Periodic flooding – Minimize the risk to new and existing development and infrastructure from flood events, while also maintaining and enhancing ecological functions associated with the river and floodplain. (Policy 4.7)
  - Natural hazard resilience – Encourage planning, design, and education in the Central City to help prevent or minimize the impacts of natural hazards such as earthquakes, floods and other hazards identified in the citywide Natural Hazard Mitigation Plan. (Policy 6.1)
    - New development – Encourage approaches to reduce future natural hazard risks and impacts when planning for or evaluating the location and design of new development.
    - Retrofitting – Encourage the retrofitting of buildings and infrastructure to withstand natural hazards. Prioritize the seismic retrofitting of unreinforced masonry buildings while preserving their architectural character. Support Multnomah County's efforts to seismically retrofit Central City bridges, recognizing the Burnside Bridge as the regionally designated priority.
    - Preparedness – Support Central City residents' and businesses' efforts to prepare for natural hazards. Ensure the Central City's most vulnerable populations are included in these efforts.
    - Code review – Monitor relevant codes to incorporate current knowledge and standards for seismic design and flood protection.

  - Climate change resilience – Support planning, service system upgrades, and infrastructure in the Central City to anticipate, respond to, and reduce the risks and adverse impacts associated with evolving climate change conditions. (Policy 6.2)
    - Flooding – Adapt to changes in hydrology, including future river levels, changes in flood frequency and duration, and changes in stormwater runoff rates.
  - Flood-ready development – Reduce risks of flooding on existing and new buildings, transportation system and infrastructure. (Policy 6.5)
    - Flood capacity – Improve flood capacity by reducing development impacts and requiring mitigation for fill within the 100-year floodplain.
    - Building design – Encourage innovated building design along the Willamette River and in the 100-year floodplain to allow for ground floor flooding.
  - Low-carbon development – Reduce carbon emissions from existing and new buildings, transportation systems and infrastructure. (Policy 6.14)
- **Metro *Climate Smart Strategy for the Portland metropolitan region***. Metro has adopted a set of policies, strategies, and near-term actions to guide the reduction of GHG emissions while furthering local land use and transportation visions (Metro 2014). The short-list of climate smart actions from 2015–2016 that are relevant to the EQRB Project are listed below:
  - Advocate for increased federal, state, regional and local transportation funding for all transportation modes as part of a diverse coalition, with top priorities of maintaining and preserving existing infrastructure, and implementing transit service enhancement plans and transit-supportive investments.
  - Advocate for federal and state governments to advance Oregon's transition to cleaner, low-carbon fuels, and more fuel-efficient vehicle technologies.
  - Seek opportunities to advance local and regional projects that best combine the most effective GHG emission-reduction strategies.
- **Metro Urban Growth Management Functional Plan Title 3 (Sections 3.07.310-3.07.360) – Water Quality and Flood Management.** This section of the plan protects beneficial water uses and functions and values of resources within Water Quality and Flood Management Areas by limiting or mitigating impacts from development activities and protecting life and property from dangers associated with flooding.
  - The Project is required to adhere to the regulations set out by the Urban Growth Management Functional Plan Title 3 and implement balanced cut and fill (no net increase in fill within the floodplain) to minimize flood impacts.

4.2 Design Standards

4.2.1 Climate Change

The following design standards required by federal, state, and local law, or by agency policy function to protect human and environmental health and apply to the analysis of climate change impacts:

- **U.S. Coast Guard Bridge Locations and Clearances** – The Willamette River is deemed a navigable water of the U.S. The Code of Federal Regulations (specifically 33 CFR 115) provides the requirements for applying for a permit to construct or modify bridges crossing navigable waters of the U.S. It also sets forth the procedures by which the application is processed by the Coast Guard. Rising sea levels and changes in rainfall patterns associated with climate change could result in rising river levels and, therefore, the design of higher bridge elevations. Bridge designs generally consider high-water scenarios that incorporate current scientific understanding of rising river levels and flood levels for bridge clearances.
- **FEMA Floodplains** – Design standards would be based on the requirements within different FEMA-mapped floodplains. The Burnside Bridge is located within and crosses the regulated floodway of the Willamette River. The east side of the bridge is located in Zone AE. The west side of the bridge is in a minimal flood area with 0.2 percent annual chance of flood hazard, Zone X (see Figure 2).
- **Multnomah County Clean Air Construction Standards** – These standards are meant to reduce emissions during the construction phase of a County project.

Additionally, while not design requirements, FHWA provides guidance and tools to assist with designing projects for climate resiliency, including on determining the potential magnitude and impacts of extreme weather events, and on designing projects to adapt to changing climates.

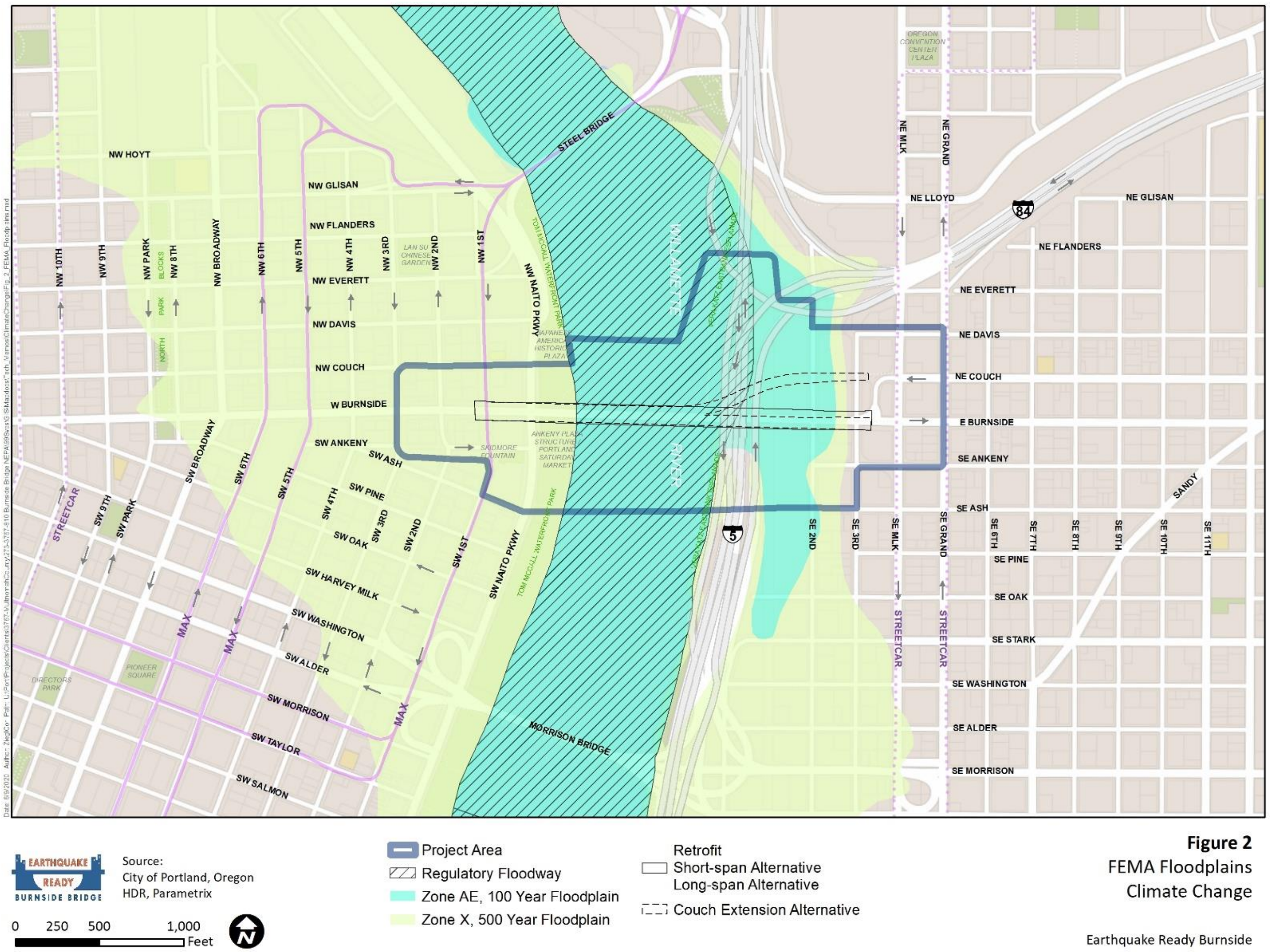
5 Affected Environment

5.1 Area of Potential Impact

The API for the climate change analysis is different than the traditional resource contexts and frameworks. At the local level, the Willamette River and its streambanks within Multnomah County are considered the API for future climate effects to the Project and to account for potential future changes in floodplain levels associated with the Willamette River. This is discussed in Section 5.3.2 and is also addressed in the EQRB Hydraulic Impacts Technical Report (Multnomah County 2021d).

The API for Project GHG emissions is defined by the Project footprint, including construction staging and detour routes. This accounts for the construction materials used for the Project and their origins. While Project GHG emissions would disperse into the global atmosphere, and, thus, contribute to the cumulative or global GHG emissions, this analysis focuses on the Project impacts to the Portland metropolitan region. The API is defined this way to provide a meaningful analysis of the Project's contribution of GHG emissions.

Figure 2. FEMA Floodplains



Source: City of Portland, Oregon, HDR, Parametrix

5.2 Resource Identification

5.2.1 Published Sources and Databases

The following were used to determine and describe existing conditions for the climate change technical report.

- The U.S. Geological Survey (USGS) Flood Inundation Mapping program (USGS n.d.) was used to estimate river flow data and flood forecasts to understand potential flooding scenarios for the Project Area.
- The Greenroads® Rating System (Greenroads n.d.) and comparable Greenroads-certified projects were reviewed. Information from Greenroads also forms the basis of the separate Greenroads Technical Report (Multnomah County 2021c).
- Hydraulic modeling completed by the U.S. Army Corps of Engineers (USACE) and USGS (assessments of Columbia and Willamette River flood stage on the Columbia Corridor Levee System) was used for the impact analysis of potential extreme weather events due to climate change on Willamette River levels.
- The Fourth Oregon Climate Assessment Report (2019) by the Oregon Climate Change Research Institute (OCCRI 2019) was used to present the state of knowledge of climate science as it pertains to Oregon and the Project.
- The 2012 ODOT Climate Change Adaptation Strategy Report (ODOT 2012) details the adaptation planning and strategy development that would help reduce the vulnerability of infrastructure to the impacts of climate change. The ODOT Climate Change Adaptation Strategy, in conjunction with the STS, was used to evaluate the current conditions of the impact of climate change on the existing bridge and the infrastructure in the Project Area.
- The Environmental Protection Agency (EPA) Motor Vehicle Emissions Simulator (MOVES; EPA n.d.) is an emission modeling system used to estimate GHG emissions for mobile sources at national, county, and project levels.
- FHWA's Infrastructure Carbon Estimator Tool (ICE; FHWA n.d.) was used to calculate estimated Project-related GHG emissions from construction and maintenance over the bridge's lifecycle.

5.2.2 Field Visits and Surveys

No field surveys or testing were conducted for the climate change analysis.

5.2.3 Contacts and Coordination

The Project includes an extensive public involvement and agency coordination effort, including local jurisdictions and neighborhoods within the Project Area. Potential contacts for climate change are listed below:

- FHWA Environmental Program specialists
- ODOT – Natalie Liljenwall, Air Quality Program Coordinator, and Michael Holthoff, Statewide NEPA Program Leader

- Multnomah County – John Wasiutynski, Director of the Multnomah County Sustainability Office
- City of Portland Bureau of Environmental Services specialists
- Greenroads Program staff and/or Greenroads Foundation members

5.3 Existing Conditions

5.3.1 GHG Emissions and Emissions Reductions Targets

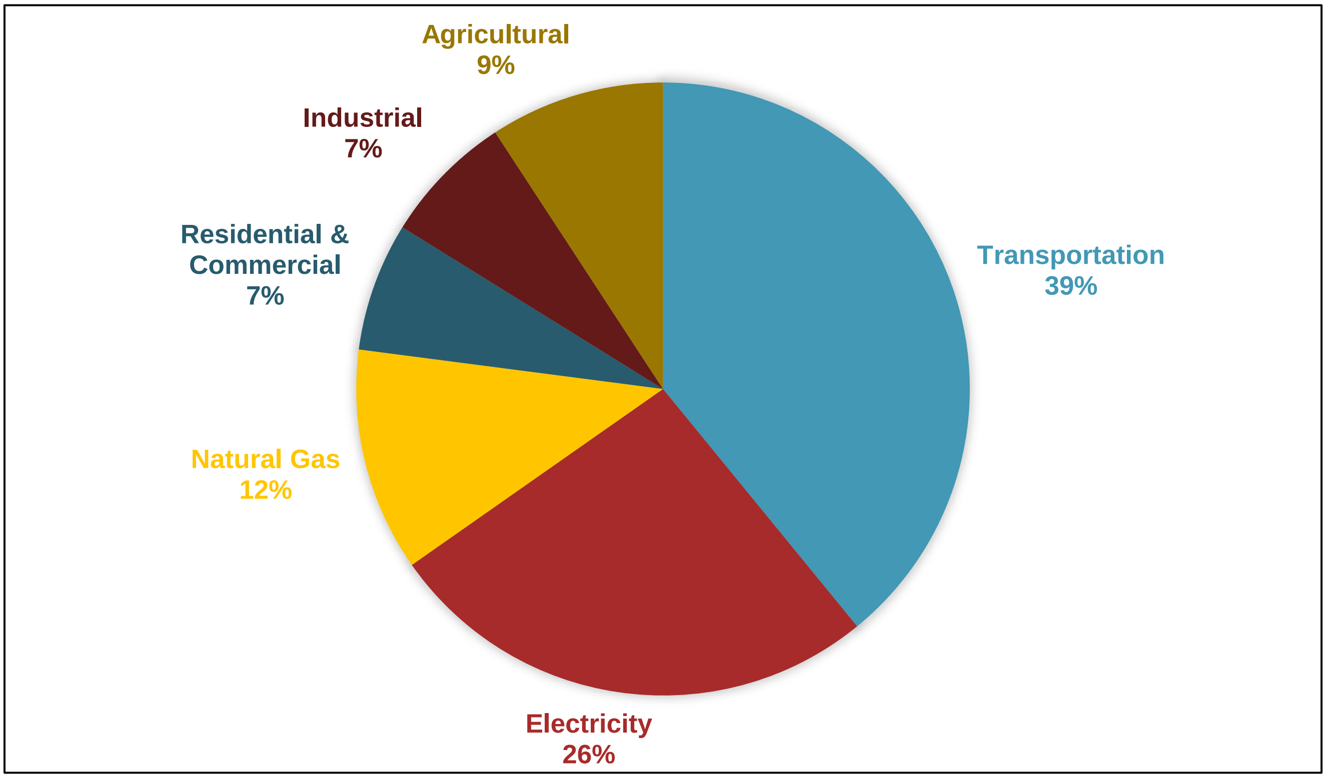
The State of Oregon has implemented a number of climate change–related policies and laws. For example, in 2016 Oregon passed the nation’s first coal-to-clean law (Clean Electricity and Coal Transition Bill) which eliminates electricity sourced from out-of-state coal-fired plants by 2030 and requires that Oregon’s large utilities supply 50 percent of all electricity from new renewable resources by 2040. Oregon has incentivized pursuing some clean energy solutions and has put policies in place that protect the state’s natural resources. House Bill 3543, passed in 2007, set specific goals for GHG emission reductions by 2020 and 2050.

While Oregon has demonstrated policy support in environmental stewardship and in building clean energy economies, there is much work to be done for these goals to be met and for the environmental, economic, and health effects of climate change to be slowed. The transportation sector is the largest contributor to human-caused GHG emissions both nationally and in Oregon. Figure 3 and Figure 4 show county and state emissions by sector. Passenger vehicles and light-duty trucks generate almost half of the transportation sector emissions, followed by heavy-duty trucks, aviation fuels, and boats. To achieve GHG-reduction targets, progress to reduce fossil-fuel emissions through trip reduction, system efficiency, and/or increased fuel efficiency will be required for all of these transportation modes. The STS was developed by ODOT to sustainably reduce GHG emissions and achieve the 2050 goal of a 75 percent reduction below 1990 levels.

5.3.2 Climate Change Consequences in Oregon

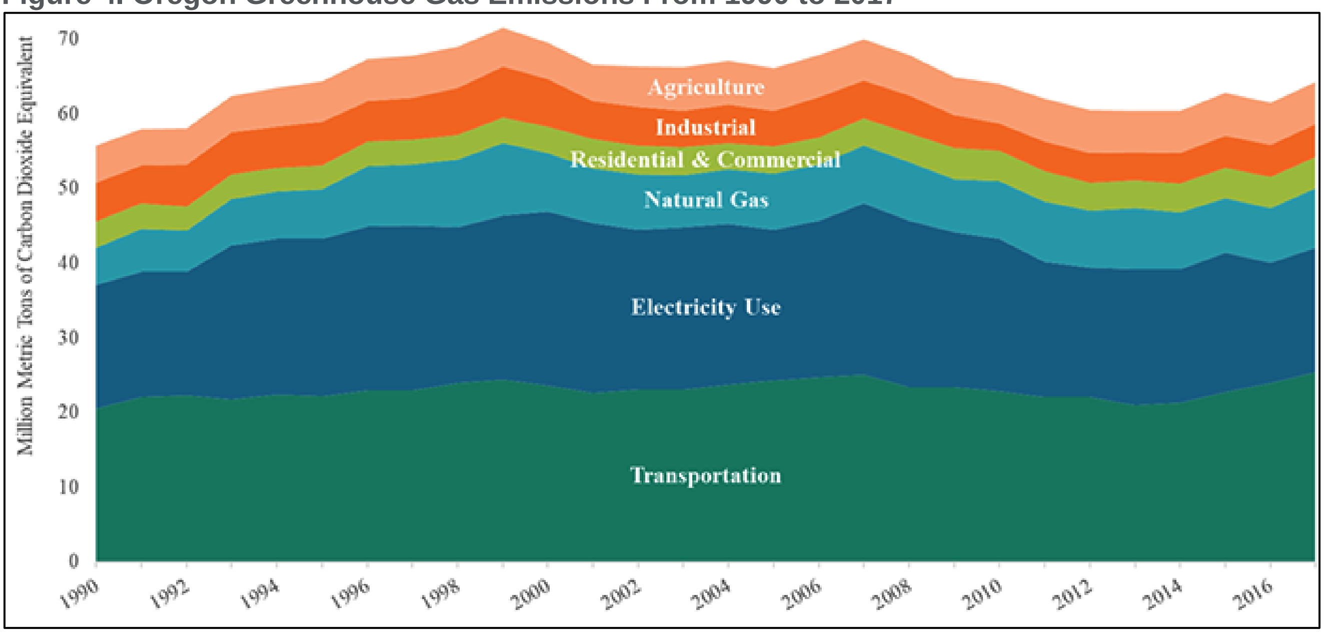
Climate change and its broad range of compounding effects are altering the social, economic, and environmental systems of the world. The impacts of climate change on the hydrological cycle will result in sea-level rise, changes in precipitation patterns and weather events, and additional runoff and associated flooding. Average summer temperatures will be higher, high-heat days will be more frequent, and summer streamflow will be reduced because of diminishing winter snowpack and seasonally drier conditions. Winters are expected to be warmer, and incidences of cold extremes will decrease. Increased and more variable streamflow in the winter will be a consequence of more intense rain events. Precipitation increases, especially in large quantities over a relatively short duration, will increase urban flooding events, groundwater levels, river levels, and risk of subsequent landslides (Mote et. al 2019).

Figure 3. Multnomah County Carbon Emissions by Sector (2017)



Source: Oregon Global Warming Commission, 2018 Biennial Report (Oregon Global Warming Commission 2018)

Figure 4. Oregon Greenhouse Gas Emissions From 1990 to 2017



Source: Oregon Department of Environmental Quality, Oregon GHG Sector-based Inventory Data (DEQ 2018)

With global temperatures increasing, sea-level rise is measurable and could impact a non-coastal city such as Portland because of tidal influences on the Columbia and Willamette Rivers. Additionally, winter river flows are expected to increase along with predicted increases in the frequency and intensity of storm surges and extreme weather events. In research conducted by USACE and USGS for the Levee Ready Columbia project, hydraulic modeling shows that current predicted flood-stage levels of the Willamette and Columbia Rivers could be dramatically altered by the effects of climate change. According to a recent assessment of Columbia and Willamette River flood stages prepared by USGS, USACE, and Levee Ready Columbia:

> "A large storm surge in combination with high flows associated with a winter storm is not a remote possibility as the atmospheric rivers that cause rain-on-snow winter floods in the Willamette River Basin often are associated with storm surges at the coastline. If circumstances are particularly adverse, high storm surge can be associated with a high spring tide, which can add another few meters to ocean water surface elevation. Therefore, when considering an extreme but plausible high flow in Portland, it is prudent to consider a storm surge and high tide at the ocean occurring in concert." (Wherry et al. 2019)

Average and peak river levels, floodplain areas and depth, and bridge clearances could be impacted by the increases in precipitation and the frequency and magnitude of extreme weather events associated with climate change. The factors that affect where and when floods occur and linking floods directly to climate change are not comprehensively understood. However, while climate change may not induce floods directly, it exacerbates many of the factors that do such as rainfall, snowmelt, and patterns of extreme weather events which can be compounded by dam or levee breaks, inadequate stormwater drainage systems, and increased urbanization and development in the floodway. Recent examples of extreme weather events and subsequent fatal and destructive floods are Hurricane Katrina in New Orleans (2005), Hurricane Sandy in New York and New Jersey (2012), Hurricane Harvey in Houston (2017), and Hurricane Maria in Puerto Rico, Dominica, and the U.S. Virgin Islands (2017). While these particular events are examples of coastal flooding, they demonstrate the flood-related consequences that could become more frequent in the future that could also be exacerbated by other factors such as sea-level rise. With respect to the Project Area, an extreme but plausible high-flow situation on the Willamette River could result in destabilized bridge approaches due to landslide and soil instability, as well as inadequate bridge clearances for the passage of water vessels.

The degree to which these future impacts of climate change may be experienced remains uncertain, as well as the extent to which they will occur in the Project Area. In an extreme weather event, the current ability of local jurisdictions to respond and the preparedness of the city, county, and state agencies to communicate and address impacts and challenges is also considered an existing condition. Existing infrastructure and emergency response systems have been designed to manage severe weather and hazards to the extent that they are known to occur. Therefore, the limitations of local jurisdictions to effectively respond to extreme and catastrophic weather events is considered an existing condition in the Project Area.

5.3.3 Emissions Modeling

FHWA Infrastructure Carbon Estimator Tool

ICE was used to calculate estimated Project-related GHG emissions from construction and maintenance over the bridge's lifecycle. Estimates include emissions from materials (production, transportation, chemical reactions), construction equipment and fuel, and routine maintenance of the bridge. Default settings in ICE were used for materials as well as construction equipment and fuel. While maintenance schedules would vary somewhat depending on the Alternative selected, that variability is too speculative to know at this point in Project engineering to include in ICE. For this reason, default values were used. This information is presented in Section 7.4, Construction Impacts.

MOVES

The MOVES (EPA n.d.) is an emission modeling system used to estimate air pollutant and GHG emissions for mobile sources at the national, county, and project levels. EPA MOVES was used to estimate Project GHG emissions associated with traffic delays from construction such as those from bridge closure and temporary bridge usage. This information was obtained from traffic data provided by Metro and ODOT and is based on the traffic analysis. The MOVES results are presented in Section 7, Environmental Consequences.

5.3.4 Climate Change–Induced Floodplain Elevation

USGS Flood Inundation Mapping Program

This program estimates streamflow data and flood forecasts to help understand potential flooding scenarios for the Project Area. For the Willamette River in the Portland area, the National Weather Service deems 18 feet above the gauge height (0 feet) as flood stage. The nearest gauge to the Project Area is located at the Morrison Bridge, approximately 0.35 miles south and upstream from the Burnside Bridge. The following table explains predicted flooding scenarios based on water level in feet above the gauge height.

Table 1. Flood Categories in the Project Area

Water Level (feet)	Flood Description
30	Above 30.0 ft, expect flooding of downtown Portland from Park Ave east to the Willamette and north of Burnside. Historically, Union Station begins to flood at this point, and rail traffic would likely be impacted. Expect flooding of Oaks Park, along with moorages and industrial areas from Oregon City through downtown Portland into industrial NW Portland.
28.8	At 28.8 ft, expect the river level to reach the top of the lowest point of the downtown Portland seawall. Flooding of some portions of Waterfront Park is possible at this and higher stages.
27	Above 27.0 ft, expect flooding of Front Street near the Burnside Bridge.
26	Above 26.0 ft, expect flooding of numerous structures along the Willamette River from Oregon City to the confluence with the Columbia.

Water Level (feet)	Flood Description
24	Above 24.0 ft, expect localized flooding in the NW Portland industrial area.
22	Above 22.0 ft, expect minor localized flooding along the Willamette from Oregon City to the confluence with the Columbia.
18	Above 18.0 ft, expect minor flooding of localized areas along the lower Willamette. Flooding is mainly confined to the islands on the Willamette River from Oregon City to the confluence with the Columbia.
17	Above 17.0 ft, expect flooding of some low spots of trails along the west and east banks of the Willamette in and near downtown Portland.

Source: National Weather Service 2019.

The most recent high-water level crest occurred on March 30, 2017, at 17.30 feet. The highest recorded crest occurred in 1894 at 33.00 feet. Water levels are observed and recorded every 15 minutes, 24 hours per day. Forecast data are available from the National Weather Service for up to 10 days from the current date.

The water levels and flooding descriptions in Table 1 are based on current and past conditions and do not account for potential extreme future scenarios predicted in preliminary data sets from USGS and USACE. In these preliminary findings, rain and snow events are more likely to increase flood risk for the Willamette and Columbia Rivers in the future as climate change intensifies seasonal weather patterns and increases sea levels. While an increase of 0.8 foot (0.25 meter) in mean sea-level rise only changes the flood stage in Portland by a few inches, a large storm surge could add up to 4.6 feet (1.4 meters) of water-surface elevation at the coast. In the modeling of future climate scenarios, the USGS and USACE data sets (Wherry et al. 2019) predict that "an extreme winter streamflow in the Willamette River resulting from a rain-on-snow type of flow could be about 20-percent greater than current conditions."

FEMA Flood Map

The Project Area is mapped on FEMA panel 4101830093E, effective on October 19, 2004 (Figure 2). The Burnside Bridge is located in and crosses the regulated floodway of the Willamette River. The eastern portion of the Project Area is mostly in Flood Zone AE, areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base flood elevations are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply. The eastern extent of this zone is about halfway between SE 2nd Avenue and SE 3rd Avenue, beneath the Burnside Bridge approach. Just west of SE 3rd Avenue, also beneath the bridge deck, a narrow strip of land is located in Flood Zone X (a minimal flood area with 0.2-percent-annual-chance of flood hazard). The entire western portion of the Project Area is also in Zone X. It is important to note that the FEMA FIRM maps have not been updated to account for any changes in river or sea-level rise due to climate change effects. There is no comprehensive information available to inform the modifications of floodplain elevations and floodplain boundaries nationwide. Potential flooding impacts are addressed in the EQRB Hydraulic Impacts Technical Report (Multnomah County 2021d).

5.3.5 Greenroads Rating System

Additional information on climate change and sustainability is being developed in a Greenroads checklist and assessment. A preliminary assessment will be completed during the Draft EIS, and would be periodically updated to help inform final design and construction decisions. Some of the strategies employed to address Greenroads criteria are likely to contribute to further reducing GHG emissions for the Project, particularly during the construction phase as it relates to construction materials and material transport.

6 Impact Assessment Methodology and Data Sources

The impacts analysis addresses the direct long-term, short-term, and indirect climate change impacts of the Project Alternatives including the No-Build Alternative.

6.1.1 Long-Term Impact Assessment Methods

Because of the magnitude of GHG emissions worldwide, climate change impacts both locally and globally will occur with or without the Project improvements. Project improvements would not be expected to substantially contribute to these impacts if evaluated relative to global levels of GHG emissions. For this analysis, operational GHG emissions were not a differentiator between Alternatives because projected roadway traffic would be approximately the same across all Alternatives. Construction-related GHG emissions would vary by Alternative and temporary bridge option.

The FHWA ICE Tool (ICE 2.0) and the EPA MOVES Tool (MOVES2014b) were used to estimate and describe GHG emissions from the Alternatives for this technical report. For the ICE Tool inputs, default construction materials were used because the Project is still in the planning phase. Details of construction materials would be developed in a later phase of the Project. Analysis year for emission factors used in GHG delay calculations were obtained from MOVES2014b county-level data provided by Metro and based on the year 2019. Metro’s MOVES2014b inputs are tailored to this analysis year (2019) and were not adjusted to model years farther in the future.

GHG emissions were estimated for each Build Alternative using MOVES2014b for the Project Area based on traffic data obtained from Metro and ODOT. This analysis also takes into account the requirements of the Multnomah County Clean Air Construction Standards (CoP n.d.). GHG emissions from the production of fossil-fuel-intensive construction materials such as concrete were considered in the long-term impact assessment.

For the construction emissions analysis, GHG emissions from traffic delays and detours were calculated using the roadway network (core and non-core links) from the delay area which was identified as the Fremont Bridge to the north of the Project Area and extending south to the Ross Island Bridge. The roadway network links are shown in Figure 5. Metro's traffic data are based on an analysis year of 2015, and for this reason a 2015 year was used for all GHG delay calculations. These data were based on existing regional conditions and did not account for the proposed I-5 Rose Quarter Project or for the proposed I-5 Bridge Replacement Project, two proposed regional projects that could occur in the same timeframe as the EQRB Project.

The traffic estimates were adjusted by Metro to account for temporary bridge or full bridge closure scenarios and compared against the existing conditions to identify the quantity of GHGs associated with delays and detours. For the full closure scenario, the river crossing at Burnside Street would be closed completely, and traffic would be routed on other existing bridges and roadways. The partial closure scenario assumed a temporary bridge would be built adjacent to the existing structure with fewer travel lanes on the bridge and approaches on the east side of the Willamette River. In this scenario, traffic that normally would cross the Burnside Bridge would be routed over the temporary bridge as well as other existing bridges.

The base year 2015 condition was used to represent a No-Build or existing condition without any changes to the configuration of the Burnside Bridge or approach links. Project Alternatives reflecting a temporary bridge and full closure were coded as modifications to the existing condition network.

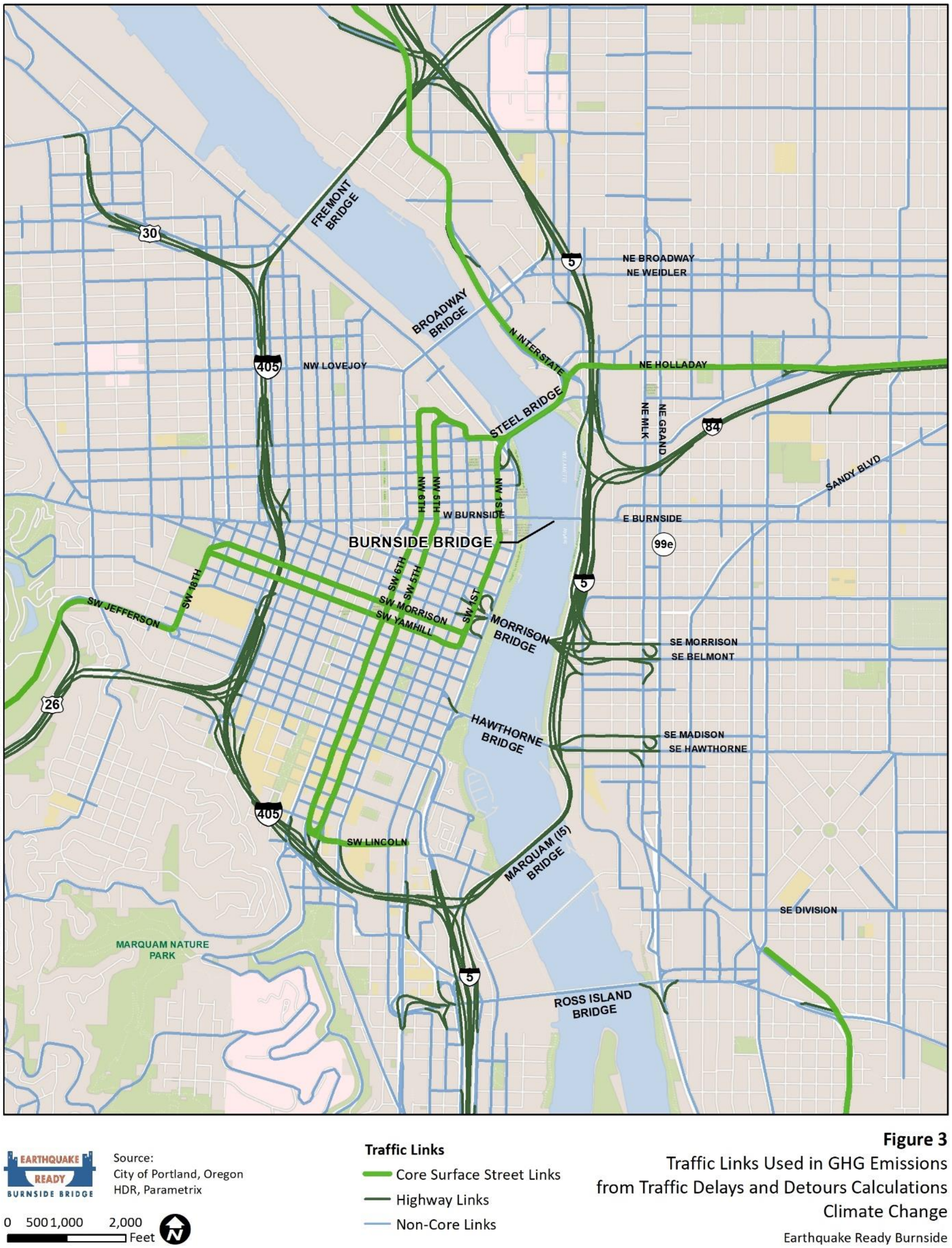
For each of the different scenarios under consideration, the full four-step travel demand model was run, and final traffic assignments were completed. These consisted of 24 individual hourly assignments. Link volumes (separated by auto and truck) and distances were output for each 24-hour assignment for use in assessment of climate change impacts.

6.1.2 Short-Term Impact Assessment Methods

Direct short-term GHG emissions contributing to climate change would occur from intensive construction-related activities. Because GHG emissions can impact climate over a very long time horizon, these emissions are appropriately captured in the long-term impact assessment. The on-road GHG emissions were calculated separately from construction and traffic delay and detour GHG emissions. The on-road emissions were categorized as operational impacts and discussed qualitatively (due to no variance between Alternatives) whereas the construction and traffic delay and detour emissions were categorized as construction impacts.

Even with traffic management strategies (strategic construction timing and detours), road closures would occur and could cause increased delay and congestion during parts of the day. Increased traffic congestion could increase GHG emissions. The findings from the traffic analysis were used in mobile source emissions modeling to compare estimated emissions under the various lane closure and traffic detour scenarios. Again, these emissions are appropriately captured in the long-term impact assessment.

Figure 5. Roadway Network Links



Source: City of Portland, Oregon, HDR, Parametrix

6.1.3 Indirect Impact Assessment Methods

Indirect GHG emissions contributing to climate change impacts could occur if, for example, the Project resulted in permanent changes to property access or transportation infrastructure that leads, over time, to land use changes that affect GHG emissions. These indirect GHG emissions would be speculative and ultimately out of the scope of the current analysis.

6.2 Cumulative Impact Assessment Methods

The cumulative impacts analyses for most topic discussions consider the Project's impacts combined with other past, present, and reasonably foreseeable future actions. The cumulative analysis of GHG emissions is a qualitative discussion of how this Project would combine with other actions and how efforts to reduce emissions across multiple sectors may affect emissions levels. The cumulative impact analysis includes a brief discussion of the current scientific consensus on likely impacts of climate change on the Portland metropolitan region and the State of Oregon, including discussions of potential sea-level rise, changes in precipitation and weather events, and additional runoff and associated flooding.

Additionally, the cumulative analysis qualitatively evaluates potential impacts of climate change to the Burnside Bridge. This analysis covers the potential impacts of climate change on average and peak river levels, floodplain areas and depth (for bridge approaches), and on bridge clearance from potential increases in precipitation and the frequency and magnitude of extreme weather events. The analysis also discusses the short- and long-term impacts of altering the bridge footprint within the floodway and the localized flooding that could result during extreme weather events.

7 Environmental Consequences

7.1 Introduction

The description of long-term impacts is divided into (1) pre-earthquake impacts, based on each Alternative's footprint and its day-to-day operations, as well as (2) impacts that would occur after the next CSZ earthquake, including how each Alternative affects resiliency, emergency response and longer-term recovery.

Transportation-related GHG emissions are caused from the combustion of fuel resulting in CO_2, nitrous oxide (N_2O), and methane (CH_4). GHG emissions are the result of both motor vehicle traffic as well as emissions embedded in construction materials. For the purposes of the discussion of GHG emissions in the Project Area, "carbon dioxide equivalent" (CO_2e) is a common unit which allows GHGs to be expressed as a single, easily comparable number. The GHG emissions analysis compares the estimated CO_2e emissions for 2019 to the projected CO_2e emissions for the No-Build and Build Alternatives in 2045 which would be the approximate lifespan of the current bridge (No-Build Alternative).

Because of the magnitude of GHG emissions worldwide, climate change impacts both locally and globally will occur with or without the Project improvements. Any net GHG emissions for any infrastructure project will contribute to ongoing climate change impacts; however, the scale of emissions from this Project relative to global levels of GHG emissions must be kept in perspective in the framework of environmental consequences.

7.2 Pre-Earthquake Impacts

EPA MOVES was used to estimate Project Area (defined in Section 1.1) GHG emissions for operational EQRB Build and No-Build Alternatives in 2045. The inputs used and results for the MOVES analysis are available upon request. This information was obtained from traffic data from Metro and ODOT and is based on the Project's traffic analysis. The detailed traffic analysis is found in the EQRB Transportation Technical Report (Multnomah County 2021e). The CO_2e emissions from vehicles crossing the Burnside Bridge for the 2045 No-Build and Build Alternatives for the Project showed no measurable difference in emissions among the Alternatives. Capacity improvements do not significantly vary among the Alternatives, therefore, projected on-road GHG emissions for each Alternative are approximately the same. Traffic analysis assumptions can be found in Section 6.1.1.

7.2.1 No-Build Alternative

Under the No-Build Alternative the Project would not be built and emissions would continue to occur as they do from traffic on and around the existing bridge. However, as advancements in vehicle technologies continue and regulations on fuel economy standards become more stringent, traffic-related GHG emissions in the Project Area are expected to lessen over time. Additionally, the expansion of public transportation in the region is expected to reduce single-occupancy vehicles from the road, reducing transportation-related GHG emissions. The estimated long-term (2045) operational GHG emissions for the No-Build Alternative are projected to be approximately 41 percent lower than the existing (2019) annual emission total based on factors unrelated to the Project. Immediately, no construction emissions would occur as there would be no construction associated with the No-Build Alternative; however, bridge maintenance and roadway rehabilitation are assumed to occur on an ongoing basis, and to be more frequent and intense than with any of the Build Alternatives.

7.2.2 All Build Alternatives

Direct

The total 2045 GHG emissions for all Build Alternatives are projected to be approximately 41 percent lower than the existing (2019) annual emission total, the same as the No-Build Alternative. As with the No-Build Alternative, the reduction in projected GHG emissions is due to advancements in expanded public transportation options and increased use of public transportation, advancement in vehicle technologies, and more stringent fuel economy standards and emission-reduction efforts on a federal, state, and local level.

Indirect

No significant indirect GHG emission impacts are expected as a result of the Build Alternatives.

7.3 Post-Earthquake Impacts

7.3.1 No-Build Alternative

The failure of the aging downtown bridges, including the Burnside Bridge, after a major CSZ earthquake is predictable. However, estimating the effects of that on GHG traffic emissions with any precision is difficult and speculative. In the No-Build scenario after the CSZ earthquake, the Burnside Bridge would be out of use and impassable, along with most other existing crossings of the Willamette River and most other viaducts and overpasses in the roadway network. Widespread road and rail line damage and debris blockage would be expected to substantially decrease the number of vehicle trips that could be taken. It is likely that GHG traffic emissions would initially be lower with the No-Build than with the Build Alternatives, due to not only debris and collapsed viaducts blocking passage on many roads (with all Alternatives), but also because of the inability of vehicles to cross the river (with the No-Build Alternative). As debris is cleared and the number of passable roads gradually increases, the lack of a viable river crossing could result in much longer trips and thus higher GHG emissions with the No-Build than with the Build Alternatives.

7.3.2 Build Alternatives

Direct

After the CSZ earthquake, any of the Build Alternatives would be expected to remain in operation. All of the Build Alternatives are being designed such that the bridge could be used immediately for emergency response after a CSZ earthquake of up to a 9.0 magnitude. Again, post-earthquake traffic scenarios and GHG emission levels are difficult to predict because of the uncertainty regarding impacts to the rest of the transportation network, the extent to which other roads in the system will be impassable, and the extent to which vehicles will be trapped by damage and debris. Immediately after the earthquake, travel is likely to be chaotic due to widespread damage and uncertainty about the roadway network and other transportation infrastructure. After the initial effects, the Build Alternatives might facilitate more trips being taken because of the availability of a usable river crossing, although the average trip length might be shorter given that the usable crossing would require less out-of-direction travel for those trips that cross the river. Initial GHG emissions could be higher than with the No-Build Alternative. However, having a viable river crossing would also make rescue and recovery more efficient and potentially reduce the need for evacuation outside of the region, which could reduce emissions. As debris is cleared and the number of passable roads gradually increases, having a viable river crossing would continue to result in less out-of-direction travel and thus lower GHG emissions with the Build Alternatives.

Indirect

No significant indirect GHG emission impacts are expected as a result of any of the Build Alternatives in a post-earthquake scenario.

7.4 Construction Impacts

The FHWA ICE tool evaluates the Project-level energy use and GHG emissions associated with the construction and maintenance of transportation facilities (roadways, bridges, and multi-modal paths). The ICE tool accounts for impacts over the lifecycle of transportation facilities, including construction, maintenance, and ongoing rehabilitation needs. The tool also accounts for upstream emissions from material mining and production for routine resurfacing. The tool is designed for new-build projects, but a calculation was completed for the No-Build Alternative using estimates of roadway and bridge maintenance. Calculations were completed for two scenarios of the Temporary Bridge (Temporary Bridge: General Traffic, Bike, and Pedestrian; Temporary Bridge: Bike and Pedestrian Only) and No Temporary Bridge Options using traffic delay and detour emissions from Table 2 and shown in Table 3 (expanded table shown in Appendix B, by construction year). Table 3 lists emissions from constructing any of the Build Alternatives and also the emissions from the construction of the Temporary Bridge. Construction timeframe assumptions are listed below Table 3. Maintenance-related emissions would be generated periodically over the lifetime of the bridge and are incorporated into the bridge and roadway construction emissions totals. Project inputs and assumptions can be found in the FHWA ICE tool details in Appendix A.

Table 2. Traffic Delay and Detour[a] GHG Emissions[b]

Condition	MT CO_2e[b]	Difference (delta) in MT CO_2e[b]
Baseline (existing conditions)	732,597.91	N/A
Full closure (no temporary bridge, 4.5 years)	734,033.63	1,435.73
Partial closure (temporary bridge, 6.5 years)	733,737.75	1,139.84

[a] Traffic data source: 2019 Metro Regional Travel Demand Model
[b] (metric tons CO2e) per year

Table 3. Total Construction and Delay/Detour GHG Emissions[a] for All Alternatives

Alternative	Total Emissions ($MT\ CO_2e$) No temp bridge	Total Emissions ($MT\ CO_2e$) With temp bridge
No-Build Alternative	***709***	***N/A***
Roadway on bridge	687	N/A
Pathways rehab	22	N/A

Alternative	Total Emissions ($MT\ CO_2e$) No temp bridge	Total Emissions ($MT\ CO_2e$) With temp bridge
Short-Span and Couch Alternatives	***10,079***	***12,255***
Temp bridge construction	N/A	768
Roadway on temp bridge [h]	N/A	460
Bridge construction	1,919	1,919
Roadway on bridge [g]	1,622	1,622
Pathways rehab [g]	76	76
Delays/detours (delta from baseline)	6,462 [c]	7,410 [d]
Short-Span and Couch Alternatives (with ped/bike only temporary bridge)	***N/A***	***13,795***
Temporary bike/ped *only* bridge construction	N/A	384
Roadway construction on temporary bike/ped *only* bridge [h]	N/A	460
Bridge construction	N/A	1,919
Roadway construction on bridge [g]	N/A	1,622
Pathways rehab [g]	N/A	76
Delays/detours (delta from baseline) [d]	N/A	9,334
Long-Span Alternative	***8,928***	***11,104***
Temp bridge construction	N/A	768
Roadway on temp bridge [h]	N/A	460
Bridge construction	768	768
Roadway on bridge [g]	1,622	1,622
Pathways rehab [g]	76	76
Delays/detours (delta from baseline) [c]	6,462 [c]	7,410 [d]
Retrofit Alternative	***7,048***	***9,394***
Temp bridge construction	N/A	768
Roadway on temp bridge [h]	N/A	460
Bridge construction	768	768
Roadway on bridge [g]	1,622	1,622
Pathways rehab [g]	76	76
Delays/detours (delta from baseline) [e]	4,582 [e]	5,700 [f]

[a] Based on a fuel cycle factor of 0.27.

[b] (metric tons CO2e) per year.

[c] The duration of the construction of the Replacement Alternatives (except Retrofit) with the No Temporary Bridge Option is estimated to be 4.5 years.

[d] The duration of the construction of the Replacement Alternatives (except Retrofit) with a Temporary Bridge is estimated to be 6.5 years, with several weeks of partial bridge closure.

[e] The duration of the construction of the Retrofit with the No Temporary Bridge Option is estimated to be 3.5 years, with 2 years of full bridge closure and 1.5 years of partial bridge operation (approximately two lanes of traffic).

[f] The duration of the construction of the Retrofit with the Temporary Bridge Option is estimated to be 5 years, with several weeks of bridge closure.

[g] The lifecycle of the bridge (maintenance calculations) for all Build Alternatives was set to 100 years.

[h] The lifecycle of the temporary bridge (maintenance calculations) was set to 6.5 years for all Build Alternatives, except Retrofit which was set to 5 years.

The GHG emissions associated with traffic delays and detours resulting from the Burnside Bridge crossing closure and partial closure (No Temporary Bridge and Temporary Bridge) have also been estimated using existing and projected traffic data from the Portland metropolitan region (Metro 2019). Table 2 shows the difference from the baseline conditions for the full closure option and the partial closure option. Delays and detours would be limited to the geographical area from the Fremont Bridge to the Ross Island Bridge; areas extending beyond those bridges were not found to be affected by the Burnside Bridge traffic patterns. Both options would cause traffic delays and detours which could increase GHG emissions from vehicle traffic. The existing traffic conditions were analyzed to create a baseline of existing GHG emissions from the region with the current Burnside Bridge conditions. The two construction options (No Temporary Bridge and Temporary Bridge) were modeled to estimate GHG emissions from on-road vehicles.

7.4.1 No-Build Alternative

Repairs, improvements, and maintenance of the existing bridge (No-Build Alternative) would be more frequent and more extensive than for any of the Build Alternatives and would still result in the high probability of the need for replacement within 50 years. The GHG emissions of the maintenance and upkeep of the existing bridge would be less than those associated with construction of any of the Build Alternatives in the short term (approximately 709 metric tons CO_2e per year), but when added to the high probability of the need for a replacement bridge in less than 50 years, the construction of the Build Alternatives would amount to lower total (or cumulative) GHG emissions. However, construction materials and methods could be developed in the future that would change this conclusion if they generated substantially less GHG emissions.

7.4.2 Without Temporary Bridge

Enhanced Seismic Retrofit Alternative

GHG emissions associated with the construction phase of the EQRB Project are expected to be consistent with other projects of this scale. The major source of GHG emissions would be mobile and stationary fossil-fuel construction equipment and heavy trucks. Construction fuel consumption is based on recent experience in building bridges in the Portland metropolitan area and provides an order-of-magnitude estimate of GHG emissions.

The Retrofit Alternative would require more maintenance, improvements, and repairs than the Replacement Alternatives over its lifetime. However, the Retrofit Alternative would have reduced construction time, especially with the No Temporary Bridge Option. It is assumed that this option would take approximately 3.5 years of construction with 2 years of full bridge closure and 1.5 years of partial bridge closure (some lanes would be open as construction continued in sections across the length of the bridge). Thus, for the Retrofit Alternative with No Temporary Bridge, the total CO_2e emissions associated with construction, maintenance, and traffic-related detours and delays are approximately 7,048 metric tons.

Replacement Alternatives: Short-Span and Couch Extension Alternatives

All Replacement Alternative bridges (except the Long-Span Alternative) with the No Temporary Bridge Option are expected to take approximately 4.5 years. The total CO_2e emissions associated with construction, maintenance, and traffic-related detours and delays are approximately 10,079 metric tons.

Replacement Alternative: Long-Span Alternative

It should be noted that the Couch Extension Alternative, Retrofit Alternative, and Short-Span Alternative, which use shorter fixed bridge spans in both the east and west approaches, would use substantially more concrete than the Long-span Option because of the need to stabilize the soil along the river. This would require more construction materials (namely concrete). The differences in GHG emissions due to soil injections have been estimated in the ICE calculations. The total CO_2e emissions associated with construction, maintenance, and traffic-related detours and delays for the Long-Span Alternative are approximately 8,928 metric tons.

7.4.3 With Temporary Bridge

GHG emission impacts associated with construction of the Replacement Alternatives would be higher for the Temporary Bridge Option than for the No Temporary Bridge Option. Several assumptions were made about the construction and demolition of the temporary bridge: the construction of the temporary bridge would last approximately 1.5 years and approximately half of the bridge would be reused (the lift portion), and approximately half of the bridge (approach spans) could be resold or, worst case, scrapped for reusable metal and materials. The Temporary Bridge Option would reduce detours and traffic congestion as compared with No Temporary Bridge during the construction of any of the Build Alternatives.

Enhanced Retrofit

As explained above, the Retrofit Alternative would have reduced construction time. It is assumed that this option would take approximately 5 years of construction with a few weeks of full bridge closure. For the Retrofit Alternative with Temporary Bridge, the total CO_2e emissions associated with construction, maintenance, and traffic-related detours and delays are approximately 9,394 metric tons.

Replacement Alternatives: Short-Span and Couch Extension Alternatives All Replacement Alternative bridges (except the Long-Span Alternative) with the Temporary Bridge Option are expected to take approximately 6.5 years with a few weeks of full bridge closure. The total CO_2e emissions associated with construction, maintenance, and traffic-related detours and delays are approximately 12,255 metric tons.

Replacement Alternative: Long-Span Alternative

As discussed above, the Long-Span Replacement Alternative would use less material (namely concrete) than the other Replacement Alternatives. For the Long-Span Alternative with Temporary Bridge, the total CO_2e emissions associated with construction, maintenance, and traffic-related detours and delays are approximately 11,104 metric tons.

Replacement Bridge Alternative with Pedestrian- and Bike-Only Temporary Bridge

The construction option of a temporary bridge that only serves pedestrians and bikes represents the highest amount of total GHG emissions associated with construction, maintenance, and traffic-related detours and delays. For this option, total estimated GHG emissions would be 13,795 metric tons. Traffic delays and detours would be the same as for the No Temporary Bridge Option because no vehicles would be crossing the temporary bridge. Construction and maintenance emissions would be the same as for any of the Build Alternatives (except the Retrofit Alternative).

7.5 Cumulative Effects

The impacts of the EQRB Project have the potential to combine with impacts of other transportation projects in the Portland metropolitan region to elevate GHG emissions through increased construction and maintenance of roadway and bridge projects. However, each project will be adhering to regulations and standards described in Section 4. These regulations and standards are part of a larger statewide effort to reduce transportation GHG emissions through the development and use of cleaner fuels, the enhancement of fuel efficiency and system investments, road expansions consistent with the objectives for reducing future GHG emissions by light-duty vehicles, and encouraging a shift from single-occupant vehicles to using bicycles, walking, or other zero emission modes. Thus, in combination with other transportation projects, GHG emissions annualized over the next 100 years (the lifespan of the Build Alternatives) have the potential to decrease with the implementation of statewide goals and efforts to reduce GHG emissions.

As discussed in Section 5.3.2, the impacts of climate change on the Portland metropolitan region and the state of Oregon will be seen in sea-level rise, changes in average and peak river levels, changes in precipitation and extreme weather events, and additional runoff and associated flooding. The degree to which these future impacts of climate change may be experienced remains uncertain, as well as the extent to which they will occur in the Project Area. In the recent assessment of Columbia and Willamette River flood stages, simulated future peak stage and projected sea-level change for the Willamette River at the Morrison Bridge is projected to increase from historical measurements by 5.5 to 6.2 feet from the year 2030 to 2059 (Wherry et al. 2019). With its immediate proximity, these estimations for the Morrison Bridge are assumed to be the same for the Burnside Bridge. The U.S. Coast Guard requires that all current water vehicle traffic be safely accommodated with a bridge replacement, which for the Burnside Bridge results in a water crossing span with at least a147-foot vertical clearance (when raised) and 205-foot-wide horizontal clearance. The simulated increase in future flood stages as a result of climate change impacts would not increase river levels so much that the current bridge or any Build Alternative bridge would be affected with the exception of the bridge approaches, which could be affected. For further detail about impacts of the flood zones on the bridge approaches see the EQRB Hydraulic Impacts Technical Report (Multnomah County 2021d).

7.5.1 No-Build Alternative

The above-mentioned 5.5- to 6.2-foot increase in water level for the Willamette River in a potential future extreme weather event could increase base flood elevations and floodplain depths. With the No-Build Alternative, bridge approach stability could be compromised as soils and sediments around the approaches and piers that are currently above the ordinary high water mark or within areas that currently do not experience periodic inundation have the potential to mobilize with increased saturation.

7.5.2 Build Alternatives

According to the EQRB Hydraulic Impacts Technical Report (Multnomah County 2021d), the proposed Build Alternatives, prior to mitigation, would increase base flood elevation due to increased size of in-water structures and lateral surface area. This, in combination with the above-mentioned increase in water level for the Willamette River in a potential future extreme weather event, could further increase water levels on the river.

In all Build Alternatives, the increase of the base flood elevation in conjunction with the future effects of climate change are being considered in design and would be addressed with mitigation. Bridge approach stability would be improved in the Build Alternatives as liquefaction of soils and sediments are considered in design and construction of the bridge, making the bridge able to withstand more saturated soils and a higher base flood elevation which could be a future condition due to climate change. Potential mitigation to avoid flood rise is discussed in the EQRB Hydraulic Impacts Technical Report (Multnomah County 2021d).

7.6 Compliance with Laws, Policies, and Standards

It is expected that the Project would be in compliance with all of the policies and standards listed in Section 4. The Project design and planning would support and meet GHG emission-reduction targets for the state, as well as air quality standards described in the EQRB Air Quality Technical Report (Multnomah County 2021a).

7.7 Conclusion

The estimated GHG emissions from the No-Build and Build Alternatives are not expected to have a significant adverse effect on global climate change. Over the long term, construction and operations and maintenance of the Build Alternatives in both pre- and post-earthquake scenarios would likely result in less GHG emissions than the No-Build Alternative because of the ultimate need for a replacement bridge within the next 50 years. However, construction materials and methods could be developed in the future that would change this conclusion if they generated substantially less GHG emissions than current materials and methods.

Construction with the No Temporary Bridge Option would result in less construction-related GHG emissions than with the Temporary Bridge. The Retrofit Alternative with No Temporary Bridge would result in the fewest GHG emissions of the Build Alternatives because this Alternative would require less materials, less construction activities and would take only 3.5 years to construct resulting in fewer detours and delays.

With regard to potential impacts from climate change such as an increase in base flood elevation, the No-Build Alternative would not increase flood elevations but would be more vulnerable to damage from higher flood levels caused by a changing climate. The Build Alternatives would be designed with climate change in mind. Coupled with the limited lifespan remaining with the No-Build Alternative and the projected long-term changes related to climate change, the Build Alternatives are anticipated to be less severely affected by climate change than the No-Build Alternative.

8 Mitigation Measures

8.1 Build Alternatives

The Project team would continue to consider and incorporate mitigation and minimization measures during the development of the Project Alternatives through the EIS, final design, and construction. Ultimately, the Project would comply with all applicable GHG and climate change regulations.

Mitigation measures for minimizing the effects of construction-related traffic congestion (and thus emissions) are in the EQRB Transportation Technical Report (Multnomah County 2021e). Additional mitigation measures for reducing emissions from construction equipment and activities would be achieved by following the Multnomah County Clean Air Construction guidance. Mitigation measures for minimizing changes in base flood elevations are described in more detail in the EQRB Hydraulic Impacts Technical Report (Multnomah County 2021d).

Construction materials and methods and the duration of construction can affect GHG emissions including emissions embedded in the development and manufacturing of materials, emissions from construction equipment, and emissions from traffic affected by temporary road or lane closures and detours. The Project initiated a Greenroads assessment that would evaluate the sustainability of construction-related choices and activities. As the Project progresses through the NEPA phase and into final design and construction contracting, the Greenroads assessment would be able to provide increasingly detailed analysis of the potential benefits and costs of such measures, with the intent of identifying feasible ways to reduce GHG emissions associated with construction materials, means and methods.

8.2 Temporary Bridge Option

Construction of the Temporary Bridge would generate substantial annualized GHG emissions when averaged over its short lifespan. Potential reduction measures could include the following:

- Reuse or partial reuse of the temporary bridge after construction is complete would reduce and offset the cumulative GHG emissions used for materials and construction of the temporary bridge (part of the modeled estimated assumptions described in Section 7.4.3).
- The lift bridge portion of the temporary bridge could be purchased or rented from a manufacturer, and if purchased, then resold to another bridge project or sold back to the manufacturer.
- The approach spans leading up to the lift portion could potentially be resold to be used in another construction project or recycled.

9 Contacts and Coordination

The Project includes an extensive public involvement and agency coordination effort, including local jurisdictions and neighborhoods within the Project Area. Potential contacts for climate change include:

- Staff at FEMA
- Region 10 FHWA Staff Specialists
- Staff at Multnomah County
- ODOT – Natalie Liljenwall and Michael Holthoff
- Greenroads Program staff and/or Greenroads Foundation members

10 Preparers

Name	Professional Affiliation	Education	Years of Experience
Kelly Carini	Parametrix	Environmental Science	5
Scott Noel	HMMH	Geography and Environmental Planning	20

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Appendix A. FHWA ICE Tool Details

ICE 2.0 Inputs for ODOT																				
Scenario Analyzed	ICE Inputs																			
	Tool Use	Infrastructure Feature	Ifrastructure Location (State)	The lifetime of your plan or project (years)	Use of custom electric emission profile (RPS)	Description	Number of Spans	Number or Lanes	Estimate DGEs from:	Total existing centerline miles	Total newly constructed centerline miles	Existing Roadway (lane miles)	Urban Principal Arterials (lane miles)	New Roadway (lane miles)	Onstreet Sidewalk (lane miles	Onstreet Bikelane (lane miles)	Onstreet Bikelane Resurfacing (lane miles)	Include roadway rehabilitation activities (reconstruct and resurface)	% roadway construction on rocky / mountainous terrain
Construct_Bridge	Project	Bridges_Overpasses	OR	100	No	EQRB Bridge Structure GHG non-Long-Span	5	5	Defaults	NA	NA		NA	NA				NA	NA
Construct_Long-Span_Bridge	Project	Bridges_Overpasses	OR	100	No	EQRB Bridge Structure GHG Long-Span	2	5	Defaults	NA	NA		NA	NA				NA	NA
Construct_Temp_Bridge	Project	Bridges_Overpasses	OR	100	No	EQRB Temporary Bridge Structure GHG	5	2	Defaults	NA	NA		NA	NA				NA	NA
Construct_Temp_Ped-Bike_Bridge	Project	Bridges_Overpasses	OR	100	No	EQRB Temporary Ped-Bike Only Bridge Structure GHG	5	1	Defaults	NA	NA		NA	NA				NA	NA
Pathways_on_Bridge	Project	Pathways	OR	30	No	EQRB Sidewalks/Paths	NA	NA		0	0.53				1.06	1.06		NA	NA
Pathways_Rehab_on_No_Build_Bridge	Project	Pathways	OR	30	No	EQRB Sidwalks/Paths no build	NA	NA		0.53	0						1.06	NA	NA
Roadway_on_Bridge	Project	Roadways	OR	30	No	EQRB Roadway GHG	NA	NA		0	0.53		2.53	2.53				Yes	0
Roadway_on_Temp_Bridge	Project	Roadways	OR	30	No	EQRB Roadway on Temp Bridge GHG	NA	NA		0	0.53		1.06	1.06				Yes	0
Roadway_Repave_on_NoBuild_Bridge	Project	Roadways	OR	30	No	EQRB Roadway repaving no build GHG	NA	NA		0.53	0	2.53	0	0				Yes	0

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Appendix B. Annual Construction and Delay/Detour GHG Emissions for Replacement Bridge Alternatives

Values are in (MT CO_2e)

Alternative	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
No-Build Alternative								**709**
Roadway on Bridge								*687*
Pathways Rehab								*22*
Replacement Bridge Alternative (no temp bridge)								**10,079**
Bridge Construction								*1,919*
Roadway on Bridge								*1,622*
Pathways Rehab								*76*
Delays/Detours	*1,436*	*1,436*	*1,436*	*1,436*	*718*			*6,462*
Replacement Bridge Alternative (with temp bridge)								**12,255**
Temp Bridge Construction								*768*
Roadway on Temp Bridge								*460*
Bridge Construction								*1,919*
Roadway on Bridge								*1,622*
Pathways Rehab								*76*
Delays/Detours	*1,140*	*1,140*	*1,140*	*1,140*	*1,140*	*1,140*	*570*	*7,410*
Replacement Bridge Alternative (with ped/bike only temporary bridge)								**13,795**
Temporary Bike/Ped ONLY Bridge Construction								*384*
Roadway Construction on Temporary Bike/Ped ONLY Bridge								*460*
Bridge Construction								*1,919*
Roadway Construction on Bridge								*1,622*
Pathways Rehab								*76*
Delays/Detours (delta from baseline)	*1,436*	*1,436*	*1,436*	*1,436*	*1,436*	*1,436*	*718*	*9,334*

Alternative	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
Replacement Long-Span Bridge Alternative (no temp bridge)								**8,928**
Bridge Construction								*768*
Roadway on Bridge								*1,622*
Pathways Rehab								*76*
Delays/Detours	*1,436*	*1,436*	*1,436*	*1,436*	*718*			*6,462*
Replacement Long-Span Bridge Alternative (with temp bridge)								**11,104**
Temp Bridge Construction								*768*
Roadway on Temp Bridge								*460*
Bridge Construction								*768*
Roadway on Bridge								*1,622*
Pathways Rehab								*76*
Delays/Detours	*1,140*	*1,140*	*1,140*	*1,140*	*1,140*	*1,140*	*570*	*7,410*
Enhanced Retrofit Alternative (no temp bridge)								**7,048**
Bridge Construction								*768*
Roadway on Bridge								*1,622*
Pathways Rehab								*76*
Delays/Detours	*1,436*	*1,436*	*1,140*	*570*				*4,582*
Enhanced Retrofit Alternative (with temp bridge)								**9,394**
Temp Bridge Construction								*768*
Roadway on Temp Bridge								*460*
Bridge Construction								*768*
Roadway on Bridge								*1,622*
Pathways Rehab								*76*
Delays/Detours	*1,140*	*1,140*	*1,140*	*1,140*	*1,140*			*5,700*