Appendix C:

White Paper Addressing Federal Planning Factor 9 in Central Lane Metropolitan Organization's 2045 Regional Transportation Plan

CONTENTS

1. EXECUTIVE SUMMARY

Central Lane Metropolitan Planning Organization (CLMPO) is subject to the Fixing America's Surface Transportation (FAST) Act. The FAST Act requires Metropolitan Planning Organizations (MPOs) to develop long range transportation plans that address ten Federal Planning Factors:

1. Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency;
2. Increase the safety of the transportation system for motorized and non-motorized users;
3. Increase the security of the transportation system for motorized and non-motorized users;
4. Increase accessibility and mobility of people and freight;
5. Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and state and local planning growth and economic development patterns;
6. Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;
7. Promote efficient system management and operation;
8. Emphasize the preservation of the existing transportation system;
9. Improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of the transportation system; and
10. Enhance travel and tourism.

Planning Factor 9 requires MPOs to consider how they will "improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation" *(23 CFR 450.306(b)(9)).* This Planning Factor was not required at the time of CLMPO's 2040 Regional Transportation Plan (RTP) adoption. The purpose of this white paper is to explore how to integrate Planning Factor 9 into CLMPO's 2045 RTP. The paper is divided into four main sections:

Introduction to Transportation Resilience

This section explores the themes of resilience and sustainability as they relate to transportation, provides background and Federal Highway Administration (FHWA) guidance on Planning Factor 9, and discusses the practical application of Planning Factor 9 by other MPOs.

Regulatory and Planning Context

This section discusses the federal, state, local, and regional regulatory and planning context, including local and regional efforts to address state and federal requirements around resilience and stormwater.

An Integrated Approach to Resilience & Sustainability

This section explores how to integrate resilience and sustainability into CLMPO's 2045 RTP. It discusses an MPO's potential role in security and emergency planning and FHWA guidance on vulnerability assessment. It then explores the known natural and non-natural hazards to the transportation system in the CLMPO area, including:

- Stormwater
- Climate change

- Seismic hazards
- Extreme weather
- Geomagnetic disturbance
- Landslides
- Riverine flooding
- Volcanic hazards
- "Non-Natural" hazards

Finally, this section explores transportation resilience within the context of the three pillars of sustainability: environment, equity, and economy.

Recommendations

This section provides recommendations for how CLMPO could address Planning Factor 9, including ideas for possible goals, objectives, and policies, as well as suggested next steps for integrating resilience into the transportation planning process. CLMPO has the option to take a broad, sustainability-based approach to planning for resilience that considers the environmental, equity, and economic feedback loops and linkages that contribute to or hinder the region's ability to survive disruptions. This section is intended to be a starting point for conversation around these themes. Recommendations for how to incorporate resilience and stormwater into the 2045 RTP include:

1. Thread resilience into the goals, objectives, and policies of all priority areas.
2. Thread resilience throughout the document where relevant.
3. Include a robust resilience section in the appendix.
4. Consider a broad range of hazards to the transportation system.
5. Conduct additional research and outreach to fill in gaps, strengthen analysis, and ensure consistency with local efforts.
6. Add resilience-related terms to the glossary.
7. Commit to taking positive steps as a region toward increasing transportation resilience beyond the RTP update. Next steps include:
   - Conduct a formal vulnerability assessment
   - Develop a local and regional Emergency Transportation Route network and prioritize retrofits
   - Incorporate resilience into project evaluation and development
   - Complete a Continuity of Operations Plan (COOP)
   - Consider becoming an official Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan Sub-Plan Holder
8. Identify potential funding sources to integrate these action items into planning.

2. INTRODUCTION TO TRANSPORTATION RESILIENCE

2.1 Resilience, Sustainability, and Transportation

A series of costly natural and human-caused disasters in recent decades have highlighted the vulnerability of our transportation infrastructure, the key role our transportation network plays in emergency response and long-term recovery, and the urgent need to plan for a transportation system that is able to withstand, recover quickly from, or adapt to both acute and slow-moving disruptions. The inclusion of transportation resilience into the Federal Planning Factors elevates it to a top priority for transportation planners.

There are three main themes central to resilience as a concept: first, the ability to absorb or resist shock; second, the ability to adapt to shock while maintaining critical functions; and, third, the time it takes to restore the system to normal functioning after an event, which may be different from how it functioned prior to the event. Because the transportation system is a network, or 'system of systems,' the goal of transportation resilience is to both reduce reliance on individual components of the system and reduce the exposure of critical assets to prevent spillover, or cascading, effects throughout the system.[1] The American Association of State Highway and Transportation Officials (AASHTO) has established five resilience principles relevant to transportation planners:[2]

1. Redesign to reduce or eliminate vulnerability
2. Improve ability to improvise during an event
3. Add redundancies in the system to improve ability to reroute traffic through one or more parallel components
4. Have backup components available to quickly replace disrupted function
5. Allow rerouting

Resilience depends on the complex interplay between environmental, social, and economic factors. Risk is not uniform across or within communities; both social and economic resilience play directly into a community or individual's ability to withstand an environmental disturbance or disaster. Because of these linkages, the concepts of resilience and sustainability are inextricably connected. A transportation system that is not resilient cannot be sustainable (and vice versa). Planners must therefore work to integrate these two interrelated concepts, rather than teasing them apart and treating them as individual concepts or goals.

The terms resilience and sustainability can take on different meanings in different contexts; it is therefore important for CLMPO to establish definitions for both as an initial step in this process. The FHWA defines resilience as "the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions."[3] This definition of resilience is broad and can be applied in both progressive (e.g. the ability to adapt to changing conditions) and regressive (e.g. how to

[1] Weilant, Strong, and Miller, *Incorporating Resilience.*

[2] American Association of State Highway and Transportation Officials, *Effective All-Hazards Infrastructure Protection.*

[3] Federal Highway Administration, *Resilience and Transportation Planning*, 1.

maintain status quo or bounce back to a state of equilibrium) contexts. Instead, this white paper proposes the following definition for resilience:

> *Resilience is the ability of a socio-environmental system to survive and transform in order to sustain itself.*

This definition of resilience assumes that change, not equilibrium or stasis, is the natural state, and allows CLMPO to measure resilience by the transportation system's ability to transform in response to stresses both large (e.g. climate change) and small (e.g. everyday flooding events).

Sustainability, like resilience, has broad application over many contexts. The most commonly accepted definition of sustainability is the ability to "meet the needs of the present without compromising the ability of future generations to meet their own needs."[4] CLMPO proposes following the United Nations Educational, Scientific, and Cultural Organization (UNESCO) definition of sustainability:

> *Sustainability is a paradigm for thinking about the future in which environmental, societal, and economic considerations are balanced in the pursuit of an improved quality of life.*[5]

Together, these definitions of resilience and sustainability direct CLMPO to address transportation resilience through the three "pillars" of sustainability: environment, society (i.e. equity), and economy. With these definitions in mind, this paper covers a comprehensive, systems-level approach to resilience through the lens of sustainability in order to present relationships between social, economic, and environmental factors that contribute to risk and vulnerability, as well as adaptation and mitigation.

2.2 Planning Factor 9

2.2.1 2015 FAST Act Requirement

The 2015 Fixing America's Surface Transportation (FAST) Act introduced a new planning factor that MPOs must consider during the transportation planning process. Specifically, Planning Factor 9 requires MPOs to address how they will "improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation" *(23 CFR 450.306(b)(9)).* Additionally, MPOs should consult with agencies responsible for natural hazard mitigation and risk reduction in the development of the metropolitan transportation plan *(23 CFR 450.316(b)).* The plan must also assess capital investments and explore strategies to reduce the vulnerability of infrastructure to natural disasters *(23 CFR 450.324(g)(7)).*

2.2.2 FHWA Guidance on Planning Factor 9

Following the FAST Act's introduction of the new Planning Factor 9, the FHWA produced a fact sheet that provides high level guidance on its application. In the fact sheet, the FHWA focuses on the threat of climate change and extreme weather events to long-term investments in transportation infrastructure

[4] World Commission on Environment and Development, *Our Common Future*, 41.
[5] UNESCO 2019, "Sustainable Development."

and identifies the transportation planning process as a key opportunity to address climate resilience. According to the FHWA, there are four main opportunities to integrate resilience (Figure 2.1).

Figure 2.1: Integrating Resilience into Transportation Planning[6]

Regional Vision & Goals	Establish goals and performance measures relating to resilience.
Long Range Transportation Plan	Use information on resilience to help identify strategies and investment scenarios.
Project Evaluation & Prioritization	Use resilience in the evaluation and prioritization of projects.
Project Development	Incorporate resilience into project design and engineering.

Though the FHWA does not provide specific guidance on how MPOs are required to address Planning Factor 9, it has produced high level guidance and best practices on approaches to resilience. For example, since 2013, the FHWA has run a Climate Resilience Pilot Program to explore a variety of approaches to improving resilience. In a 2016 report, the FHWA identified three steps utilized by pilot participants in successful approaches to assessing vulnerability and integrating climate resilience into transportation decision-making (Figure 2.2).

Figure 2.2: Successful Approaches to Assessing Vulnerability and Integrating Climate Resilience[7]

Step 1	Define the Scope	– Identify key climate variables, sensitive assets, & impact thresholds – Articulate objectives – Select and characterize relevant assets – Consider geography, decision timeframe, coverage of assets & climate stressors, project budget & timeline, data availability, near-term priorities, existing studies, expertise of local partners, and a broad range of stressors (not just climate)
Step 2	Assess Vulnerability	– Collect and integrate data on assets – Develop climate inputs – Develop information on asset sensitivity to climate – Incorporate likelihood and risk – Identify and rate vulnerabilities – Assess asset criticality
Step 3 (pt. 1)	Integrate into Decision-Making	– Incorporate into asset management – Integrate into emergency and risk management – Contribute to long range transportation plan – Assist in project prioritization – Identify opportunities for improving data collection, operations, or designs – Build public support for adaptation investment – Educate and engage staff and decision-makers

[6] UNESCO 2019, "Sustainable Development."

[7] Federal Highway Administration, *Climate Resilience Pilot Program*.

Step 3 (pt. 2)	Incorporate Results into Transportation Programs and Processes	– Develop resources to incorporate climate information into engineering design – Align assessments with long range planning – Streamline climate change adaptation planning with asset management – Engage and coordinate with various partners and stakeholders on adaptation projects

2.2.3 How MPOs are Incorporating Planning Factor 9

In 2018, the FHWA conducted a literature review to understand how MPOs are integrating resilience into the transportation planning process. The resulting white paper provides a broad understanding of how 52 DOTs and 101 MPOs are incorporating resilience into long range plans and programming documents.[8] The FHWA found that, in addition to federal- and state-level directives and requirements, DOTs and MPOs reported several reasons why they were integrating resilience, including: economic benefits, improved safety, maintaining mobility and operations, preparing to adapt to climate change, and responding to damage from catastrophic weather events. In practice, MPOs were integrating resilience into development of long-range plans, Transportation Improvement Plans, Transportation Asset Management Plans, and environmental reviews at several key points in the planning process:

- Incorporating resilience-specific goals and objectives that guide plan development
- Considering resilience when defining problems and needs addressed by the plan
- Considering resilience as part of criteria for evaluating projects
- Identifying, adopting, and implementing strategies that address vulnerabilities and achieve resilience goals
- Using performance measures to monitor how strategies are improving resilience

The FHWA found that the first step many MPOs took in assessing problems or needs was to understand the hazards and vulnerabilities that threatened their systems. Most MPOs achieved this through a formal vulnerability assessment, though some used scenario planning or workshops. Others considered the themes relating to climate, natural hazards, and resilience without any sort of formal or systematic assessment of vulnerability, though many discuss the need for such an assessment as an important next step in the planning process.

2.2.4 Survey of Regional Transportation Plans

Initial research for this white paper included a brief review of a select number of RTPs[9] from MPOs in Oregon and around the country to better understand how they are treating the themes of resilience and stormwater in their long-range planning (Figure 2.3). The RTPs selected for review were completed after passage of the FAST Act in 2015[10] and met one or more of the following criteria: 1) they were from an

[8] Federal Highway Administration, *Integrating Resilience into Transportation Planning*

[9] Federal code refers to MPO long range transportation plans as Metropolitan Transportation Plans (MTPs), however, for the purpose of this white paper and to stay consistent with CLMPO's use of the term, Regional Transportation Plan (RTP) is used to describe CLMPO's plan and long-range transportation plans in general, except where specific mention is made to an MPO that refers to its own plan as an MTP.

[10] Note: MPOs were not required to develop RTPs that incorporate Planning Factor 9 until after May 27, 2018.

MPO in Oregon, 2) they were produced by MPOs with similar population and geography, or 3) they were from areas that have relatively robust regional approaches to resilience or stormwater management. Of the RTPs reviewed, six were from Oregon and five were from MPOs in other states. It is important to note that this review was not intended to be exhaustive, but rather to provide a basic understanding of what might be deemed adequate consideration of resilience and stormwater by the FHWA.

Figure 2.3: Regional Transportation Plans

Metropolitan Planning Organization	Location	Update Year & Planning Horizon
Albany Area Metropolitan Planning Organization (AAMPO)	Albany, OR	2018 – 2040
Bend Metropolitan Planning Organization (BMPO)	Bend, OR	2017 – 2040
Corvallis Area Metropolitan Planning Organization (CAMPO)	Corvallis, OR	2017 – 2040
Oregon Metro	Portland, OR	2018 – 2040
Rogue Valley Metropolitan Planning Organization (RVMPO)	Central Point, OR	2017 – 2042
Salem-Keizer Area Transportation Study (SKATS)	Salem, OR	2019 – 2043
Delaware Valley Regional Planning Commission (DVRPC)	Philadelphia, PA	2017 – 2045
New York Metropolitan Transportation Council (NYMTC)	New York, NY	2017 – 2045
Puget Sound Regional Council (PSRC)	Seattle, WA	2017 – 2040
Southwest Washington Regional Transportation Council (SWRTC)	Vancouver, WA	2019 – 2040
New Orleans Regional Planning Commission (NORPC)	New Orleans, LA	2019 – 2048

Review of the selected RTPs revealed considerable variation in the treatment of the themes of resilience and stormwater. MPOs took four main approaches, addressing Planning Factor 9 themes to varying degrees of depth and detail:

1. Incorporate resilience into goals, objectives, policies, or strategies (e.g. AAMPO, DVRPC, Metro, CAMPO, PSRC)
2. Address resilience in its own distinct section in the body of the RTP (e.g. Bend)
3. Weave discussion of resilience throughout other relevant sections (e.g. Metro, NORPC)
4. Include additional detail in the appendix (e.g. PSRC)

Of the 11 plans, two provide particularly useful examples for the treatment of resilience: PSRC's Regional Transportation Plan – 2018 and BMPO's 2040 Bend Metropolitan Transportation Plan. PSRC provides extensive detail pertaining to resilience in Appendix O: Resilience. Though resilience is discussed briefly in Chapter 2: Plan Investments and Chapter 5: Plan Implementation, Appendix O provides an in-depth, 32-page discussion of resilience in the PSRC area that defines the risks, establishes potential impacts in the region, and identifies actions being taken at multiple levels to address risks. PSRC's Appendix O provides an example for how CLMPO might structure a discussion of resilience that provides thoughtful insight and region-specific guidance.

BMPO was the only MPO under review to dedicate an entire chapter to resilience themes (Chapter 13: Security and Emergency Planning). Chapter 13 addresses disaster mitigation and, more specifically, the possible role of the MPO in security and emergency planning. This chapter defines the MPO's role in planning for and responding to every stage of a natural disaster. In Chapter 13, BMPO also discusses current security/emergency planning efforts that focus on or include transportation in the Bend area.

Of the plans reviewed, two provide useful examples for the treatment of stormwater: Metro's 2018 Regional Transportation Plan and PSRC's Regional Transportation Plan – 2018. Though Metro's plan does not have a dedicated stormwater section, Metro's approach is holistic in that it includes specific language around green infrastructure and recognizes that streets and parking resources should be employed to serve many functions, including nature corridors and stormwater management. Metro has shown long-term dedication to stormwater and green infrastructure and has published several handbooks addressing the nexus between livability, street design, and ecology, including the *Livable Streets Handbook*, *Green Streets: Innovative Solutions for Stormwater and Stream Crossings,* and *Wildlife Crossings: Providing Safe Passage for Urban Wildlife*.

PSRC's Regional Transportation Plan – 2018 briefly discusses transportation-related impacts to water quality in the body of the plan, including approaches to managing stormwater, such as reducing impervious surfaces and using low-impact materials. This plan's primary value with respect to stormwater is Appendix A: Policies and Mandates, which includes several very specific goals and policies relating to environmental stewardship and water quality that are derived from the region's management, environmental, economic, and transportation strategy known as VISION 2040. Appendix A outlines policy ideas that can be used for reference as CLMPO develops its own stormwater-specific policies. For example, the Water Quality Goal states: "The region will meet or do better than standards for established water quality. The quality of the water flowing out of the region–including Puget Sound–should be as good as or better than the quality of water entering the region."[11]

Although the three plans explored above may serve as models for the content and/or structure of CLMPO's efforts to address resilience and stormwater to fulfill Planning Factor 9, each one treats resilience and stormwater essentially as separate subjects, with limited, if any, overlap or interaction between the two. This white paper proposes that CLMPO take a more comprehensive approach to Planning Factor 9 that incorporates resilience and stormwater as inter-related elements of a sustainable system with a triple bottom line. To that end, a strong example of a more comprehensive, sustainability-focused approach is DVRPC's Connections 2045: Plan for Greater Philadelphia. In this plan, "Sustain the Environment" is listed as the first of several guiding principles, and there are many explicit and actionable goals and strategies relating to climate resilience, stormwater, air quality, green infrastructure, and other inter-related issues, including food production. Chapter 5: Taking Action also ties the sustainability principles and goals to direct actions in the region. Overall, this plan provides a valuable resource for environmentally focused goals, policies, and actions.

In the absence of specific guidelines or requirements from FHWA on precisely how to address Planning Factor 9, MPOs took a variety of approaches to considering resilience and stormwater. Following is a list of best practices and takeaways from this review intended to help guide CLMPO's development of these themes in the 2045 RTP (Figure 2.4).

[11] Puget Sound Regional Council, *Regional Transportation Plan – 2018*, 2.

Figure 2.4: Best Practices in RTP Treatment of Resilience and Stormwater

DO…	DON'T…
Include data and information on local context and specific threats, actions, recommendations, etc. and relate them directly and explicitly to transportation	Be too vague or general about local impacts or how they affect transportation
Use concise language to summarize the main points for readability (and reserve additional detail for appendices)	Overload the section with so much detail that the purpose/overall picture is lost, or that the average reader cannot understand it
Provide detail that can be used in the NEPA process	Use detail for NEPA as a stand-in for deeper analysis of resilience and stormwater themes
Consider interrelated themes in a holistic way	Relegate connected topics to individual silos that do not allow a systems-level perspective

3. REGULATORY AND PLANNING CONTEXT

3.1 Federal Regulatory Context

In addition to requirements relating to the FAST Act, several federal regulations, national directives, and executive orders establish requirements or recommendations that states and MPOs must consider resilience (Figure 3.1). This list may not be comprehensive, but it represents an effort to seek out relevant regulations and guidance.

Figure 3.1: Federal Regulations and Directives Guiding Transportation Resilience

Regulations for Facilities Repeatedly Damaged by Emergencies	US DOT requires State DOTs to evaluate whether "there are reasonable alternatives" to "roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events."[12] MPOs are encouraged to consider these evaluations during the development of transportation plans and programs as well as environmental review.
Transportation Asset Management Plans (TAMPs)	State TAMPs must establish a process for full lifecycle planning for assets; develop a risk-based management plan; include a description of transportation assets and develop a risk management analysis that is informed by the evaluations of facilities repeatedly damaged by emergencies; and integrate the TAMP into state transportation planning processes.
Executive Order 13653 (revoked)	Executive Order 13653, Preparing the United States for the Impacts of Climate Change (November 1, 2013) ordered the nation to prepare for the impacts of climate change through climate preparedness and resilience. All federal agencies were directed to promote: (1) engaged and strong partnerships and information sharing at all levels of government; (2) risk-informed decision-making and the tools to facilitate it; (3) adaptive learning, in which experiences serve as opportunities to inform and adjust future actions; and (4) preparedness planning.[13] Though EO 13653 was revoked by Executive Order 13783, Promoting Energy Independence and Economic Growth (March 28, 2017)—which makes no reference to climate change or resilience—it laid the foundation for future orders about resilience, including FHWA Order 5520.
FHWA Order 5520	Under Executive Order 13653, FHWA Order 5520 (December 15, 2014) established FHWA policy on preparedness and resilience with respect to climate change and extreme weather.
Other Regulations and Guidance	– Robert T. Stafford Disaster Relief and Emergency Assistance Act (1988) – Disaster Mitigation Act (2000) – Presidential Policy Directive 8: National Preparedness (2011) – Presidential Policy Directive 21: Critical Infrastructure Security and Resilience (2013) – Department of Homeland Security National Infrastructure Protection Plan 2013: Partnering for Critical Infrastructure Security and Resilience – Executive Order 13636: Improving Critical Infrastructure Cybersecurity (2013) – National Environmental Policy Act (NEPA) environmental review processes

[12] Federal Highway Administration, *Integrating Resilience into Transportation Planning.*

[13] Executive Order 13653, 78 FR 66817 (2013)

3.2 State Regulatory and Planning Context

Oregon Statewide Planning Goal 7: Natural Hazards directs local communities to regulate development in hazard-prone areas. Specifically, local comprehensive plans are required to address floods (coastal and riverine), landslides, earthquakes and related hazards, tsunamis, coastal erosion, and wildfires.[14] The State of Oregon's Natural Hazards Mitigation Plan (NHMP) provides the most complete, up-to-date description of Oregon's natural hazards. Local jurisdictions rely on information presented in the State's plan to prepare their own local natural hazard mitigation plans. The State's NHMP is updated every five years and is currently undergoing an update.

Additionally, the State has taken steps toward addressing both greenhouse gas (GHG) emissions and seismic resilience as they relate directly to transportation.

Greenhouse Gas Emissions

ORS 468A.205 set a goal of achieving GHG levels at least 75% below 1990 levels by 2050 and also directed "state and local governments, businesses, nonprofit organizations, and individual residents to prepare for the effects of global warming and by doing so, prevent and reduce the social, economic, and environmental effects of global warming."[15] House Bill 2001 (2009), also known as the Jobs and Transportation Act, directed both the Eugene-Springfield and the Portland Metropolitan Areas to conduct local scenario planning to explore how to meet emissions reduction targets. The state-set target for CLMPO was a 20% reduction below 2005 levels by 2035. The bill required CLMPO to consider the target in its scenario planning, not to adopt it. The results of that effort are discussed below in Section 3.4 CLMPO Existing Efforts.

The Oregon Sustainable Transportation Initiative (OSTI), a partnership between the Oregon Department of Transportation (ODOT) and Department of Land Conservation and Development (DLCD), leads the implementation of a statewide effort to reduce GHG emissions from transportation, which accounts for 31% of emissions in Oregon. Senate Bill 1059 (2010) directed OSTI to develop the Oregon Statewide Transportation Strategy (STS), a two-year scenario planning process to identify short- and long-term strategies to reduce emissions, which was adopted by the Oregon Transportation Commission (OTC) on March 20, 2013. The STS identifies 18 strategies, with 133 elements in six categories: vehicle and engine technology advancements, fuel technology advancements, enhanced system and operations performance, transportation options, efficient land use, and pricing and funding mechanisms.

The State has recently taken actions to implement and strengthen statewide GHG emissions reductions targets. In September 2019, Governor Brown directed ODOT, DLCD, the Department of Energy, and the Department of Environmental Quality to form a four-agency working group to create a work plan for implementing STS. In March 2020, Executive Order 20-04 revised Oregon's previous targets to a 45% reduction below 1990 levels by 2035 and an 80% reduction below 1990 levels by 2050 (up from 75% by 2050 established by ORS 468A.205). In June 2020, ODOT formed a new Climate Office to implement the Executive Order. An initial draft of the four-agency working group's two-year work plan, called Every Mile

[14] Oregon Department of Land Conservation and Development, *Goal 7: Areas Subject to Natural Disasters and Hazards*.
[15] ORS 468A.205 (2)

Counts, identifies three key objectives and a number of priority actions that will help achieve the revised goals (Figure 3.2).

Figure 3.2: Multi-Agency Draft Work Plan Objectives and Priority Actions[16]

Objective	Priority Actions
Reduce Vehicle Miles Traveled Per Capita	**Statewide Trip Reduction Policy** – Require some businesses to implement policies that reduce employees' vehicle miles traveled (e.g. telecommuting, flexible work schedules, free transit passes, parking cash-out programs, bike/ped options, etc.) **Parking Management** – Limit growth of parking spaces, increase number of pay-to-park locations, raise parking rates, or other strategies to disincentivize driving
Support the Use of Cleaner Vehicles and Fuels	**Interagency Zero Emission Vehicle (ZEV) Action Plan** – Efforts to increase awareness of and access to ZEVs, improve charging infrastructure, increase state use of ZEVs **Transportation Electrification Infrastructure Needs Analysis** – ODOT required to complete analysis by June 2021 per the Executive Order; must consider rural needs and focus on meeting goals for ZEVs set in SB 1044 (2019) **Expand the Clean Fuels Program** – DEQ rulemaking process to extend and enhance requirements of existing program **Adopt New Emissions Standards and ZEV Requirements for Medium- and Heavy-Duty Trucks** – California's emissions standards and requirements for manufacturers to be considered
Consider GHG in Decision-Making	**Transportation Planning Rule** – Amend the TPR and other planning rules to require local governments to plan for transportation systems and land uses that reduce GHG emissions **Scenario and GHG Reduction Planning** – MPO Scenario planning supported by ODOT and DLCD to guide rulemaking **GHG Reduction Performance Measures** – State, local, and programmatic performance measures to be developed

Seismic Resilience

In addition to GHG emissions, ODOT and other State agencies have engaged in resilience planning with respect to statewide seismic risk that will be critical to CLMPO's assessment of the risk to and resilience of its own transportation system. Governor Brown issued a resiliency policy agenda in October 2018 called "Resiliency 2025: Improving Our Readiness for the Cascadia Earthquake and Tsunami," which re-emphasized the need to plan for seismic resilience.[17] The policy agenda follows in the footsteps of *The Oregon Resilience Plan: Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami*, prepared by the Oregon Seismic Safety Policy Advisory Commission in 2013, which maps priorities for policy and investment over the next 50 years. In 2012 and 2014, respectively, ODOT published the *Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification Report* and the *Oregon Highways Seismic Plus Report*, which identified lifeline corridors and specific seismic hazards

[16] ODOT, DLCD, ODOE, and DEQ, *Every Mile Counts.*
[17] Office of the Governor, *Resiliency 2025.*

affecting lifeline routes. These studies provide the basis for this paper's seismic analysis; see Section 4.3 Hazards to the CLMPO Area Transportation System for expected impacts from a Cascadia subduction zone earthquake in the CLMPO area.

3.3 Local Regulatory and Planning Context

CLMPO partner agencies have engaged in numerous efforts to address hazard mitigation, stormwater, and climate change in local policies and plans. CLMPO's planning around resilience should be consistent with these existing local efforts. Though a comprehensive review of each of the plans and policies discussed in this section is beyond the scope of this paper, they are critical to understanding the local landscape with respect to resilience and they should be taken into consideration throughout the transportation planning process.

Hazard Mitigation

A proactive approach to natural hazard mitigation—including policy changes, projects, and education and outreach—reduces the loss of life, property damage, and injury caused by natural hazards. It also makes financial sense; a report to congress by the National Institute of Building Science's Multi-Hazard Mitigation Council contends that every $1 spent on hazard mitigation saves up to $6.[18]

The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (Stafford Act) and the Disaster Mitigation Act of 2000 (DMA 2000) provide the federal regulatory framework for local natural hazards mitigation planning. Specifically, DMA 2000 amended the Stafford Act to require local governments to develop NHMPs before they are eligible to receive federal disaster assistance. Figure 3.3 lists local NHMPs and related efforts.

Figure 3.3: Local Hazard Mitigation Plans

Jurisdiction	Plan	Description
Cities of Eugene and Springfield	**Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan (2020)**	Strategic, non-regulatory plan that provides the foundation for coordination and collaboration among participating agencies and the public; identifies and prioritizes future mitigation activities; and aids in meeting Federal requirements for assistance programs
Lane County, Cities of Coburg, Creswell, Dunes City, Florence, Oakridge, Veneta, Westfir	**Lane County Multi-Jurisdictional Hazard Mitigation Plan (2017)**	Plan supporting all of Lane County, including both rural and incorporated areas, in achieving a better understanding of natural hazards, the risk they pose, and committing to actions to minimize those risks
Cities of Eugene and Springfield	**Regional Climate and Hazards Vulnerability Assessment (2013)**	In support of the Eugene-Springfield Area Multi-Jurisdictional Hazards Mitigation Plan, staff from the City of Eugene and the City of Springfield engaged representatives from 11 sectors to collect information about adaptive capacity and vulnerability to specific hazards

[18] Cities of Eugene and Springfield, *Natural Hazards Mitigation Plan*.

Stormwater

Stormwater management is an issue of significant importance to transportation planning. The transportation system is composed primarily of impervious surfaces, which directly affects both water quality and quantity. Runoff from paved surfaces carries pollutants that, if left untreated, can contaminate local waterways and groundwater. Impervious surfaces also contribute to street flooding, which can damage property and cause loss of life.

The Federal Clean Water Act of 1972 prohibits any release of pollutants into waters of the United States without a National Pollutant Discharge Elimination System (NPDES) Permit, which regulates the amount of certain pollutants permissible in a discharge. Large- and medium-sized cities with municipal separate stormwater sewer systems (MS4s) that discharge untreated stormwater into local waterbodies—including Eugene and Springfield—are required to obtain NPDES Permits, develop a Stormwater Pollution Prevention Plan or Stormwater Management Plan, and implement measures to prevent pollutant discharge in stormwater runoff. Figure 3.4 presents a list of local stormwater plans.

Figure 3.4: Local Stormwater Plans

Jurisdiction	Plan	Description
City of Eugene	**Stormwater Management Manual (2014)**	Developed to implement the Stormwater Development Standards outlined in Eugene Code 9.6791 – 9.6797, which govern flood control, quality, flow control (headwaters), oil control, source controls, dedication of easements, and operation and maintenance
City of Eugene	**Comprehensive Stormwater Management Plan (1995)**	Establishes comprehensive public policy for addressing stormwater conveyance and urban stormwater quality issues
Lane County	**Stormwater Management Plan (2011)**	Proposed revisions to Lane County's original Stormwater Management Plan (2003) considered as part of Lane County's NPDES Phase II permit renewal application
City of Springfield	**Stormwater Management Facility Master Plan (2008)**	Provides a guide for comprehensive, efficient, and multi-objective management of the City's stormwater system
City of Springfield	**Stormwater Management Plan (2010)**	Provides policy and management guidance for activities affecting stormwater to help the City of Springfield fulfill State and Federal water quality requirements as well as local water resources management objectives
City of Coburg	**Water Master Plan (2016)**	A technical appraisal of the state of the current water system and needed improvements intended to help guide the planning or growth of the community and water system
City of Coburg	**TMDL Implementation Plan (2008)**	Describes the strategies the City will implement to reduce temperature, bacteria, and mercury pollution in the Upper Willamette sub-basin of the Willamette River as a requirement of the Willamette Basin TMDL as approved by the EPA in September 2006

Climate Change

The City of Eugene, Lane County, and Lane Transit District have developed policies around climate change that establish goals for GHG emissions reductions (Figure 3.5).

Figure 3.5: Local Climate Change Plans & Policies

Jurisdiction	Plan	Description
City of Eugene	**Climate Recovery Ordinance (2014)**	Set four goals for GHG reductions in Eugene, including two community goals and two City operations goals. Community: 1. Reduce community fossil fuel use by 50% of 2010 levels by 2030 2. Reduce total community GHG emissions to an amount that is no more than the City of Eugene's average share of a global atmospheric GHG level of 250 ppm by 2100, which was estimated in 2016 to require an annual average emission reduction level of 7.6%. City Operations: 1. All city of Eugene owned facilities and operations shall be carbon neutral by 2020, meaning no net release of GHGs. 2. Reduce the City of Eugene's use of fossil fuels by 50% compared to 2010 usage.
City of Eugene	**Climate Action Plan 2.0 (2019)**	Identifies research-based actions to help the city meet its climate goals and advance progress toward the Climate Recovery Ordinance
Lane County	**Climate Action Plan (in progress)**	Currently in the first of three phases that will include: 1. A GHG inventory to establish reductions targets (Phase I, complete) 2. A comprehensive countywide plan to establish goals and strategies (Phase 2) 3. A resiliency plan to identify adaptation strategies (Phase 3) 4. A suite of Action Initiatives supporting green jobs, clean energy projects, and climate-friendly industries 5. Open and transparent public communications to monitor progress toward goals 6. A Climate Advisory Committee to advise the Board of Commissioners on ongoing climate action work
Lane County	**Operational Greenhouse Gas Inventory (2020)**	The first phase of a three-phased approach to the development of the Climate Action Plan
Lane Transit District	**Climate Action Policy (2020)**	Establishes short-term and long-term goals for GHG reductions, including: 1. Purchasing 25 electric buses by 2023 2. Reducing GHG emissions by 75% by 2030 and phasing out fossil fuel vehicles in its fleet by 2035 3. Exploring emerging technology and working with partner jurisdictions, including Lane Council of Governments, to improve GHG emissions reductions

3.4 CLMPO Existing Efforts

CLMPO has undertaken recent planning efforts that relate directly to regional resilience and should be considered as part of this process (Figure 3.6).

Figure 3.6: CLMPO Existing Efforts

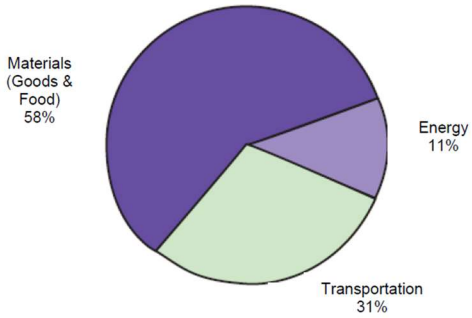
Planning Effort	Description
Eugene-Springfield Metropolitan Region Greenhouse Gas Inventory (2010)	Identifies major sources of greenhouse gas emissions in the Eugene-Springfield area
Regional Transportation Options Plan (2014)	Recommends core transportation options programs and services
Central Lane Scenario Planning (2015)	Explores how to meet the DLCD-set GHG emissions reduction target of 20% below 2005 levels by 2035 in the Eugene-Springfield Metropolitan Region
Central Lane Scenario Planning Health Impact Assessment (2015)	Documents regional health impacts and related cost savings to anticipated reductions in GHG emissions associated with policies under consideration as part of the scenario planning process
CLMPO Strategic Assessment (underway)	Builds on the results of the Central Lane Scenario Planning work and the Eugene Transportation Plan scenario findings to test and quantify what regional policies, programs, and investment actions, grouped to make scenarios, will allow the MPO to achieve its long range local and State planning vision and goals; intended to guide the policy development and investment strategy options of the RTP update

Eugene-Springfield Metropolitan Region Greenhouse Gas Inventory (2010)

In 2010, CLMPO conducted a Greenhouse Gas Inventory for the Eugene-Springfield Metropolitan Area. The region is responsible for an estimated 3.2 million metric tons of GHG emissions per year, which accounts for 4.6% of total state emissions.[19] The inventory found that the average Eugene household emits 31.9 metric tons of carbon dioxide equivalent annually, a figure that is lower than for households of the Portland Metro area and the United States. The report attributes relatively lower household footprints to three main factors: abundant sources of hydropower used for clean energy, lower per capita vehicle travel due to local planning efforts to reduce sprawl and encourage transportation options, and lower estimated consumption of goods attributable to lower incomes. The inventory groups emissions sources into three broad categories (Figure 3.7).

Figure 3.7: Major Sources of Eugene-Springfield Greenhouse Gas Emissions[20]

[19] Note: The inventory looked at emissions between July 2005 and June 2006.
[20] Central Lane Metropolitan Planning Organization, *Greenhouse Gas Inventory*.


Materials
(Goods &
Food)
58%
Energy
11%
Transportation
31%

The inventory found that a majority of transportation-related emissions were the result of passenger transportation and local freight:

- Local passenger transport, including all cars and light trucks in the region – 17%
- Other passenger transport, including long-distance passenger travel by air, inter-city rail, inter-city bus, cars, and light trucks – 12.4%
- Local freight, including vehicles weighing more than 10,000 pounds – 1.3%
- Transit, including fuel consumption for buses and other transit fleet vehicles – 0.3%

Central Lane Scenario Planning (2015)

The 2009 Jobs and Transportation Act (JTA) required the CLMPO area to conduct local scenario planning to explore how to meet a DLCD-set GHG emissions reduction target of 20% below 2005 levels by 2035. CLMPO's Scenario Planning effort concluded in 2015. Though the major goal was GHG reduction, CLMPO's plan took a broader approach that also incorporated social equity, public health, and economic health (Figure 3.8). This planning effort concluded that under the direction of current policy (the Reference Scenario), the region would only see a 3% reduction in per capita GHG emissions from 2005 levels by 2035. The region will not meet the 75% target without a mix of strategies—the Preferred Scenario consists of a balanced approach toward investment in seven areas: active transport, fleet and fuels, transit, pricing, parking management, education and marketing, and roads. According to the 2015 report, the Preferred Scenario will require new sources of revenue to fully implement.[21] CLMPO was not required to adopt a Preferred Scenario as part of this process.

Figure 3.8: CLMPO Scenario Planning Goals Above and Beyond GHG Reductions

Goal	Criteria
Foster Economic Vitality	Driving costs as a percentage of household income Average household income by housing type Average parking costs Value of time lost to congestion
Improve Public Health	Physical activity per capita Health benefits from increased walking and biking Cost savings due to reduced disease burden Change in the number of fatal or severe injury accidents
Enhance Equity	Driving costs as a percentage of household income Average household income by housing type

Central Lane Scenario Planning Health Impact Assessment (2015)

As part of the scenario planning effort in 2015, CLMPO partnered with Lane County Public Health to conduct a Health Impact Assessment (HIA) to determine regional health impacts and related cost savings of anticipated reductions in GHG emissions associated with the policies under consideration. The strategies espoused by the Scenario Planning process focus on reducing Vehicle Miles Traveled (VMT) as the primary mechanism through which CLMPO can affect substantive changes in GHG emissions; improving fuel economy of the vehicle fleet and reducing the carbon intensity of fuels used, though important strategies, are generally outside the control of the MPO.

[21] Central Lane Metropolitan Planning Organization, *Central Lane Scenario Planning*.

Climate change presents a threat to human health and well-being through severe weather, wildfire, air quality, and food-, water-, and vector-born illness, so human health is an important co-benefit of GHG emissions reductions. The HIA found that the strategies and investments considered through the Scenario Planning process could prevent 20 premature deaths per year and save the region over $30 million in health care costs. Active transport would have the largest impact on health—95% of deaths avoided and 99% of illnesses avoided were associated with increased physical activity. The study concluded that strategies and investments that increase active transportation, and therefore physical activity, are key to maximizing public health benefits.

4. AN INTEGRATED APPROACH TO RESILIENCE & SUSTAINABILITY

4.1 MPO Role in Security and Emergency Management Planning

Though emergency response and public safety agencies in the region assume primary responsibility for planning for and responding to emergency situations, an MPO can also make a significant contribution to security and emergency planning efforts due to its existing role as a convener for cooperative decision-making and conduit for financial resources (Figure 4.1). While these options are dependent upon funding availability and policy board direction, an MPO may facilitate:

- Conducting a **vulnerability analysis** on the transportation system to understand risks and help prioritize strategies to address needs
- Analyzing the transportation network for **redundancies** to ensure efficient movement of people and supplies in the event of an emergency and to address choke points
- Analyzing the transportation network for **emergency transportation routes** and identifying gaps in the network

Figure 4.1: Potential MPO Roles in Security and Emergency Planning[22]

Stage of Incident	Possible MPO Role
Prevention and Preparedness	• Funding new strategies/technologies/projects that can help prevent events • Conducting vulnerability analyses on regional transportation facilities and services • Secure management of data and information on transportation system vulnerabilities • Providing a forum for security/safety agencies to coordinate surveillance, prevention, and preparedness strategies • Funding and coordinating regional transportation surveillance system that can identify potential danger prior to occurrence • Coordinating drills and exercises among transportation providers to practice emergency plans • Involving incident management/emergency response entities in planning processes • Coordinating with security officials in development of prevention and preparedness strategies • Hazardous route planning • Analyzing transportation network for redundancies in moving large numbers of people (e.g. modeling person and vehicle flows with major links removed or reversed, accommodating street closures, adaptive signal control strategies, impact of traveler information systems, strategies for dealing with "choke" points such as tollbooths) • Analyzing transportation network for emergency route planning/strategic gaps in network • Providing a forum for discussions on coordinating emergency response • Disseminating best practices in incident-specific engineering design and emergency response to agencies • Disseminating public information on options available for possible response • Funding communications systems and other technology to speed response to incidents

[22] Bend Metropolitan Planning Organization, *2040 Bend Metropolitan Transportation Plan*, 13-182. Adapted from: Georgia Institute of Technology. *The Role of the Metropolitan Planning Organization (MPO) in Preparing for Security Incidents and Transportation System Response,* Michael D. Meyer, Ph.D., P.E., 2004.

Monitoring	• Coordinating public information dissemination strategies • Funding communications systems for emergency response teams and agencies
Recovery	• Conducting transportation network analyses to determine the most effective recovery investment strategies • Acting as a forum for developing appropriate recovery strategies • Funding recovery strategies
Investigation	• Providing any data collected as part of surveillance/monitoring that might be useful for investigation
Institutional Learning	• Acting as a forum for regional assessment of organizational and transportation system response • Conducting targeted studies on identified deficiencies and recommending corrective action • Coordinating changes to multi-agency actions that will improve future responses • Funding new strategies/technologies/projects that will better prepare the region for the next event

4.2 Assessing Vulnerability

Vulnerability is a measure of a transportation system's or asset's sensitivity to risk, including its adaptive capacity, or ability to cope with current or expected future impacts. A vulnerability assessment is a key step in improving the resilience of the transportation system—in order to take steps to mitigate risk and therefore improve the resilience of the system, a transportation agency must first understand the risks that threaten the system as well as its existing capacity to deal with those risks.

The FHWA has provided guidance on assessing vulnerability associated with climate change and extreme weather intended for state DOTs, MPOs, and local jurisdictions called the *Vulnerability Assessment and Adaptation Framework*.[23] The framework is informed by 24 climate change resilience pilot programs the FHWA has conducted in partnership with transportation agencies across the country since 2010. It is a structured, step-by-step manual to help transportation agencies asses the vulnerability of their transportation systems and help them integrate adaptation into decision-making. There are seven steps in the framework:

1. **Articulate objectives and define study scope.** The first step involves narrowing the focus of the study and setting the parameters given time and resource constraints. The framework provides guidance on the selection of relevant asset and climate variables.

2. **Obtain asset data.** The framework provides best practices for collecting data, as well as guidance on the type of data that may be useful to collect for different assets.

3. **Obtain climate data.** The framework provides a variety of potential sources for local climate data.

4. **Assess vulnerability.** This step helps transportation agencies determine the risk level for a transportation asset or system by evaluating the system's exposure, sensitivity, and adaptive capacity.

[23] Filosa, et al., *Vulnerability Assessment and Adaptation Framework*

5. **Identify, analyze, and prioritize adaptation options.** Adaptation options can include natural, structural, or policy-based solutions. The framework provides guidance on the selection of appropriate options and walks through two evaluation methods to help prioritize them: multi-criteria analysis and economic analysis.

6. **Incorporate assessment results in decision-making.** The framework identifies strategies to integrate the results of the vulnerability assessment into transportation planning; project development and environmental review; project level design and engineering; transportation systems management, operations, and emergency management; and asset management.

7. **Monitor and revisit.** The process must be iterative as new data become available and conditions evolve.

It is important to note that the FHWA's *Vulnerability Assessment and Adaptation Framework* focuses exclusively on climate change vulnerability, but there are many other transportation-related risks, both natural and "non-natural," that can and should be included in a vulnerability analysis. In 2019, the Transportation Research Board funded research by the RAND Community Health and Environmental Policy Program to build on and expand the Vulnerability Assessment and Adaptation Framework for practical implementation by DOTs and MPOs.[24] The recommendations from this report include:

- Expand the objectives and scope of the framework to include shocks and stresses not directly tied to climate change, including cyberattacks
- Broaden asset data to include human and equipment assets, and identify criticality of these assets
- Expand hazard data to consider a wider array of hazards and determine whether they are systemwide or if they influence only a subset of assets
- Use indicators identified to assess the resilience of the system in a way that acknowledges the interaction of the criticality and exposure of the assets
- Engage stakeholders and decisionmakers to help weigh the trade-offs that come with prioritizing options
- Use an established critique, e.g. multicriteria decision analysis, economic analysis, benefit-cost analysis, or life cycle cost analysis, to facilitate prioritization
- Consider the benefits of investments in times of both normalcy and disruption

4.3 Hazards to the CLMPO Area Transportation System

There are numerous naturally occurring and human-caused hazards that can potentially affect the transportation system (Figure 4.2). This section focuses on hazardous threats to the CLMPO transportation system, including stormwater, climate change, seismic hazards, drought, extreme weather, geomagnetic disturbance, landslides, riverine flooding, volcanic hazards, and "non-natural" hazards.[25] The majority of the information on specific hazards and their potential effects in the region in this section are

[24] Weilant, Strong, and Miller, *Incorporating Resilience.*

[25] The threats listed are consistent with those identified in the Eugene-Springfield and Lane County Multi-Jurisdictional Natural Hazard Mitigation Plans. Further consultation with local agencies is necessary to ensure that all relevant risks to the local system are understood and considered.

derived from local hazard mitigation plans and the Oregon Resilience Plan.[26] Stormwater hazards are presented first as a required component of Planning Factor 9, followed by the two hazards most significant to the region (climate change and seismic hazards); the remaining natural hazards are presented alphabetically, with "non-natural" hazards—including pandemics—presented last.[27] This section refers to the work already conducted by local jurisdictions, including the Eugene-Springfield Area Multi-Jurisdictional Hazards Mitigation Plan and the Lane County Multi-Jurisdictional Hazard Plan.

MPOs have utilized formal transportation-specific vulnerability assessments to understand the full nature and extent of the risks to the transportation system. CLMPO has not conducted a formal vulnerability assessment on the transportation system in the CLMPO area but could explore this option as an action item in the 2045 RTP. Funding availability and policy board direction will determine the MPO's ability to conduct a vulnerability assessment.

Figure 4.2: Potential Hazards to the Transportation System[28]

Naturally Occurring	Tornadoes, high winds, electrical storms, ice storms, snowstorms and blizzards, floods, earthquakes, naturally occurring epidemics, landslides, hurricanes, typhoons, tropical storms, wildfires, droughts, dust/windstorms
Human-Caused (Intentional)	Misuse of resources, security breaches, theft, fraud or embezzlement, fire or arson, vandalism, sabotage (external and internal actors), workplace violence, bomb threats and other threats of violence, terrorist assaults (explosive, firearms, conventional weapons, chemical, biological radiological, nuclear agents), labor disputes or strikes, disruption of supply sources, rioting or civil disorder, war, hostage taking, aircraft, ship, or port hijacking
Human-Caused (Unintentional)	Voice and data telecommunications failures or malfunctions, unavailability of key personnel, human errors, power outages (external or internal), water outages, gas outages, HVAC systems failures or malfunctions, accidental damage to or destruction of physical plant and assets, accidental contamination or hazardous materials spills, accidents affecting transportation system, uninterruptible power supply (UPS) failure or malfunction, inappropriate training on emergency procedures

Stormwater

Expected Regional Impacts from Stormwater

Effective stormwater management is critical for mitigating issues related to both water quality and quantity. Roads, paved trails, parking lots, and other impervious surfaces ubiquitous to the urban landscape can alter natural hydrology and prevent water from absorbing into the ground, and instead direct large volumes of runoff into nearby streams, rivers, and lakes and/or wastewater treatment plants, pipelines, and reservoirs. Stormwater runoff carries pollutants, nutrients, and bacteria that can impair the quality of nearby waterbodies and harm wildlife. Excess stormwater during a heavy rain event can also

[26] Unless otherwise noted, the source of information about the hazards presented in this sub-section is the Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan.

[27] At the time this white paper was written, the COVID-19 pandemic had prompted a partial economic shutdown and presented new challenges and opportunities for the transportation system. Though a full exploration of the effects of the pandemic on the transportation system are outside the scope of this paper—and will likely take years to fully comprehend—pandemics are briefly considered as a topic for a future white paper in the "non-natural" hazards sub-section.

[28] National Academies of Sciences, Engineering, and Medicine, *Continuity of Operations (COOP) Planning*

collect in lower-lying areas and, without sufficient pervious ground to absorb it, can cause flooding that poses a direct risk to human life and property. An increase in the frequency of heavy rainfall associated with climate change will exacerbate issues relating to street flooding and increase the need for effective stormwater management.

Potential Impacts from Stormwater to the Transportation System

The primary threat stormwater poses to the transportation system is from street flooding. Inundation and washouts from heavy rainfall can block roads, damage assets, and interrupt utilities, while debris buildup can block drainage systems, which further contributes to flooding. Flooding can cause long-term damage to infrastructure through scour and erosion. Street flooding can also cause damage to property and, in extreme cases, flash flooding can be life threatening.

The potential effects of the transportation system on local water quality is addressed in Section 4.4.1 Sustainability Pillar 1: Environment.

Regional Efforts to Address Risk from Stormwater

The Eugene-Springfield Area and Lane County Multi-Jurisdictional Natural Hazards Mitigation Plans each recommend transportation-related strategies to mitigate stormwater flooding (Figure 4.3).

Figure 4.3: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan	
Stormwater Improvements	Projects include culvert replacements and streambank stabilization. Using prioritization criteria, the highest priority stormwater capital projects are selected for inclusion in the Cities' Capital Improvement Programs. Projects prioritization criteria include whether a project addresses a potential risk to life or property (e.g. flooding), and whether it resolves an ongoing repetitive issue.
Lane County Multi-Jurisdictional Natural Hazard Mitigation Plan	
Upgrade Culverts and Stormwater Drainage Systems	For locations with repetitive flooding, flood damage, or road closures, determine and implement mitigation measures such as upsizing culverts or storm water drainage ditches.
Construction of Stormwater Detention / Retention Ponds	Reduce localized flooding, decrease damage to road infrastructure, and increase natural watershed potential.

Potential MPO Strategy to Address Risk from Stormwater

Green streets that incorporate green infrastructure into their design can help mitigate the negative effects of stormwater runoff generated by the transportation system. Green infrastructure uses both natural and engineered features that replicate natural systems to help slow, infiltrate, and filter stormwater runoff. Examples include bioretention cells, rain gardens, bioswales, street trees, and natural features in the landscape, such as wetlands. Green infrastructure has numerous co-benefits that may help achieve other RTP goals (Figure 4.4). Policies that promote the use of green infrastructure as a means to address stormwater management throughout the region could be considered.

Figure 4.4: Examples of How Green Infrastructure Can Help Achieve RTP Goals[29]

RTP Goal	Examples of how green Infrastrucutre can help achieve RTP goals
Vibrant Communities	Green infrastructure, including trails, parks, street trees, vegetation, and bioswales, contribute to community beautification and public health by connecting people with nature in their daily lives.
Shared Prosperity	Green infrastructure can promote economic growth as a valued public amenity, create construction and maintenance jobs, add to property value, support walkable and bikeable communities, businesses and commercial districts, and lower the costs associated with climate change.
Transportation Choices	Green streets can promote active travel and access to transit by providing enjoyable routes that are shaded and buffered from traffic.
Reliability and Efficiency	Green infrastructure treatments, such as access management and medians with bioswales, can be designed to support reliability and efficiency by reducing crashes and conflicting movements.
Safety and security	Street trees and other green infrastructure can help calm traffic to desired speeds, provide welcoming places that increase security, and improve resiliency and reduce impacts of major storm events.
Healthy Environment	Green infrastructure can enhance and protect the natural environment by supporting clean air and water, filtering stormwater runoff, reducing erosion, protecting, creating and connecting habitat for birds, fish and other wildlife.
Healthy People	Green infrastructure can reduce water, air, noise and light pollution, encourage active lifestyles and link people to trails, parks and nature that enhance human health and well-being.
Climate Leadership	Trees and green infrastructure can support climate adaptation by cooling streets, parking lots and buildings, better managing stormwater and reducing the urban heat island effect. Trees and vegetation can be managed to sequester greenhouse gases to help mitigate climate change.
Equitable Transportation	Clean air and water and access to nature can be improved and habitat can be preserved and enhanced when green infrastructure is provided in historically marginalized communities.
Fiscal stewardship	Protecting the environment and natural resources today can save money for the future and reduce infrastructure construction and maintenance costs.
Transparency and Accontability	All stakeholders can be represented, including those that cannot speak for themselves – wildlife and the natural environment. Performance-based planning includes considering environmental effects throughout the planning process.

Climate Change

Expected Regional Impacts from Climate Change

According to the *Fourth Oregon Climate Assessment Report*,[30] the state of Oregon is already experiencing the effects of climate change. Since 1900, the Pacific Northwest has warmed two degrees Fahrenheit on average, and the warming trend appears to be accelerating. The year 2015 was Oregon's warmest on

[29] Portland Metro, *2018 Regional Transportation Plan,* 3-53.

[30] Mote, et al., *Fourth Oregon Climate Assessment Report.*

record, and the report points to the year's challenges as an indication of things to come: irrigation shortages, heat and drought impacts to agriculture, coastal fisheries losses, reduced recreation, wildfires, harmful algal blooms, impacts to drinking water, increased incidence of heat illness, record infectious disease cases, and increases in emergency food assistance. Following the record 2015, 2016 to 2018 were all warmer than the 1970 to 1990 average. The report lays out several troubling trends that can be expected in Oregon by 2100, including:

- Continued Warming – Oregon is expected to be four to nine degrees Fahrenheit warmer, depending on global emissions.
- Changes in Rainfall – Annual precipitation is projected to remain constant, but more of the precipitation will be concentrated in the winter months, leaving the summer months drier and at elevated risk for wildfires. Heavy winter rainfall may lead to landslides that close transportation corridors.
- Changes in Snowfall – Spring snowpack will continue to decline, particularly at lower elevations, which will directly affect surface and groundwater supply and will lead to water scarcity and economic losses. In winter, an increase in precipitation falling as rain will cause an increase in streamflow; in summer, flows could be as much as 50% lower in some basins, affecting the generation of hydroelectric power, leading to water scarcity in areas not served by reservoirs or groundwater, and negatively impacting commercial and tribal fisheries.
- Rising Seas – Seas could rise as much as 8.2 feet along the Oregon coastline as ice sheets melt irreversibly.
- Extreme Heat – By mid-century, most places will see an increase of 30 days over 86 degrees Fahrenheit, increasing health risks associated with extreme heat.
- Increasing Fire Risk – As summers get hotter and drier by mid-century, fire risk will increase. The Willamette Valley and Eastern Oregon will see the largest increases in risk.
- Impacts to Agriculture & Natural Resources – Though some regions may experience positive changes—such as a longer growing season—water scarcity, more pests and weeds, and reduced crop quality will increasingly be of concern. Timber production may be affected as trees experience drought stress from lower moisture content.

According to the International Panel on Climate Change (IPCC) Fifth Assessment Report, climate change is expected to increase displacement of people as migration patterns shift in response to extreme weather and long-term changes in climate.[31] For example, sea level rise alone may put up to 13.1 million people living on U.S. coasts at risk by 2100, which could spur a mass migration away from the coastline.[32] Though specific impacts of climate migration in Oregon and the CLMPO area are complex and relatively unknown, speculation by the media and the public that the Pacific Northwest could see an influx of climate migrants[33] from other areas of the country experiencing more severe climate change impacts has

[31] International Panel on Climate Change, *Climate Change 2014 Summary for Policymakers*, 20.
[32] Kollipara, *Rising seas could displace more Americans.*
[33] The term "climate refugee" is commonly used to describe people displaced—either voluntarily or involuntarily—by changes to the natural environment caused by climate change, such as sea level rise or extreme heat. However, the term lacks an internationally recognized legal definition, and there is no legal mechanism by which individuals can seek climate refugee status. This white paper uses the term "climate migrant" to signify an individual displaced by environmental pressure.

prompted some planners, policymakers, and researchers to consider whether long-term planning decisions should account for an influx of population.[34] There is some evidence to suggest that people wanting to escape sea level rise, heat, wildfires, and other extreme weather conditions may consider the CLMPO area an attractive alternative. An influx of climate migrants to the CLMPO area would have important implications for transportation systems and infrastructure.

Potential Impacts of Climate Change to the Transportation System

In addition to risks to life and property, climate change poses many risks to transportation infrastructure. Figure 4.5 presents a summary of climate impacts on the highway system, though not all impacts apply to the CLMPO area. Most infrastructure was designed to meet the challenges of historic climate, not to withstand conditions expected as the climate warms.

Figure 4.5: Summary of Climate Impacts on the Highway System[35]

Climatic/Weather Change	Impact to Infrastructure	Impact to Operations/Maintenance
Temperature		
Change in extreme maximum temperature	– Premature deterioration of infrastructure – Damage to roads from buckling and rutting – Bridges subject to extra stresses through thermal expansion and increased movement	– Safety concerns for highway workers limiting construction activities – Thermal expansion of bridge joints, adversely affecting bridge operations and increasing maintenance costs – Vehicle overheating and increased risk of tire blowouts – Rising transportation costs (increase need for refrigeration) – Materials and load restrictions limit transportation options – Closure of roads because of increased wildfires
Change in range of maximum and minimum temperature	– Shorter snow and ice season – Reduced frost heave and road damage – Later freeze and earlier thaw of structures because of shorter freeze season lengths – Increased freeze-thaw conditions in selected locations creating frost heaves and potholes on road and bridge surfaces – Increased slope instability, landslides, and shoreline erosion from permafrost thawing leads to damaging roads and bridges due to foundation settlement (bridges and large culverts are particularly sensitive to movement caused by thawing permafrost)	– Decrease in frozen precipitation would improve mobility and safety of travel through reduced winter hazards, reduce snow and ice removal costs, decrease need for winter road maintenance, and result in less pollution from road salt, and decrease corrosion of infrastructure and vehicles – Longer road construction season in colder locations – Vehicle load restrictions in place on roads to minimize structural damage due to subsidence and the loss of bearing capacity during spring thaw period (restrictions likely to expand in

[34] Binder and Jurjevich, *Winds of Change*, 2.

[35] National Academies of Sciences, Engineering, and Medicine, *Strategic Issues facing Transportation, Vol. 2.*

Climatic/Weather Change	Impact to Infrastructure	Impact to Operations/Maintenance
	– Hotter summers in Alaska lead to increased glacial melting and longer periods of high stream flows, causing both increased sediment in rivers and scouring of bridge supporting piers and abutments	areas with shorter winters but longer thaw seasons) – Roadways built on permafrost likely to be damaged due to lateral spreading and settlement of road embankments – Shorter season for ice roads
Precipitation		
Greatest changes in precipitation levels	– If more precipitation falls as rain rather than snow in winter and spring, there will be an increased risk of landslides, slope failures, and floods from the runoff, causing road washouts and closures as well as the need for road repair and construction – Increasing precipitation could lead to soil moisture levels becoming too high (structural integrity of roads, bridges, and tunnels could be compromised leading to accelerated deterioration) – Less rain available to dilute surface salt may cause steel reinforcing in concrete structures to corrode – Road embankments could be at risk of subsidence/heave – Subsurface soils may shrink because of drought	– Regions with more precipitation could see increased weather-related accidents, delays, and traffic disruptions (loss of life and property, increased safety risks, increased risks of hazardous cargo accidents) – Roadways and underground tunnels could close due to flooding and mudslides in areas deforested by wildfires – Increased wildfires during droughts could threaten roads directly or cause road closures due to fire threat or reduced visibility – Clay subsurfaces for pavement could expand or contract in prolonged precipitation or drought, causing pavement heave or cracking
Increased intense precipitation, other change in storm intensity (except hurricanes)	– Heavy winter rain with accompanying mudslides can damage roads (washouts and undercutting), which could lead to permanent road closures – Heavy precipitation and increased runoff can cause damage to tunnels, culverts, roads in or near flood zones, and coastal highways – Bridges are more prone to extreme wind events and scouring from higher stream runoff – Bridges, signs, overhead cables, and tall structures could be at risk from increased wind speeds	– The number of road closures due to flooding and washouts will likely rise – Erosion will occur at road construction project sites as heavy rain events take place more frequently – Road construction activities could be disrupted – Increases in weather-related highway accidents, delays, and traffic disruptions are likely – Increases in landslides, closures, or major disruptions of roads, emergency evacuations, and travel delays are likely – Increased wind speeds could result in loss of visibility from drifting snow, loss of vehicle stability/maneuverability, lane obstruction (debris), and treatment chemical dispersion – Lightning/electrical disturbance could disrupt transportation electronic infrastructure and signaling, pose risk

Climatic/Weather Change	Impact to Infrastructure	Impact to Operations/Maintenance
		to personnel, and delay maintenance activity
Sea Level		
Sea level rise	– Erosion of coastal road base and undermining of bridge supports due to higher sea levels and storm surges – Temporary and permanent flooding of roads and tunnels due to rising sea levels – Encroachment of saltwater leading to accelerated degradation of tunnels (reduced life expectancy, increased maintenance costs and potential for structural failure during extreme events) – Further coastal erosion due to the loss of coastal wetlands and barrier islands removing natural protection from wave action	– Coastal road flooding and damage resulting from sea level rise and storm surge – Increased exposure to storm surges – More frequent and severe flooding of underground tunnels and other low-lying infrastructure
Hurricanes		
Increased hurricane intensity	– Increased infrastructure damage and failure (highway and bridge decks being displaced)	– More frequent flooding of coastal roads – More transportation interruptions (storm debris on roads can damage infrastructure and interrupt travel and shipments of goods) – More coastal evacuations

Regional Efforts to Address Risk from Climate Change

Local and regional efforts to address climate change include policies, programs, and projects aimed at both mitigation (reducing GHG emissions in order to curb the global rise in temperature) and adaptation (adjusting to the observed effects of climate change). Figure 4.6 provides an overview of CLMPO partner agency plans and policies to improve the region's resilience to climate change.[36] Regional adaptation strategies focusing on specific hazards are discussed individually in subsequent sections.

Figure 4.6: CLMPO and Member Agency Plans and Policies that Address Climate Change

Member Agency	Actions
CLMPO	– Central Lane Scenario Planning – Central Lane Scenario Planning Health Impact Assessment
City of Coburg	– Lane County Multi-Jurisdictional Hazard Mitigation Plan
City of Eugene	– Climate Action Plan 2.0 – Climate Recovery Ordinance – Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan

[36] Though this overview focuses on CLMPO partner agencies, CLMPO recognizes that numerous other local agencies and organizations are directly impacted by disruptions to the transportation system and are working to address climate change. Further coordination and consultation with these agencies could be pursued as a next step.

	–	Regional Climate and Hazards Vulnerability Assessment
City of Springfield	–	Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan
	–	Regional Climate and Hazards Vulnerability Assessment
Lane County	–	Lane County Multi-Jurisdictional Hazard Mitigation Plan
	–	Lane County Climate Action Plan
Lane Transit District	–	Climate Action Policy Statement and Fleet Procurement Goals *(in development)*
ODOT	–	Eugene-Springfield Metropolitan Region Greenhouse Gas Inventory

Seismic Hazards

Expected Regional Impacts from Seismic Hazards

The Pacific Northwest and the State of Oregon are vulnerable to seismic hazards from four sources: shallow crustal earthquakes, deep intraplate earthquakes resulting from the subduction of the Juan de Fuca Plate beneath the North American Plate, very large subduction zone earthquakes that occur along the boundary between the Juan De Fuca and North American Plates, and volcanic activity. Oregon is subject to far less frequent, but bigger and potentially more damaging earthquakes than its seismically active neighbors, Washington and California. In geologic terms, Oregon is a mirror of northern Japan, where the 9.0 Tohoku earthquake and subsequent tsunami caused widespread devastation and sparked the Fukushima Daiichi nuclear disaster in 2011. Oregon is located along what is known as the "Ring of Fire," an arc of subduction zones in the Pacific Ocean marked by frequent and often catastrophic seismic activity. The Pacific Plate is moving east and subducting under the coasts of Northern California, Oregon, Washington, and Southern British Columbia along a 620-mile fault known as the Cascadia Subduction Zone (CSZ).

There is a clear and imminent threat from the CSZ in Oregon. According to the *Eugene-Springfield Area Multi-Jurisdictional Natural Hazard Mitigation Plan*, the odds of a powerful CSZ earthquake with magnitude 8.0 or greater in the next 50 years are roughly one in three. Such an earthquake will cause several minutes of severe ground shaking, large tsunamis, and widespread damage. In the past 10,000 years, the entire fault has ruptured (i.e. moved) with a magnitude 9.0 or greater 20 times, three quarters of the fault has ruptured with a magnitude 8.5-8.8 two to three times, and just the Southern portion has ruptured with a magnitude 7.6-8.5 nineteen times.[37] The most recent rupture along the CSZ fault occurred in January 1700 and caused tsunamis that hit the coasts of Oregon, Washington, and Japan. These earthquakes strike at variable time intervals, but the 320-year span since the last event is among the largest. According to the *Oregon Resilience Plan*, "there is no scientific doubt that another great subduction earthquake will strike the Pacific Northwest; the questions now are how soon, how large, and how destructive that earthquake will be." [38]

The *Oregon Resilience Plan* breaks the State of Oregon into four geographic zones based on relative risk: the Tsunami Zone, in which near total damage and major loss of life is expected; the Coastal Zone, in which severe shaking will damage the transportation network and isolate communities; the Valley Zone, in which moderate but widespread damage would disrupt life for a period of weeks or months; and the

[37] Cities of Eugene and Springfield, *Natural Hazards Mitigation Plan*.

[38] Oregon Seismic Safety Policy Advisory Commission, *The Oregon Resilience Plan*, 4.

Eastern Zone, in which light damage would allow communities to recover quickly and become critical emergency response centers. The CLMPO area is in the Valley Zone.

CSZ simulations show that all of Oregon would experience two to four minutes of ground shaking, with coastal areas experiencing severe to violent shaking, cities along the I-5 corridor experiencing strong to very strong shaking, and areas east of the Cascades experiencing light to moderate shaking. Without additional investment in seismic resilience, Oregon can expect severe damage to buildings and lifelines that would result in massive loss of life and long-term disruption to the economy. The region's transportation networks are a key factor in the state's recovery, first in facilitating emergency response and then restoring mobility. Without a coordinated and sustained effort to improve the resilience of the region, a CSZ earthquake will have devastating impacts:[39]

- The combined effects of the earthquake and tsunami could result in 1,250 to 10,000+ fatalities
- Tens of thousands of buildings will either collapse or be so damaged that they take months to years to repair
- The damage could produce 1 million truckloads of debris
- Disruptions to the liquid fuel supply from Washington State would affect all sectors of the economy, including those critical to emergency response and economic recovery
- Disruptions to businesses and the economy could last a month or more, causing businesses to close or relocate

Investing in the resilience of the transportation system makes financial sense. The *Oregon Highways Seismic Plus Report* estimates a $335 billion economic impact over seven years following a CSZ event, which could be reduced by 24% with pre-emptive seismic retrofitting.[40] Without further intervention to prepare buildings and lifelines, damage would be so extensive that the restoration of full service could take three months to one year in the southern Willamette Valley, more than one year in hard-hit coastal areas, and many more years in communities hit by a tsunami.

Potential Impacts of Seismic Hazards to the Transportation System

The Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan found that all sectors are extremely vulnerable to a CSZ earthquake and that our systems, infrastructure, and personnel are ill-prepared for a disaster on that scale. The first statewide building codes mandating seismic resistance for new construction did not appear until 1974, and it was not until 1993 that building codes addressed the impacts of a CSZ earthquake, which nearly doubled the forces used in earlier codes. This means that a majority of buildings in the state of Oregon were not designed to withstand the kind of intense shaking that will occur during a CSZ event. A Statewide Seismic Needs Assessment conducted by the Department of Geology and Mineral Industries (DOGAMI) in 2007 found that 50% of public school buildings and 25% of public safety buildings in Oregon are at high or very high risk of collapse. In 2013, when the *Oregon Resilience Plan* was published, only 409 of the state's 1,567 bridges, or 26%, had been designed to CSZ earthquake specifications.[41]

[39] Oregon Seismic Safety Policy Advisory Commission, *The Oregon Resilience Plan.*

[40] ODOT, *Oregon Highways Seismic Plus Report*.

[41] Oregon Seismic Safety Policy Advisory Commission, *The Oregon Resilience Plan.*

Earthquakes pose a particular risk to transportation infrastructure, which is both a vulnerable asset and a primary factor in the region's ability to recover from a significant seismic event. There are several specific threats associated with seismic activity:

- **Ground shaking** is the primary cause of damage from earthquakes
- **Ground shaking amplification** refers to the way certain soils and soft sedimentary rocks can intensify shaking
- **Surface faulting** occurs when seismic activity causes displacement at the earth's surface
- **Landslides** can occur when unstable slopes are subject to shaking
- **Liquefaction** occurs when certain sediments become saturated with water and temporarily act like a fluid instead of a solid

Lifeline systems upon which emergency response and long-term recovery depend (including highways and pipelines that deliver and distribute petroleum required to repair broken links in the transportation system) are extremely vulnerable to ground failure caused by shaking, amplification, faulting, landslides, and liquefaction. A major dam failure would cause further damage to roads and bridges. Damage to the transportation system will initially hinder rescue operations, inspection of critical infrastructure for damage, and restoration of activities and services. Though ODOT has been working on seismic retrofits to the highway system, a large portion of the transportation network would be damaged and unusable following a CSZ event.

Immediately following a CSZ event, local roads and streets may provide the only access to critical facilities like hospitals, fire stations, and temporary food and housing. Much of the local road network would be subject to serious damage, but in some cases local roads and streets could provide redundancy for the state highway lifelines. Air transportation and public transit will also both play critical roles in emergency response. Until highway and rail transportation is restored, air transport will provide a critical lifeline for many of Oregon's residents who cannot be reached by other means of transportation immediately following a CSZ earthquake. As lifeline routes are restored, transit buses can assist in evacuations, transport emergency workers and supplies, and provide transportation to recovery-related jobs.

ODOT Efforts to Address Risk from Seismic Hazards

Between 2012 and 2014, ODOT participated in and led several massive efforts to address seismic resilience of the state transportation system, the products of which included the *Oregon Seismic Lifelines Identification Project* (2012), which identified lifeline routes and laid out ODOT's approach to establishing seismic resilience on the state's highway system; the *Oregon Resilience Plan* (2013), which looked at state- and sector-wide effects of a CSZ event in Oregon; and the *Oregon Highways Seismic Plus Report* (2014), which prioritized retrofits to the transportation system in five phases. The extensive research, data, and framework from these reports should form the foundation of CLMPO's approach to seismic resilience.

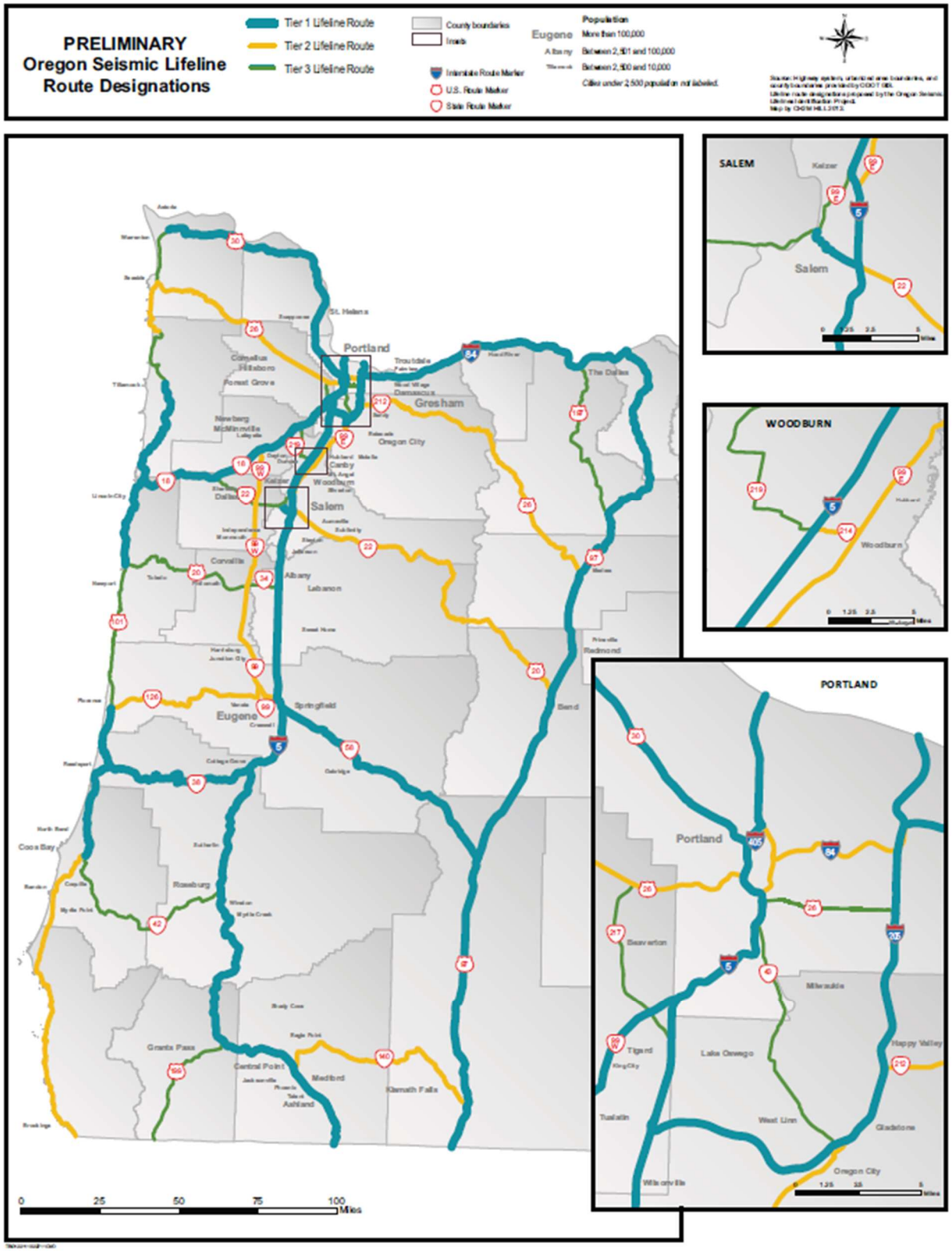
ODOT's approach to seismic lifeline routes relies on the Eastern Zone for a continuous North-South network that connects Central Oregon to Washington and California as well as several East-West corridors to connect to the vulnerable regions in the western part of the state. ODOT further breaks the

lifeline system into three tiers to help prioritize retrofits and repairs first to facilitate immediate emergency response and then to restore general mobility:

> Tier 1: the backbone system that facilitates access to the hardest-hit regions, major population centers, and hubs for rescue and recovery operations. The *backbone system*—the minimum network of highway routes with the greatest potential to aid short-term rescue operations as well as long-term recovery—includes four routes:
>
> – I-5 from OR 58 (Eugene) to I-84 (Portland)
> – I-84 from I-5 (Portland) to US 97
> – US 97 from I-84 to the California border
> – OR 58 from I-5 (Eugene) to US 97 (Bend)
>
> Tier 2: a larger network that links most urban areas and provides lifeline route redundancy.
>
> Tier 3: a more complete transportation network that provides access to rural areas including all of the Oregon coast, critical utilities, emergency response staging areas, and strategic freight corridors or facilities.

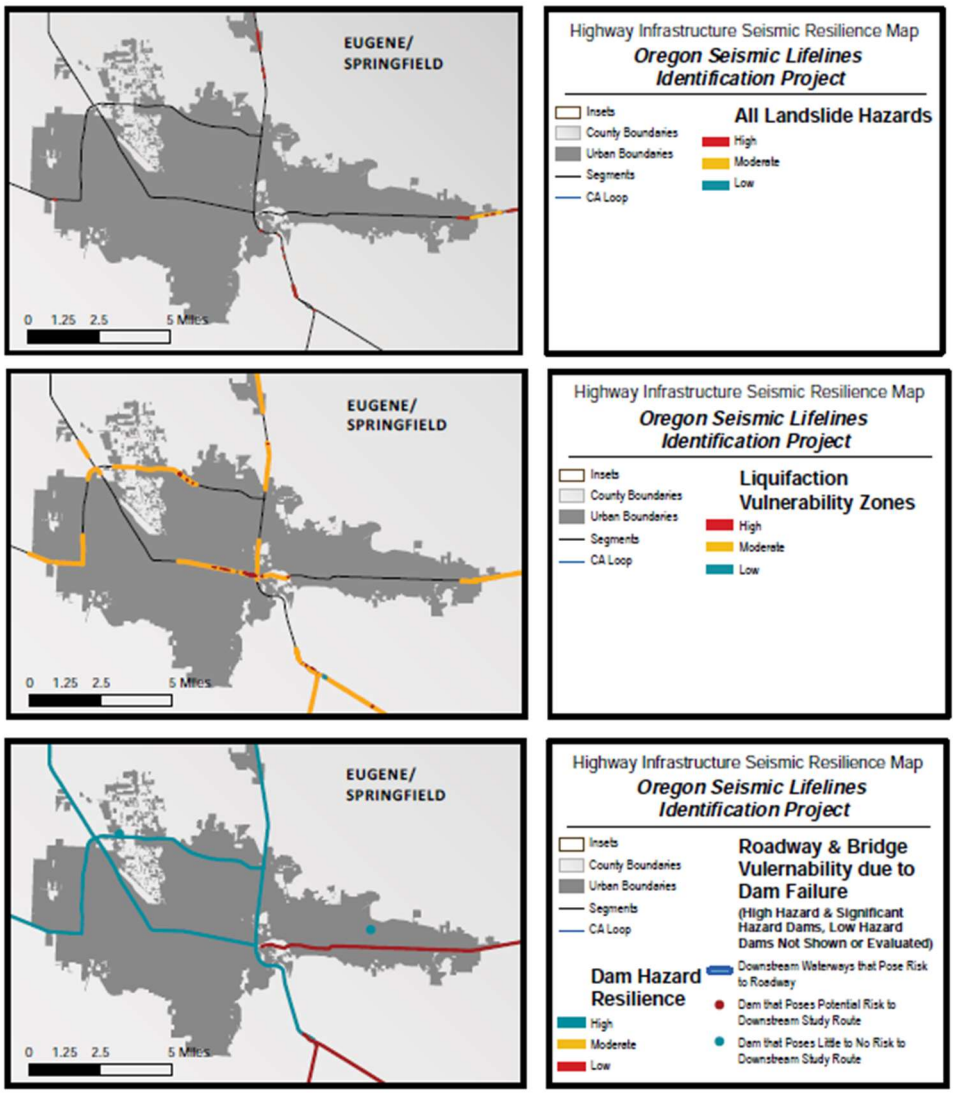
Eugene's location on both major East-West and North-South lifeline routes position it as a critical nexus in response and recovery following a CSZ event (Figure 4.7). Key Tier 1 lifeline routes through the CLMPO area include OR-58 and I-5; key Tier 2 lifeline routes include OR-126 and US-99W. Figure 4.8 shows the relative risks to these highways from landslide hazards, liquefaction, and dam failure.

Figure 4.7: Oregon Seismic Lifeline Route Designations[42]



[42] ODOT, *Oregon Highways Seismic Plus Report*, 65.

Figure 4.8: Risks to Eugene-Springfield Lifeline Routes from Landslides, Liquefaction, and Dam Failure[43]



Regional Efforts to Address Risk from Seismic Hazards

The Eugene-Springfield Area and Lane County Multi-Jurisdictional Natural Hazards Mitigation Plans both recommend several transportation-related strategies to mitigate earthquake hazards (Figure 4.9).

Figure 4.9: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazard Mitigation Plan	
Local Active Transportation Infrastructure Evaluation	Evaluate off-street path bridges, crossing over the Willamette River, to complete a high-level seismic assessment of all major city bridges
Local Transportation Infrastructure Seismic Upgrades *(priority)*	**Complete seismic improvements to three of the thirteen priority transportation structures**

[43] ODOT, *Oregon Seismic Lifelines Identification Project*.

Emergency Fuels Assessment Phase II *(priority)*	Finish phase two of the Emergency Fuels Assessment for Lane County
Increased Fuel Capacity *(priority)*	Research methods to increase fossil fuel capacity around critical facilities; such as upgrading generator fuel tanks to high capacity tanks
Seismically Retrofit Eugene Fueling Station *(priority)*	Seismically retrofit fueling station and associated buildings to ensure it is usable after a Cascadia Subduction Zone earthquake
Earthquake Damage Study	In partnership with DOGAMI, update the earthquake damage estimate study for the Eugene-Springfield Area
Seismic Upgrades	Finish seismic upgrades to City owned facilities
Lane County Multi-Jurisdictional Natural Hazard Mitigation Plan	
Participate in ODOT Bridge Seismic Resiliency Planning Project	Increase bridge resiliency to seismic forces and response capability, decrease loss of life and property.

In 2017, ODOT requested Lane County to identify alternate routes to seismically vulnerable bridges and assess the costs to repair vulnerable bridges along local lifeline routes (Figure 4.10). According to the Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan, "The Glenwood area is planned to be freight off-load and redistribution point." [44]

Figure 4.10: Critical Bridges in the Eugene-Springfield Area[45]

Bridge	Sufficiency Rating	Est. Cost to Upgrade
Bridges that Must be Operational After Event		
08638: Belton over Willamette River	74	$2,000,000
08705: Debrick Slough WB on Ramp to Beltline	64	$450,000
Bridges Needed to Bring Help from I-5/Hwy 58		
016329: Glenwood Blvd over UPRR	93	$300,000
W6099C: Franklin Blvd over Hwy 1	55	$2,000,000
08051: Main Street over Willamette River (Springfield)	76	$2,250,000
Bridges Providing Critical Intercity Link to Access Hospital or other Vital Resource		
6648: Ferry Street Bridge over the Willamette (Eugene)	31	$2,000,000
09596: Mohawk Blvd over Hwy 126 (Springfield)	64	TBD

Potential CLMPO Strategy to Address Risk from Seismic Hazards

As a next step in planning for seismic resilience, CLMPO could follow the lead of Portland Metro, which has designated a network of regional Emergency Transportation Routes (ETRs)—priority routes used to facilitate life-saving response activities following an emergency—to complement the statewide system of Lifeline Routes. In 2019, upon recommendation in its 2018 RTP, Portland Metro partnered with the Regional Disaster Planning Organization (RDPO) to update its ETRs, which were designated in 1996 and last updated in 2006. Funding for the project came from FEMA's Urban Areas Security Initiative (UASI) grant, which funds projects that enhance regional preparedness and expand regional collaboration in major metropolitan areas. See Appendix 6.3 A Case for Establishing Regional Emergency Transportation Routes.

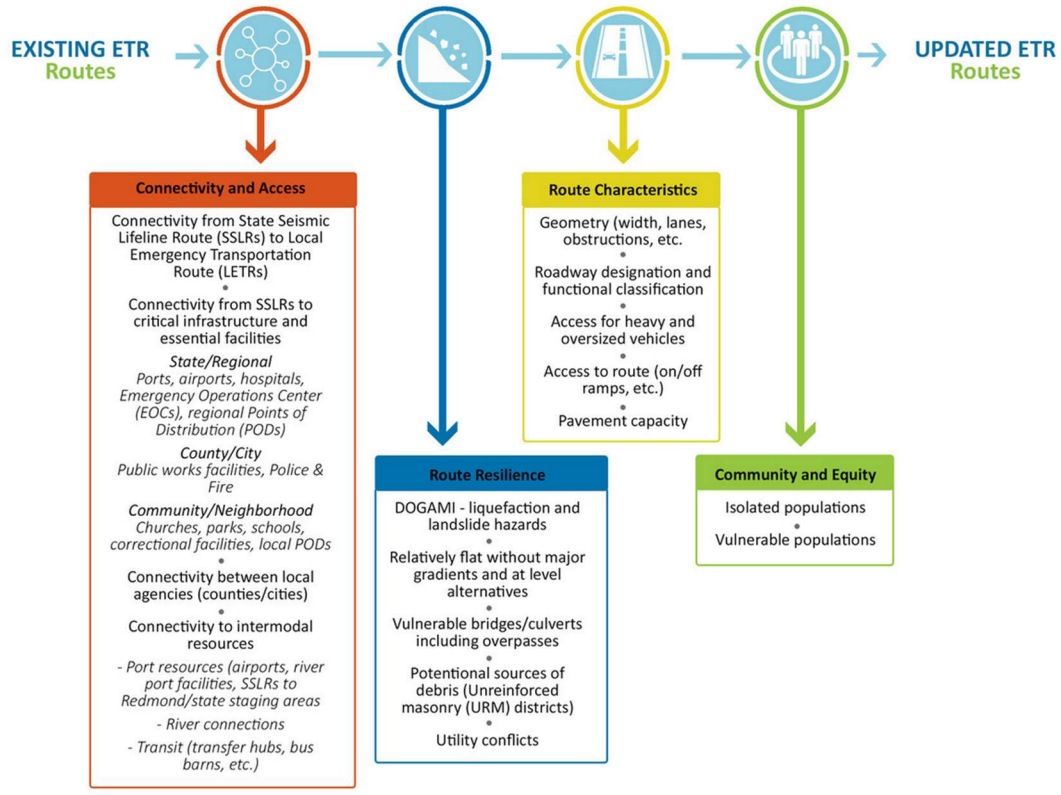
[44] Cities of Eugene and Springfield, *Natural Hazards Mitigation Plan,* 4-22.
[45] Ibid.

There are four types of ETRs:

1. Local Emergency Response Streets are a network of streets in a single jurisdiction that facilitate ordinary fire, police, and medical emergencies.
2. Local Emergency Transportation Routes are pre-designated routes used during a large-scale event in the initial response phase and early recovery to transport first responders, fuel, supplies, and patients. Local ETRs connect regional nodes to destinations of local importance (e.g. staging areas, essential infrastructure, and intermodal transfer points) and add redundancy to the Tier 2 and 3 Statewide Lifeline Routes.
3. Regional Emergency Transportation Routes are pre-designated routes that move first responders and supplies across jurisdictional boundaries among regional nodes and connect population centers, critical infrastructure, and services of regional importance. RETRs also connect Statewide Lifeline Routes and local ETRs.
4. Statewide Lifeline Routes are state-owned roadways identified by ODOT as critical to emergency response and recovery activity. Lifeline Routes connect regions of statewide importance; as described above, there are a few key north-south and east-west routes.

CLMPO could consider engaging in a similar planning effort to identify and prioritize its own RETRs following Metro's model (Figure 4.11).

Figure 4.11: Portland Metro's Process for Updating Regional ETRs[46]



[46] Regional Disaster Preparedness Organization, *Emergency Transportation Routes.*

Drought

Expected Regional Impacts from Drought

Drought is considered a slow-onset hazard, yet it poses a serious and far-reaching threat to the region. In the short term, drought causes a decline in water levels of streams, rivers, reservoirs, lakes, and ground water, which threaten water supplies and disrupt ecological processes; reduced agricultural productivity; and increased risk of wildfires. In the long-term, drought can have serious economic consequences. According to the National Oceanic and Atmospheric Association (NOAA), drought is the second most economically destructive weather-related hazard.[47]

There are three types of drought:

1. Meteorological drought occurs when precipitation drops below the regional average.
2. Hydrological drought occurs when decreased precipitation causes declines in soil moisture, groundwater, snowpack, streamflow, lakes, and reservoir levels.
3. Agricultural drought occurs when the available supply of water does not meet demands from agriculture, regardless of the status of meteorological drought.

Drought is not uncommon in Lane County. In 2001, 2014, and 2015, 100% of the county experienced severe drought. Droughts are expected to increase in frequency and severity in the Pacific Northwest due to climate change. More precipitation is expected to fall as rain rather than snow, shifting the timing of snowmelt and further exacerbating drought conditions.

Potential Impacts from Drought to the Transportation System

Drought conditions can increase the risk of dust storms and wildfires, which can affect visibility, compromise air quality, and lead to road closures. Drought coupled with high temperatures can cause subsidence and rail line buckling, threatening transportation assets and causing derailments. In Oregon, where shallow underground karst aquifers are prevalent, subsidence and sinkhole formation can occur when depleted aquifers collapse. Drought can also have severe impacts on other sectors that are highly dependent on the availability of water, such as energy, communications and information technology, emergency response, healthcare, and manufacturing. Economic consequences of prolonged drought may affect the availability of funding for transportation projects.

Regional Efforts to Address Risk from Drought

This paper did not identify transportation-specific efforts or policies to address drought.

Extreme Weather

Expected Regional Impacts from Extreme Weather

Extreme weather events happen infrequently and typically cause little damage in the CLMPO area. The region is susceptible to windstorms, winter storms, thunderstorms, hail, tornadoes, and severe heat. Windstorms and winter storms are most common to the area, though most winters produce little snowfall and the cities of Eugene and Springfield experience major falls of ten or more inches only every

[47] Cities of Eugene and Springfield, *Natural Hazards Mitigation Plan*.

10-20 years. Since 1937, there have been six recorded tornadoes in Lane County, which caused no deaths and minimal damage. In 2014, the region experienced a record number of days with temperatures over 90, and 2017 witnessed one of the longest heat waves in history that lasted from the end of July through the beginning of August. Climate change may exacerbate extreme weather in the CLMPO area in several ways: higher summertime temperatures (both highs and lows), a decrease in total precipitation, and an increase in severe winter storms.

Potential Impacts from Extreme Weather to the Transportation System

Transportation infrastructure is susceptible to a variety of potential impacts from extreme weather. Storms of any kind can disrupt utilities and transportation, particularly if they lead to accumulation of snow or ice, downed trees, flooding, or landslides. Storms also cause delays and traffic accidents. Freezing conditions can hasten deterioration of roads that are already cracking, while higher temperatures degrade some asphalts, leading to softening, rutting, buckling, or migration of liquid asphalt. Extreme heat also accelerates deterioration of bridge infrastructure through thermal expansion of joints and paved surfaces as well as deterioration of steel, asphalt, protective cladding, coats, and sealants. Heat waves present health and safety risks for maintenance and construction crews and can delay construction. Heat can also cause vehicles to overheat and accelerate tire deterioration, as well as pose a barrier to active transportation modes.

Regional Efforts to Address Risk from Extreme Weather

The Eugene-Springfield Area and Lane County Multi-Jurisdictional Natural Hazards Mitigation Plans each recommend one transportation-related strategy to mitigate hazards from extreme weather (Figure 4.12).

Figure 4.12: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan	
Defective Tree Maintenance *(priority)*	Utilize contract crews to perform maintenance pruning. Provide clearance and mitigate defects, such as overextended branches prone to failure under increased loads, along major arterials and priority traffic routes. Unhealthy or structurally unsound trees will be removed and replanted.
Lane County Multi-Jurisdictional Natural Hazard Mitigation Plan	
Reduce the Impact of Tree Damage from Windstorms	Reduce cost in loss of property and cleanup, decrease disruptions in power and transportation.

Geomagnetic Disturbance

Expected Regional Impacts from Geomagnetic Disturbance

A geometric disturbance (GMD) refers to a naturally occurring pulse of energy, most commonly caused by solar flares. Most GMD events cause little to no damage. However, in severe cases, X-ray and UV radiation initially causes radio blackouts and GPS errors. Minutes to hours after initial impact, satellites can be electrified and damaged by particles (protons, electrons, and high atomic number and energy ions). After a day or more, clouds of magnetized plasma called coronal mass ejections can arrive, causing widespread power blackouts that damage anything plugged into a wall socket or running on electricity. The specific threat to the CLMPO area is unknown.

Potential Impacts of Geomagnetic Disturbance to the Transportation System

A severe GMD event could temporarily cripple or permanently damage Intelligent Transportation Systems (ITS) operations that are reliant on electricity, emphasizing the importance of redundancy and the ability to maintain communications and operations without power.

Regional Efforts to Address Risk from Geomagnetic Disturbance

This paper did not identify transportation-specific efforts or policies to address GMD.

Landslides

Expected Regional Impacts from Landslides

According to the Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan, though the probability of a landslide in the CLMPO area is high, the vulnerability is low, because local damage is expected to be geographically limited to where the slide occurs unless infrastructure or waterways are involved. Four types of landslides are possible in the region:

1. Rockfalls – abrupt movement of material that detaches from steep slopes or cliffs; can be caused by gravity, weathering, undercutting, and/or erosion
2. Rotational Slides – movement of a mass downward and outward along a concave rupture; common along roads constructed by cut and fill
3. Translational Slides – movement of a mass along a flat surface
4. Flows – slide material moves downhill as a semi-fluid mass that scours the slope along its path; typically moves rapidly and increases in volume along the way

Many natural and human factors increase the likelihood of landslides in the region, including geology, rainfall, seismic activity, volcanic activity, grading on slopes for development, structures and traffic loads, alterations to groundwater or drainage, removal or change of vegetation on steep slopes, and water content in soils and rock. Within the past 150 years, most landslides in the area have been smaller slides near waterways or related to development activity. The south hills of Eugene and Springfield are the areas most susceptible to slides, and Highway 126 is the most commonly affected state highway in the county.

Climate Change and earthquakes are both significant risk factors for landslides. Increased precipitation associated with Climate Change can destabilize slopes and cause landslides. In particular, there is an increased risk of landslides due to mixed rain and melting snow events in low- to mid-elevation mountains. Ground shaking during earthquakes can reactivate existing landslides, which tend to move farther and more quickly than new landslides, which typically only move a few inches to a few feet. A DOGAMI study in 2018 (IMS-60) revealed three times the number of historic landslides than were previously known to exist in the area. According to the study, there are over 700 slides covering 6% of the 230-square mile study area, which included the Cities of Eugene, Springfield, and Coburg, with a buffer to include surrounding populated areas of Lane County—including Goshen and Waterville—as the project budget and scope allowed.[48]

[48] Calhoun, et al., *Landslide Hazard and Risk Study*, 2.

Potential Impacts from Landslides to the Transportation System

Landslides can pose a direct threat to transportation infrastructure and to motorists. They can cause immediate injury or loss of life if debris strikes motorists, pushes them off the roadway, or buries them; if motorists hit debris in the roadway; or if motorists drive onto collapsed roadways. Landslides on the slope above a highway can also lead to long-term closures and disrupt utilities that share the right of way. In the event of a CSZ earthquake, landslides on major lifeline routes will impede rescue operations and hinder long-term recovery. Nearly every highway in western Oregon is susceptible to or affected by landslides, particularly in the Oregon Coast Range, where very high annual rainfall weakens slopes, and a large number of landslides occur each year.

Regional Efforts to Address Risk from Landslides

The Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan recommends one transportation-related strategy to mitigate landslide hazards (Figure 4.13).

Figure 4.13: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan	
Analysis of 2018 DOGMAI Landslide Study	Using the DOGAMI landslide study released the summer of 2018 (IMS-60), determine areas and buildings at risk from landslides and propose comprehensive land use policies and construction standards accordingly

Riverine Flooding

Expected Regional Impacts from Riverine Flooding

Lane County has more river miles of floodplain than any other county in the State of Oregon, and much of the CLMPO area is at risk of flooding.[49] Flooding threatens public health and safety and can damage economic prosperity. According to the Federal Emergency Management Agency (FEMA), flooding is the most common natural disaster.[50]

Possible sources of riverine flooding in the region include the Middle Fork of the Willamette River, the Willamette River, and the McKenzie River, as well as numerous smaller creeks and sloughs. Riverine flooding occurs most often in December and January as a result of winter rains. It is most commonly associated with La Niña weather patterns, which can bring prolonged rains and rapid snowmelt. Climate change is expected to cause less frequent but heavier rain and a higher proportion of precipitation falling as rain rather than snow, both of which will increase flood risk in watersheds and basins. The region has already seen a 12% increase in very heavy rain events between 1958 and 2012.

According to FEMA, the region has experienced six major flooding events since the 1860s, with the largest occurring in 1964 and the most recent in 1996. The CLMPO area is protected by several upstream flood control dams on both the McKenzie and Willamette Rivers, and Springfield is protected from the

[49] Lane County Website, *Floodplain Information.*
[50] The Pew Charitable Trust, *Repeatedly Flooded Properties.*

McKenzie River by the 42nd Street Levee.[51] These flood control structures, built in the 1940s through the 1960s, significantly reduced the risk of riverine flooding from larger rivers and tributaries. However, they do not protect against smaller streams, which still pose a flood risk to the area.

An additional, though less significant, flooding threat comes from the potential for dam or levee failure. The failure rate of dams is very low (less than 1%), and over one third of failures are caused by overtopping rather than collapse.[52] However, dam failure is a cascading risk associated with seismic activity, landslides, and volcanic activity. Though the probability is low, there are nine upstream dams that would cause widespread flooding to the CLMPO area if they were to fail.

Potential Impacts from Flooding to the Transportation System

The impacts from flooding to the transportation system range from property damage and risk to human life to road closures and service interruptions. For example, in February 1996, flooding in the Mohawk Valley between Marcola and Springfield closed many Lane County roads and I-5 was inundated just north of Eugene. High stream flows can also accelerate erosion and scour, which can compromise infrastructure.

Regional Efforts to Address Risk from Flooding

The Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan and the Lane County Multi-Jurisdictional Natural Hazard Mitigation Plan both recommend transportation-related strategies to mitigate riverine flooding (Figure 4.14). The Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan also cites several existing hazard mitigation strategies, including widening the focus of flood hazard mitigation to include the management of riparian vegetation; participating in the National Flood Insurance Program (NFIP) and the Community Rating System (CRS), which incentivizes local floodplain management policies and actions that exceed minimum standards set by the NFIP; and the 42nd Street levee, which Springfield owns, operates, and maintains.

Figure 4.14: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan	
Levee Certification *(priority)*	**Seek and maintain certification of the 42nd Street Levee and other flood control structures within Springfield**
Update Floodplain Maps	Actively seek funding to update the Eugene-Springfield floodplain maps focusing on the Willamette River through Eugene and the Mill Race, Willamette River through Glenwood, and the 42nd St Levee seclusion zone in Springfield

[51] According to the Eugene-Springfield Multi-Jurisdictional Natural Hazards Mitigation Plan, the 42nd Street levee must be recertified as structurally adequate to maintain its accreditation: "Areas protected by flood control levees, such as Springfield's 42nd Street Levee, were originally mapped as being protected from the 100-year flood incident. However, in response to numerous levee failures during Hurricane Katrina, levees now must also be certified as being structurally adequate to retain their accreditation as flood control structures. If the City of Springfield is unable to obtain certification for the 42nd Street Levee, the next update of the flood control maps for the section of the McKenzie River paralleled by the levee may be prepared as if the levee was not in place. This would greatly increase the area of the City within the mapped 100-year floodplain" (2-36).

[52] Cities of Eugene and Springfield, *Natural Hazards Mitigation Plan*.

Lane County Multi-Jurisdictional Natural Hazard Mitigation Plan	
Make USACE Inundation Maps Available for Public Viewing	Inform the public on flood hazard to decrease loss of property.
Maintain and Enhance Community Rating System (CRS)	Increase the use of CRS to decrease costs of flood insurance.

Volcanic Hazards

Expected Regional Impacts from Volcanic Hazards

The volcanically active Cascade Range runs from British Columbia, through Washington and Oregon, to northern California, including twelve major volcanos and hundreds of lesser volcanic features. The most active mountain in the range, Mount St. Helens, has erupted over 14 times in the past 4,000 years. There are 20 active volcanoes along the crest of the Cascades in Oregon, including the Three Sisters and Mount Jefferson. Eruptions in the Oregon Cascades in the past 4,000 years have included three on Mt. Hood, four in the Sisters area, two in the Newberry Volcano area, and other minor eruptions near Mount Jefferson, the Santiam Pass near Mount Washington, and near the Belknap Crater.

The Three Sisters, fifty miles east of Springfield, pose the largest volcanic hazard to the region, though the probability of future occurrence is relatively low (one incident is expected within a 75- to 100-year period). Hazards from volcanic activity affecting the CLMPO area include ash falls and lahars. Ash falls from explosive eruptions can blanket hundreds or even thousands of miles downwind in rock fragments. Ash fall from an eruption as far away as Mount St. Helens could affect the CLMPO area, though the impacts would likely be minor in all but the most severe cases. Lahars, which are flows of mud, rock, and water that can move at speeds of 20 to 40 miles per hour, can cover everything in their path in mud and, near the source, can carry trees, houses, and even boulders. Existing communities located on lahar flows from historic eruptions put populated areas at risk from future eruptions. Lahars from the Three Sisters could enter the McKenzie River, which in turn may cause flooding and degrade water quality as far west as the Thurston area on the eastern edge of the metro area. Lahar impact areas in the CLMPO region are expected to look similar to FEMA floodplain maps of the McKenzie River.

Potential Impacts from Volcanic Hazards to the Transportation System

Ash falls can reduce visibility and air quality, impacting many modes of transportation. Lahars can cause damage to transportation assets and lead to road closures that hinder mobility.

Regional Efforts to Address Risk from Volcanic Hazards

The Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan recommends one strategy to mitigate volcanic hazards that may be relevant to transportation (Figure 4.15).

Figure 4.15: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan	
Lahar Risk Study	Evaluate the lahar risk to the McKenzie River Valley

Wildfires

Expected Regional Impacts from Wildfires

Dry summers, hilly topography, and abundant natural fuel sources, such as vegetation, make the CLMPO area susceptible to wildfires. The wildfire hazard is greatest in the hills of Eugene and Springfield, where forested areas with high fuel loads border development, and steep slopes cause faster spread of fire. In addition to the direct threat wildfires can pose to human life and property, they can impair air quality from hundreds of miles away and have significant implications for human health. Climate change will lead to higher average annual temperatures and reduced precipitation in spring, summer, and fall, which will exacerbate wildfire risk. The Eugene-Springfield Area Multi-Jurisdiction Natural Hazards Mitigation Plan, finalized in January of 2020, calculated a high probability that a wildfire will occur in the area within a 0- to 35-year period. By September of 2020, the CLMPO area was threatened by the Holiday Farm Fire, one of many burning simultaneously across the state, which had burned over 173,000 acres and destroyed 431 residences and 24 commercial buildings by October 2; prompted evacuations throughout the McKenzie River Valley, including the Thurston area of Springfield; and caused the worst air quality ever recorded in the Eugene-Springfield area. [53] [54]

Potential Impacts from Wildfires to the Transportation System

Fires cause immediate and direct impacts to transportation infrastructure and public safety. They also increase the long-term risk of erosion, flash flooding, and landslides, as burned areas devoid of vegetation increase runoff with heavy rain, destabilizing slopes. Reduced air quality due to wildfires directly impacts active transportation and can pose risks to public health, particularly for those with impaired lungs.

Regional Efforts to Address Risk from Wildfires

The Eugene-Springfield Area and Lane County Multi-Jurisdictional Natural Hazards Mitigation Plans both recommend transportation-related strategies to mitigate hazards from wildfire (Figure 4.16). Additionally, CLMPO's partner, Lane Regional Air Protection Agency (LRAPA), regulates, monitors, and reports on air quality in the region.

Figure 4.16: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan	
Fuels Reduction	Reduce fuels on public lands, focusing on the hillsides in the southern portions of both Cities
Update the Wildland-Urban Interface (WUI) Plan	Update the Eugene-Springfield WUI plan and address access routes
Species Specific Tree Removal	Identify and remove species with known failure profiles and potential defects. Plant or replant drought tolerant and disease, pest, and damage resistant tree species. Work with City departments, contractors and non-profits to complete this work.
Eugene-Springfield Area Multi-Jurisdictional Natural Hazard Mitigation Plan	
Maintain Vegetation Management Standards	Reduce wildfire fuels near structures and waterways.

[53] The Register-Guard, *Updates: Holiday Farm Fire*.
[54] McDonald, Rachael, *Hazardous Air Quality*.

"Non-Natural" Hazards

Expected Regional Impacts from "Non-Natural" Hazards

"Non-natural" hazards may include civil unrest, dam or levee failures, epidemics, and releases of hazardous materials. These hazards can be triggered as cascading impacts of other hazards, they can be the result of accidents, or they can be caused by acts of terror.

Potential Impacts of "Non-Natural" Hazards to the Transportation System

"Non-natural" hazards could cause widespread disruption to the transportation system. More in-depth research into "non-natural" hazards and their potential effects on the transportation system was beyond the scope of this white paper. However, they could be explored in a future white paper—as the current COVID-19 pandemic is demonstrating, "non-natural" hazards can cause unexpected challenges and opportunities.

Regional Efforts to Address Risk from "Non-Natural" Hazards

The Eugene-Springfield Area and Lane County Multi-Jurisdictional Natural Hazards Mitigation Plan both recommend strategies to mitigate hazards from "non-natural" hazards that may be relevant to transportation (Figure 4.17).

Figure 4.17: Selected Transportation-Related Strategies

Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan	
Vulnerable Populations Two Weeks Ready	Utilizing relevant vulnerable populations maps developed for the Lane Livability Consortium, develop an outreach plan to engage vulnerable populations to be Two Weeks Ready with emergency supplies.
Mass Evacuation *(priority)*	Develop and exercise a City evacuation plan
Lane County Multi-Jurisdictional Natural Hazard Mitigation Plan	
Load GIS layers of dam inundation areas into mass notification system	Accurately notify those in the path of dam inundation floodwaters in time to evacuate.

4.4 Addressing the Three Pillars of Sustainability

This white paper proposes that CLMPO approach resilience through the lens of sustainability to recognize the complex relationships and linkages between social, economic, and environmental factors that contribute to risk and vulnerability. This section explores how to address transportation resilience through the three "pillars" of sustainability: environment, equity, and economy. The sub-sections explore the complex interrelationships between transportation and each of the pillars:

Sustainability Pillar 1: Environment – This sub-section focuses on the documented effects of the transportation system on the natural environment. It considers climate change, air quality, water quality, and wildlife and habitat.

Sustainability Pillar 2: Equity – This sub-section explores the complex relationships between social equity and transportation policy, which has an enormous impact on public health, mobility, access to opportunity, and neighborhood quality.

Sustainability Pillar 3: Economy – This sub-section discusses how disruptions in the transportation system can cause cascading impacts to the economy and explores the wealth creation framework as a way to guide project prioritization.

4.4.1 Sustainability Pillar 1: Environment

This paper has already explored the numerous natural hazards that threaten the transportation system. The transportation system's impacts on the natural environment are also well documented: vehicle emissions impair air quality and contribute to climate change, urban stormwater runoff pollutes nearby waterbodies, transportation corridors fragment natural habitat, ecosystem disturbance allows invasive species to proliferate, and motor vehicles kill hundreds of millions of animals annually.[55]

These environmental impacts should be avoided, where possible, following the mitigation sequencing approach commonly used in wetlands compensatory mitigation under the Clean Water Act:

1. Avoiding the impact altogether by not taking certain action or parts of action
2. Minimizing impacts by limiting degree or magnitude of the action and its implementation by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts
3. Rectifying the impact by repairing, rehabilitating, or restoring affected environment
4. Reducing or eliminating the impact over time by preservation and maintenance operations during life of action or project
5. Compensating for the impacts by replacing, enhancing, or providing substitute resources or environments
6. Monitoring the impact and taking appropriate corrective measures

"Eco-sustainable transportation" is an aspirational framework for transportation planning that goes beyond the traditional definition of sustainable transportation to mitigate the effects of the transportation system on the natural environment. Eco-sustainable transportation is defined as

[55] UC Davis Road Ecology Center, *Wildlife-Vehicle Conflict.*

"transportation systems where the ecological impacts have been minimized so as to pose no threat to ecological systems."[56] An ecological approach challenges us to understand the complex interactions between transportation systems and natural ecosystems.

Climate Change

Transportation is a major source of the greenhouse gas emissions that drive human-induced climate change. CLMPO's 2010 GHG Inventory for the Eugene-Springfield Metropolitan Area concluded that the region is responsible for an estimated 3.2 million metric tons of GHG emissions per year, 31% of which is caused by transportation. The expected regional impacts of climate change and effects on the transportation system are explored at length in Section 4.3 Hazards to the CLMPO Area Transportation System.

CLMPO's GHG Inventory and Scenario Planning efforts (described in Section 3.4 CLMPO Existing Efforts) have provided a broad understanding of GHG emissions sources in the region as well as a suite of strategies to meet the State-set 2050 target for emissions reductions from the transportation sector. The strategies focus heavily on transportation options (TO), parking strategies, and transit as the means to reduce single occupancy vehicle trips and produce other co-benefits, including health outcomes and congestion management. The regional TO program comprises a variety of efforts to encourage alternative transportation modes.

Air Quality

The transportation system has a direct and measurable effect on air quality. Five of the six criteria pollutants designated by the Clean Air Act controlled by the National Ambient Air Quality Standards (NAAQS)—carbon monoxide (CO), lead, nitrogen oxides, ozone, and particulate matter—are byproducts of our transportation modes and systems, and they all have adverse human and environmental health impacts.

LRAPA monitors air quality in the CLMPO area and provides the data necessary for CLMPO's air quality analysis. The Eugene-Springfield area is currently designated as a maintenance area for coarse particulate matter (PM_{10}) under the Clean Air Act. It was designated as a nonattainment area for PM_{10} in 1987, and in 2013 it was re-designated by the Environmental Protection Agency (EPA) to attainment with a 10-year limited maintenance plan, prepared by LRAPA, which requires analysis of certain transportation projects to ensure conformity prior to approval of the Transportation Improvement Program. In 2014, the region completed a 20-year maintenance period for CO, meaning air quality standards for CO have been met for the past 20 years. The area is currently in compliance with standards for ozone and $PM_{2.5}$.

Water Quality

The transportation system—including paved streets and trails, parking lots, and driveways—creates a vast network of impervious surfaces in the urban landscape that accounts for 65% of all impervious surface area.[57] Urban stormwater runoff from impervious surfaces can carry heavy metals and petroleum

[56] Transportation Research Board, *Ecology in Sustainable Transportation.*
[57] Portland Metro, *2018 Regional Transportation Plan.*

products directly into nearby streams and waterways, impairing surface and groundwater quality and damaging sensitive aquatic ecosystems.

The Federal Clean Water Act of 1972 prohibits any release of pollutants into waters of the United States without a National Pollutant Discharge Elimination System (NPDES) Permit, which regulates the amount of certain pollutants permissible in a discharge. Large- and medium-sized cities with municipal separate stormwater sewer systems (MS4s) that discharge untreated stormwater into local waterbodies—including Eugene and Springfield—are required to obtain NPDES Permits. The MS4s of both Eugene and Springfield convey water from streets and properties via a system of catch basins, pipes, ditches, and waterways that drain directly into the Willamette River and its tributaries, such as Amazon Creek in Eugene and the McKenzie River in Springfield.

Recent research from the National Marine Fisheries Service and Washington State University suggests that green infrastructure is an inexpensive, practical way to remove pollutants from stormwater runoff that adversely affects salmon.[58] Green infrastructure has numerous co-benefits, including urban temperature regulation, noise reduction, air purification, traffic calming, habitat, and aesthetic benefits, among many others. Many types of green infrastructure can be safely and effectively integrated into the transportation network, and local jurisdictions are already doing so through programmatic and regulatory actions, including environmental services, storm water programs, and Code requirements.

Figure 4.18: CLMPO and Member Agency Plans that Address Water Quality

Member Agency	Plans and Policies
City of Eugene	– Stormwater Management Manual (2014) – Comprehensive Stormwater Management Plan (1995)
Lane County	– Stormwater Management Plan (2011)
City of Springfield	– Stormwater Management Facility Master Plan (2008) – Stormwater Management Plan (2010)
City of Coburg	– Water Master Plan (2016) – TMDL Implementation Plan (2008)

Wildlife & Habitat

In addition to impairing air and water quality and actively altering the climate on which sensitive ecosystems depend, the transportation system threatens biodiversity by contributing to habitat fragmentation, generating noise and light pollution, and bringing vehicles and wildlife into direct conflict. Urban development directly disturbs ecosystems, which can lead to the proliferation of invasive species. It also disrupts the connectivity of forests, grasslands, and waterways that provide critical habitat for wildlife, which can alter food systems, increase temperatures, and change interactions among species. Habitat fragmentation is particularly detrimental to larger species with greater ranges. Fragmentation can be addressed by improving the permeability of transportation corridors, which act as barriers to wildlife movement. In addition to reducing the amount of contiguous habitat, noise and light pollution generated by the transportation system have deleterious effects on both wildlife and human health. Finally, motor

[58] Hillier, *Saving Salmon from Roadway Runoff.*

vehicles cause a shocking number of animal fatalities. One million vertebrates are struck and killed daily on the nation's roads.[59] These collisions also pose a significant safety threat to drivers.

4.4.2 Sustainability Pillar 2: Equity

Social equity and environmental resilience are interdependent. Vulnerability and risk are not distributed evenly within or across communities. People of color, low-income individuals, women, the elderly, and children often disproportionately bear the burden of natural hazards and climate change. Other factors that exacerbate risk include housing conditions (e.g. having a flammable roof or vegetation within ten meters of the home), social isolation (e.g. linguistic isolation, fear of public agencies, or geographic isolation), lack of health insurance, lack of access to a vehicle, disability status, or institutionalization status. The Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan identifies 15 variables that play a role in vulnerability to natural hazards:

- Age
- Income
- Residence
- Tenure
- Employment
- English skills
- Household type
- Disability
- Home insurance
- Health insurance
- Debt and savings
- Car
- Gender
- Injuries (hazard specific)
- Residence damage (hazard specific)

It is imperative to understand the complex interactions between transportation and social resilience, starting with equity. The transportation system has an enormous impact on public health, mobility, access to opportunity, and the quality of our neighborhoods. Auto dependence contributes to pollution, climate change, reduced physical activity, negative impacts on mental health, and traffic crashes. According to a 2009 PolicyLink report entitled, *Healthy, Equitable Transportation Policy*, "transportation policy *is*, in effect, health policy—and environmental policy, food policy, employment policy, and metropolitan development policy, each of which bears on health independently and in concert with the others."[60]

Transportation policy since World War II has prioritized highway development at the expense of public transportation, which has driven national growth and prosperity while also disproportionately harming low-income and Black, Indigenous, and People of Color (BIPOC) communities—who make up the majority of public transit users—by limiting their access to employment, education, health care, and other social and economic opportunities. The legacy of the highway system is one of inequality and discrimination—the practice of siting major highways in low-income and BIPOC neighborhoods displaced or physically divided entire communities, while the highway system itself has played a central role in promoting urban sprawl, increasing auto-dependence, and reinforcing segregation.

The combined legacy of land use, housing, and transportation policies from the mid-Twentieth Century continue to plague low-income communities and people of color. Residential segregation persists alongside large and growing gaps in income and wealth, which heavily influence transportation options and available infrastructure. Where people live matters—it strongly affects their mobility and access to

[59] Goldfarb, *How Roadkill Became an Environmental Disaster.*
[60] Policy Link, Prevention Institute, and Converge Partnership, *Healthy, Equitable Transportation Policy,* 10.

opportunity and resources. Transportation costs also have an outsized burden on low-income families, who spend a larger portion of their incomes on transportation and often commute farther due to spatial mismatch between their communities and employment opportunities.

Transportation policy has created or exacerbated racial and socioeconomic disparities in public health and safety. People of color and low-income communities are more likely to live in proximity to major highways and the associated vehicle exhaust, which is linked to impaired lung development, lung cancer, heart disease, respiratory illness, and premature death. In addition to being less healthy, the transportation system is less safe for low-income communities and people of color. There is a higher incidence of pedestrian, cyclist, and motorist injuries in low-income neighborhoods, which typically have less pedestrian and bicycle infrastructure.[61] The transportation system also has a deeply troubling role to play in the increased rates of incarceration among BIPOC, particularly Black males. There are staggering racial disparities in the way people of color are treated by law enforcement, including traffic enforcement. For example, black and Hispanic drivers are more likely to be pulled over in "discretionary" (rather than safety) stops than white drivers and are significantly more likely to be searched or arrested. Whether due to latent racial bias or overt discrimination, these practices expose people of color to increased incarceration rates and a greater risk of injury and death during a police encounter.[62]

Title VI of the Civil Rights Act of 1964 prohibits "discrimination on the basis of race, color, and national origin, including matters related to language access for limited English proficient (LEP) persons."[63] Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* of 1994 builds on Title VI and is intended "to prevent minority communities and low-income communities from being subject to disproportionately high and adverse environmental effects."[64] The 2045 RTP will include a Title VI analysis and plan to evaluate disproportionate impacts to these populations.

4.4.3 Sustainability Pillar 3: Economy

The movement of goods and people is an indicator of economic activity that relies heavily on the transportation system, which plays a key role in facilitating access to employment, goods, and services. According to the Transportation Research Board, in 2014 the estimated contribution of the transportation sector to GDP was valued at $1,001.9 billion.[65] Though its direct impacts can be difficult to measure and quantify, there are many ways in which investments in transportation infrastructure and services can support the economy and increase economic competitiveness:

- Commuting – make travel to work faster, more reliable, and cheaper; improve connections between employers and the specialized skill sets they require
- Freight Delivery – increase availability of specialized supplies, improve reliability and reduce costs of shipping

[61] Sanchez, Stolz and Ma 2003, *Moving to Equity.*
[62] The Sentencing Project 2018, *Report to the United Nations.*
[63] FTA, *Circular 4702.1B, Title VI Requirements and Guidelines for FTA Recipients*, 12.
[64] FTA, *Circular 4703.1: Environmental Justice Policy Guidance for Federal Transit Administration Recipients*, 3.
[65] Firestone and White, *Economic Value*.

- **Production** – generate market efficiencies; support economies of scale, economies of specialization, and just in time production
- **Supply Chain** – reduce transportation costs, improve reliability, increase connectivity
- **Product to Consumer** – increase access to goods and services, reduce product delivery cost

Disruptions in the transportation system can cause cascading impacts to the economy by limiting mobility and access and interrupting the supply chains that provide raw materials and goods. A resilient transportation system that has the ability to withstand disruptions and adapt to changes can therefore help insulate a community from events that threaten economic stability.

Economic resilience goals should be integrated into the transportation planning process to ensure synergy. Economic outcomes from transportation projects are commonly measured by changes in employment, income, business output, GDP, building floor area, direct private investment, property values, and property tax revenue. However, a broader understanding of community outcomes can help contextualize transportation and related investments beyond jobs and return on investment. According to the National Association of Development Organizations (NADO), transportation is a key component of the wealth creation framework, which is a holistic approach to regional economic and community development that incorporates eight kinds of community capital:

1. Social – Trust, networks
2. Natural – Land, water, air, biodiversity
3. Political – Influence in decision-making
4. Built – Infrastructure and service
5. Individual – Skills, health, wellness
6. Cultural – Traditions, world view
7. Financial – Monetary resources available for investment
8. Intellectual – Knowledge, resourcefulness, creativity

According to the framework, a robust, resilient, and sustainable economy is one that promotes and sustains each form of capital rather than focusing on one or two at the expense of the others. Wealth creation initiatives are intentionally inclusive and focused on local ownership and control of assets. NADO suggests that the wealth creation framework may be useful in transportation planning efforts as a means to strengthen the linkages among the different kinds of capital to increase both transportation and economic resilience. Transportation infrastructure and services are part of a region's built capital, and investments to the transportation network support other kinds of capital—such as individual, intellectual, and social capital—by connecting people to employment, education, health services, and each other. Figure 4.19 illustrates ways in which the wealth creation framework may help guide project prioritization to support specific types of capital and ensure consistency with regional goals and vision.

Figure 4.19: Asset-Based Project Criteria for Transportation Projects

Type of Capital	Asset-Based Project Criteria
Built	– Does the project improve the condition of the existing network? – Can new capacity or services be maintained in the future without becoming a liability?
Political	– Is the project in line with the community or regional vision and supported by stakeholders?

	– Can project sponsors address any concerns that might impede project delivery?
Financial	– Is the project likely to retain or increase jobs that pay a living wage? – Is the project likely to leverage other investments? – Does the project support financial success of families, businesses, or other regional institutions? – Is there investment by the community in the form of matching funds or preliminary engineering?
Individual	– Does the project increase access to job sites within or near the region? – Does the project increase access to education, job training, or other sites to build skills? – Does the project increase access to healthcare or wellness? – Does the project help to avoid healthcare costs, e.g. by increasing active transportation or improving transportation safety?
Natural	– Does the project support revitalization or new development in areas targeted for growth? – Does the project avoid harm to natural resources? – Does the project include environmental services, such as green infrastructure to help manage stormwater runoff?
Social Capital	– Does the project facilitate people making connections with one another or building trust (e.g. connecting to a community center or place where people gather)?
Cultural	– Does the project enhance, complement, or protect the qualities like about their community or region? – Does the project avoid harm to local cultural or historical sites or resources? – Does the project improve access to locally important sites or events? – Does the project address mobility concerns of businesses involved in sectors important to regional identity? – Is the project in line with cultural norms, recognizing that norms change over time?
Intellectual	– Does the project support regional innovation? – Does the project invest in ITS? – Does the project prepare the region for evolving transportation technologies?

5. RECOMMENDATIONS

CLMPO has the option to take a broad, sustainability-based approach to planning for resilience that considers the environmental, equity, and economic feedback loops and linkages that contribute to or hinder the region's ability to survive disruptions. Recommendations for how to incorporate resilience and stormwater into the 2045 RTP include:

1. **Thread resilience into the goals, objectives, and policies of all priority areas.** As proposed to date, there are seven priorities the RTP will address: Transportation Choices, Safety and Security, Healthy People and Environment, Equity, Competitive Economy, Reliability and Efficiency, and Preservation. Resilience is currently incorporated into Safety and Security in the form of two objectives and one policy, which relate to the vulnerability of the system to various hazards as well as regional emergency response and recovery planning. CLMPO could consider making Resilience an eighth, stand-alone priority, as it is a large enough topic and a significant enough priority to warrant specific and explicit focus. CLMPO could also consider incorporating resilience more fully and more explicitly throughout the goals, objectives, and policies associated with the other seven priorities. The ideas for goals, objectives, and policies presented in Figure 5.1 are just some examples of how CLMPO could incorporate resilience into the 2045 RTP; they borrow heavily from the resources discussed above (including the RTPs of DVRPC, PSRC, and Metro, as well as the FHWA literature review) and are intended to be a starting point for conversation around these themes.

Figure 5.1: Ideas for Additional Goals, Objectives, and Policies

Resilience	Goal: Lead the development of resilient transportation systems and services that anticipate, prepare for, and adapt to both natural and non-natural hazards Objectives: – Reduce the transportation system's vulnerability to natural disasters, climate change, and hazardous incidents – Prepare the transportation system for the impacts of climate change – Increase the redundancy of the transportation system – Protect the transportation system against disaster, develop prevention and recovery strategies, and plan for coordinated emergency response – Avoid transportation-related development in hazard areas, e.g. steep slopes and floodplains Strategies: – Develop a local system of Emergency Transportation Routes that add redundancy to the state's Lifeline Routes – Conduct a formal vulnerability assessment for the region to evaluate risks to critical transportation assets and identify strategies and actions to reduce vulnerability – Consider climate and other natural and non-natural risks during transportation planning, project development, design, and management processes – Integrate green infrastructure into the transportation network when practicable to avoid, minimize, and mitigate negative environmental impacts of climate change, natural disasters, and extreme weather events

	– Coordinate and cooperate with federal, state, local, and other agencies involved in regional resiliency, transportation security planning, emergency response efforts, and recovery efforts – Incorporate resilience into project evaluation criteria – Use climate projections instead of historical data to plan, maintain, and construct system elements, e.g. pavement, bridges, and drainage systems – Develop a project-level checklist to evaluate facility risks and vulnerability due to natural and non-natural hazards at the time funding is programmed, and incorporate project design features to improve resiliency of facilities and infrastructure
Transportation Choices	Objectives: – Develop a multimodal transportation system that cultivates economic development, growth, and resiliency
Safety & Security	Objectives: – Reduce the transportation system's vulnerability to natural disasters and climate change Strategies: – Prioritize funding projects that improve both safety and efficiency
Healthy People & Environment	Objectives: – Design transportation improvements that protect the environment by preserving air and water quality, minimizing noise impacts and light pollution, preserving habitat connectivity, and encouraging energy conservation – Become a model for how diverse urban areas can fight against climate change – Minimize the amount of stormwater runoff that enters the region's streams – Protect natural resources and conserve scenic and historic areas and open spaces, including the urban tree canopy and other green infrastructure Strategies: – Integrate green infrastructure strategies in transportation planning and design to avoid, minimize, and mitigate adverse environmental impacts, improve water quality, and manage stormwater – Pursue a diverse set of strategies identified in the Central Lane Scenario Planning preferred scenario to reduce transportation-related greenhouse gas emissions – Identify, preserve, and enhance significant open spaces networks, wildlife corridors, and linkages across jurisdictional boundaries – Remove transportation-related barriers to wildlife movement and reconnect key habitat corridors – Support land use policies that promote compact development that reduces the need for travel in single occupancy vehicles – Support local policies that reduce impervious coverage – Promote the planting and stewardship of street trees in urban and suburban areas
Equity	Objectives: – Ensure that resilience infrastructure is accessible to the region's most vulnerable residents Strategies: – Engage vulnerable populations and ensure that the voices of underrepresented populations are included in conversations and decision-making about transportation resilience – Support local policies that prevent displacement – Support local policies that site affordable housing with transit-oriented development

Competitive Economy	Objectives: – Develop a multimodal transportation system that cultivates economic development, growth, and resiliency – Pursue a sustainable multimodal freight transportation system that supports the health of the economy, communities, and the environment through clean, green, and smart technologies and practices – Protect freight network assets that are vulnerable to natural hazards Strategies: – Use triple bottom line accounting, which considers social, environmental, and financial impacts, to guide decision-making
Reliability & Efficiency	Objectives: – Develop a resilient transportation network that can maintain or re-establish reliability and efficiency quickly following shocks and disruptions to facilitate emergency response and long-term recovery Strategies: – Incorporate asset-based project criteria for transportation projects following the wealth creation framework
Preservation	Objectives: – Preserve and maintain the region's motor vehicle, transit, and bike/ped infrastructure in a way that improves safety, security, and resiliency while minimizing life cycle cost and impact to the environment

2. **Thread resilience throughout the document where relevant.** Resilience is so interrelated with all other aspects of transportation planning that it should be integrated into the conversation rather than relegated to a distinct section where linkages may be obscured. That said, further detail about resilience should be included as an appendix.

3. **Include a robust resilience section in the appendix.** A complete section that discusses hazards, vulnerabilities, CLMPO's role in promoting transportation resilience, and local efforts to address resilience should be included for reference in the appendix.

4. **Consider a broad range of hazards to the transportation system.** Many resilience resources, including guidance from the FHWA, focus on climate change as the primary hazard. However, there are many efficiencies to be gained by considering a broad range of hazards together. It is critical to understand the vulnerability of our transportation system to a broad range of hazards, keeping in mind the cascading effects that can both exacerbate and be exacerbated by social equity, environmental, and economic linkages. Hazards may include climate change, seismic events, stormwater, riverine flooding, landslides, extreme weather, drought, wildfires, volcanic hazards, geometric disturbance, "non-natural" hazards (e.g. civil unrest, epidemics, releases of hazardous materials), and possibly others.

5. **Conduct additional research and outreach to fill in gaps, strengthen analysis, and ensure consistency with local efforts.** This white paper focused on how to incorporate resilience into the 2045 RTP, however, there are opportunities to advance this research in several ways. First, a much more robust outreach effort that incorporates feedback from related local, state, and federal agencies and organizations is needed to meet federal guidelines on

collaboration and to more fully understand the local context. Needs for additional research and outreach include: develop a more complete understanding of existing local plans, policies, and actions to address potential hazards to the transportation system; create a more specific set of potential strategies to address social and economic resilience; better integrate natural resource planning and transportation planning; and consider travel modes and their specific vulnerabilities to hazards and contributions to resilience planning efforts. See Appendix Section 6.1 Collaboration for recommendations about additional outreach and collaboration.

6. Add resilience-related terms to the glossary. See Appendix Section 6.2 Glossary for recommendations on terms to include.

7. Commit to taking positive steps as a region toward increasing transportation resilience beyond the RTP update. Next steps may include (in no particular order):

   - Conduct a formal vulnerability assessment. A vulnerability assessment is a key step in improving the resilience of the transportation system–in order to take steps to mitigate risk and therefore improve the resilience of the system, a transportation agency must first understand the risks that threaten the system as well as its existing capacity to deal with those risks. See Section 4.2 for a discussion of FHWA guidance on vulnerability assessment.

   - Develop a local and regional Emergency Transportation Route network and prioritize retrofits. Local and regional Emergency Transportation Routes complement and extend the Statewide Lifeline Routes, connecting across jurisdictions and providing access to staging areas, essential infrastructure, and intermodal transfer points. Portland Metro is currently in the process of updating its regional Emergency Transportation Routes; CLMPO could follow and learn from Metro's process.

   - Incorporate resilience into project evaluation and development. Use resilience in the evaluation and prioritization of projects and incorporate it into project design and engineering. Conduct research into how other agencies have successfully incorporated resilience goals and performance measures into project evaluation and development.

   - Explore opportunities to develop a Continuity of Operations Plan (COOP) or similar internal emergency plan. A COOP is only activated when a disturbance disrupts the internal operation of a transportation agency. COOPs support other emergency response plans by providing a roadmap to ensure continuous performance of essential functions and operations; protect essential facilities and assets; reduce or mitigate disruptions to operations; minimize loss of life, injury, and property damage; and help agencies recover and resume full services quickly and efficiently. COOPs establish procedures for alerting and activating employees, identifying critical agency or business functions, identifying alternate facilities that can house operations during a disruption, delegating authority or orders of succession, and resuming normal operations. FEMA and the Transportation

Research Board have provided guidance on COOP development, and CLMPO could follow the lead of other MPOs across the country that have developed their own COOPs.

- Consider becoming an official Eugene-Springfield Area Multi-Jurisdictional Natural Hazards Mitigation Plan Sub-Plan Holder. Sub-Plan Holders participate in the 5-year plan update cycle, hazard identification and risk assessment, and take part in annual mitigation action reviews. Becoming a Sub-Plan Holder can help improve communication and coordination as well as leverage individual capacities to implement comprehensive mitigation actions, share costs and resources, and avoid duplicating of efforts.

8. Identify potential funding sources to integrate these action items into planning. Get creative and look beyond traditional funding sources. Consider transportation's connections to other fields, such as public health and disaster management.

6. APPENDIX

6.1 Collaboration

In accordance with 23 CFR 450.316 and 23 CFR 450.324, CLMPO must consult with appropriate tribal, federal, state, and local agencies responsible for other planning activities affected by transportation, including state and local planned growth, economic development, tourism, natural disaster risk reduction, environmental protection, airport operations, or freight movements. In the 2045 RTP, CLMPO must document the agreed-upon consultation processes, any comments received, and the disposition of comments and how CLMPO addressed them.

Additional research is needed to identify agencies local to the CLMPO area to ensure that all appropriate entities are included in consultation. CLMPO would benefit from consultation specifically in pursuit of Planning Factor 9, including water resources management agencies and watershed councils, agencies or departments dealing with hazard mitigation and natural disaster risk reduction, agencies responsible for planning and regulation around air quality and climate change, public health agencies, and economic development agencies. Figure 6.1 presents some ideas for additional consultation that borrows heavily from Metro; this list is not comprehensive and should be considered a starting point.

Figure 6.1: Ideas for Additional Consultation

Agency Type	CLMPO List of Agencies to Consult
Tribal Governments	– Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians – Confederated Tribes are Siletz Indians
Water Resources Management	– US Army Corps of Engineers – Oregon Water Resources Department – Oregon Department of Environmental Quality – Oregon Department of State Lands – Oregon Watershed Enhancement Board – Eugene Water and Electric Board – Springfield Utility Board – Rainbow Water District – Lane County Water Resources – City of Springfield Development and Public Works Department – City of Eugene Department of Public Works – City of Coburg Department of Public Works
Hazard Mitigation and Natural Disaster Risk Reduction	– Lane County Emergency Management – City of Eugene Emergency Management – City of Springfield Emergency Management – Lane Preparedness Coalition
Air Quality and Climate Change	– US Environmental Protection Agency – Oregon Department of Environmental Quality – Oregon Department of Energy – ODOT Climate Office – Lane Regional Air Protection Agency
Public Health	– Lane County Public Health

	– Oregon Health Authority
Economic Development	– City of Eugene Economic Development – City of Springfield Economic Development – City of Coburg Economic Development – Lane County Community & Economic Development Department – Business Oregon

6.2 Glossary

The following terms relate to Planning Factor 9 themes. Most terms in this section are pulled directly from Portland Metro's 2018 Regional Transportation Plan.

Adaptation – This term refers to adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects.

Adaptive Capacity – This term refers to a system's ability to change in response to shocks and stresses to maintain normal functioning.

Climate change – Any significant change in the measures of climate lasting for an extended period of time. Climate change includes major variations in temperature, precipitation or wind patterns, among other environmental conditions, that occur over several decades or longer. Changes in climate may manifest as a rise in sea level, as well as increase the frequency and magnitude of extreme weather events now and in the future.

Emergency – Any human-made or natural event or circumstance causing or threatening loss of life, injury to person or property, and includes, but is not limited to, fire, explosion, flood, severe weather, drought earthquake, volcanic activity, spills or releases of oil or hazardous material, contamination, utility or transportation disruptions, and disease.

Emergency transportation routes – Priority routes used during and after a major regional emergency or disaster to move people and response resources, including the transport of first responders (e.g., police, fire and emergency medical services), fuel, essential supplies and patients.

Exposure – This term refers to whether an asset or system is located in an area experiencing direct effects of a hazard, such as climate change.

Environmental mitigation activities – Strategies, policies, programs, and actions that, over time, will serve to avoid, minimize, rectify, reduce or eliminate impacts to environmental resources associated with the implementation of a long range statewide transportation plan or metropolitan transportation plan.

Extreme events – This term refers to risks posed by climate change and extreme weather events. The definition does not apply to other uses of the term nor include consideration of risks to the transportation system from other natural hazards, accidents, or other human induced disruptions.

Extreme weather events – Significant anomalies in temperature, precipitation and winds and can manifest as heavy precipitation and flooding, heatwaves, drought, wildfires and windstorms (including tornadoes). Consequences of extreme weather events can include safety concerns, damage, destruction and/or economic loss. Climate change can also cause or influence extreme weather events.

Greenhouse gas emissions – The six gases identified in the Kyoto Protocol and by the Oregon Greenhouse Gas Mandatory Reporting Advisory Committee as contributing to global climate change: carbon dioxide (CO2), nitrous oxide (N2), methane (CH4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). Greenhouse gases absorb solar radiation and act like a heat-trapping blanket in the atmosphere, causing climate change. More information is available at epa.gov/climate change.

Green infrastructure – A network of multi-functional green spaces and environmental features, both natural and engineered, that use or replicate natural systems to better manage stormwater, protect streams and enhance wildlife corridors—trees, soils, water and habitats. Examples include: permeable paving, vegetated swales, rain gardens, green streets, green roofs, green walls, urban forestry, street trees, parks, green corridors such as trails, and other low impact development practices.

Green streets – An innovative stormwater management approach that captures rain where it falls by using vegetation, soil and engineered systems to slow, filter and clean stormwater runoff from impervious surfaces.

Mitigation – Planning actions taken to avoid an impact altogether, minimize the degree or magnitude of the impact, reduce the impact over time, rectify the impact, or compensate for the impact. Mitigation includes:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.
(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
(e) Compensating for the impact by replacing or providing substitute resources or environments.

Resilience or resiliency – Resilience is the ability of a socio-environmental system to survive and transform in order to sustain itself.

Security (public and personal) – Protection from intentional criminal or antisocial acts while engaged in trip making through design, regulation, management, technology and operation of the transportation system.

Sensitivity – This term refers to how the asset or system fares when exposed to the hazard.

Sustainability – Sustainability is a paradigm for thinking about the future in which environmental, societal, and economic considerations are balanced in the pursuit of an improved quality of life

Sustainable – A method of using a resource such that the resource is not depleted or permanently damaged.

Vulnerability – Vulnerability in the transportation context is a function of the asset's or system's sensitivity, exposure, and adaptive capacity. Exposure refers to whether an asset or system is located in an area experiencing direct effects of a hazard; sensitivity refers to how the asset or system fares when exposed to the hazard; and adaptive capacity refers to the system's ability to change in response to shocks and stresses to maintain normal functioning.

6.3 A Case for Establishing Regional Emergency Transportation Routes

Proposed Project Summary

Emergency Transportation Routes (ETRs) are priority routes that facilitate lifesaving and life-sustaining response activities during an emergency. The transportation system in the Central Lane Metropolitan Planning Organization (CLMPO) region is vulnerable to numerous natural and non-natural hazards. Establishing a set of regional ETRs represents a key opportunity to enhance the transportation resilience of the region and contribute to security and emergency planning efforts led by emergency response and public safety agencies. This project would help address federal regional transportation planning requirements and is consistent with the 2021 transportation priorities of the Oregon Metropolitan Planning Organization Consortium (OMPOC). Project goals could include:

1. Designate a regionally accepted and catalogued network of regional ETRs that provide connectivity to critical infrastructure, essential facilities, population centers, and vulnerable communities.
2. Build a comprehensive dataset for use in future planning.
3. Develop a set of recommendations for follow-on work, including a prioritized list of potential retrofits needed to increase regional ETR resilience to hazards.

Background

What are Emergency Transportation Routes?

ETRs are priority routes targeted for rapid damage assessment and debris removal during an emergency to facilitate lifesaving and life-sustaining response activities. ETRs are expected to play a key role in post-disaster recovery efforts. There are four types of ETRs:

Local Emergency Response Streets are a network of streets in a single jurisdiction that facilitate ordinary fire, police, and medical emergencies.

Local Emergency Transportation Routes are pre-designated routes used during a large-scale event in the initial response phase and early recovery to transport first responders, fuel, supplies, and patients. Local ETRs connect regional nodes to destinations of local importance (e.g. staging

areas, essential infrastructure, and intermodal transfer points) and add redundancy to Statewide Lifeline Routes.

Regional Emergency Transportation Routes are pre-designated routes that move first responders and supplies across jurisdictional boundaries among regional nodes and connect population centers, critical infrastructure, and services of regional importance. Regional ETRs also connect Statewide Lifeline Routes and local ETRs.

Statewide Lifeline Routes are state-owned roadways identified by the Oregon Department of Transportation (ODOT) as critical to emergency response and recovery activity. Lifeline Routes connect regions of statewide importance via a few key north-south and east-west routes.

Why are Regional Emergency Transportation Routes Important?

The transportation system in the CLMPO area is vulnerable to numerous hazards, including stormwater, seismic hazards, climate change, extreme weather, geomagnetic disturbance, volcanic hazards, landslides, and "non-natural" hazards. The catastrophic wildfire events across the State of Oregon in 2020 underscored the vulnerability of the transportation system to natural hazards and the need to provide a set of clearly established emergency routes. Unfortunately, prolonged drought and record heat indicate earlier and possibly more severe wildfire seasons going forward in Oregon. Eighty percent of Lane County is currently experiencing severe to extreme drought; the Eugene-Springfield area is listed in the extreme category and at risk of high wildfire activity.[66]

There is also a clear and imminent threat from seismic activity along the Cascadia Subduction Zone (CSZ), a 620-mile fault that runs along the coast from Northern California to Southern British Columbia. The region's transportation networks will play a key role in the state's recovery following a CSZ earthquake, first in facilitating emergency response and then restoring mobility. Immediately following a CSZ event, local roads and streets may provide the only access to critical facilities like hospitals, fire stations, and temporary food and housing. Much of the local road network would be subject to serious damage, but in some cases local roads and streets could provide redundancy for the state highway lifelines. As lifeline routes are restored, transit buses can assist in evacuations, transport emergency workers and supplies, and provide transportation to recovery-related jobs. Identification and evaluation of ETRs prior to a catastrophic CSZ event will be critical to emergency response and will help prioritize investments in seismic retrofitting to prepare critical lifelines in the transportation system and reduce the anticipated economic impact.

What is the Role of the Central Lane Metropolitan Planning Organization?

CLMPO is subject to the Fixing America's Surface Transportation (FAST) Act, which requires MPOs to develop long range transportation plans that address ten Federal Planning Factors. Planning Factor 9 requires MPOs to consider how they will "improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation" *(23 CFR 450.306(b)(9)).* The Planning Factor 9 White Paper presented to TASC in October of 2020 explores how to integrate resilience into CLMPO's 2045 RTP. ETRs were identified as a key opportunity for CLMPO to enhance the

[66] https://www.drought.gov/states/oregon/county/Lane

transportation resilience of the region and contribute to security and emergency planning efforts led by emergency response and public safety agencies.

Additionally, OMPOC, comprising all eight MPOs in the State of Oregon, has identified improving the resiliency of the transportation system as a 2021 transportation priority in a June 2021 memo. The memo, directed to Congress and reviewed by the CLMPO Metropolitan Policy Committee, stated the case with urgency:

> *We ask Congress to advance resiliency as a key outcome in federal grant programs, dedicate funding to support capital projects to improve resiliency, and acknowledge that resiliency needs differ across the country, from flooding and coastal degradation, to earthquake preparedness, to fire safety…We need dedicated funds for planning, interagency coordination, maintenance and capital improvements to strengthen current emergency routes and identified lifelines. This type of coordinated, multi-jurisdictional planning is complicated, expensive, and valuable because it helps jurisdictions identify and prioritize needs…Investing now will also help accelerate response and recovery times within the region and help ensure equitable outcomes.*

As a next step in planning for seismic resilience, CLMPO could follow the lead of Portland Metro, which has designated a network of regional ETRs to complement the statewide system of Lifeline Routes. In 2019, upon recommendation in its 2018 RTP, Portland Metro partnered with the Regional Disaster Planning Organization (RDPO) to update its regional network of ETRs, which were designated in 1996 and last updated in 2006. A similar project led by CLMPO could leverage existing state and local efforts to identify and assess priority routes through the region, including ODOT's Statewide Lifeline Routes and Lane County's network of ETRs, designated in collaboration with ODOT.

To further enhance the transportation resilience of the region, CLMPO's effort could focus on identifying additional local and regional routes—particularly through the MPO area—to ensure that all critical facilities, population centers and vulnerable communities, Lane County ETRs, and Statewide Lifeline Routes are connected during an emergency. Lane County's effort to designate ETRs focused on establishing alternate routes on Lane County roads where there were either fewer seismically vulnerable bridges or lower rehabilitation and replacement costs. CLMPO's effort could expand on Lane County's ETR evaluation framework to include additional factors such as connectivity, access, route resilience, community, and equity following Portland Metro's model (see Figure 2 below). Additionally, bicycle and pedestrian infrastructure could be considered as part of the analysis.

Developing Regional Emergency Transportation Routes in the CLMPO Region

Key Partners & Stakeholders

Regional and multidisciplinary collaboration is key to ensuring that there is one set of regionally recognized ETRs through the CLMPO region. Key partners for designating regional ETRs will have expertise in emergency management, transportation planning, public works, engineering, operations, ports, and public transit. In addition to public engagement, an effort to designate regional ETRs in the CLMPO region could include:

- DOGAMI
- ODOT
- Lane County

- Transit Providers (LTD, LCOG, South Lane Wheels)
- Cities of Eugene, Springfield, Coburg, Creswell, Cottage Grove, Florence
- Transportation, emergency management, & public works departments of each jurisdiction
- University of Oregon
- Port of Siuslaw
- Association of Oregon Counties

Current Funding Opportunities

The following grant programs represent potential funding opportunities for establishing regional ETRs in the CLMPO region. Not all programs listed are currently available to the CLMPO region; many require a Presidentially declared disaster. There may be additional funding opportunities for transportation resilience associated with an infrastructure bill.

FUNDING PROGRAM	DESCRIPTION	ELIGIBILITY
BUILDING RESILIENT INFRASTRUCTURE AND COMMUNITIES (BRIC) HTTPS://WWW.OREGON.GOV/OEM/EMRESOURCES/GRANTS/PAGES/HMA.ASPX	Pre-disaster FEMA program that supports states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is a new FEMA pre-disaster hazard mitigation program that replaces the existing Pre-Disaster Mitigation (PDM) program. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. State funds managed by state hazard mitigation officer (SHMO) under the state Hazard Mitigation Assistance program.	SHMO may apply on behalf of sub-applicants
STATE HOMELAND SECURITY PROGRAM (SHSP) HTTPS://WWW.FEMA.GOV/GRANTS/PREPAREDNESS/HOMELAND-SECURITY	FEMA program that supports implementation of state homeland security strategies to address planning, organization, equipment, training, and exercise needs to prevent, prepare for, protect against, and respond to, acts of terrorism and other catastrophic events. Eligible projects address an identified gap to prevent, prepare for, protect against, and respond to acts of terrorism or other catastrophic events, and support at least one of the state investment justifications.	Local and tribal units of government (including any council of government)
EMERGENCY MANAGEMENT PERFORMANCE GRANT (EMPG) HTTPS://WWW.FEMA.GOV/GRANTS/PREPAREDNESS/EMERGENCY-MANAGEMENT-PERFORMANCE	FEMA program that provides state, local, tribal and territorial emergency management agencies with the resources required for implementation of the National Preparedness System and works toward the National Preparedness Goal of a secure and resilient nation. The EMPG's allowable costs support efforts to build and sustain core capabilities across the prevention, protection, mitigation, response and recovery mission areas.	Counties, Tribes, Cities > 85,000

FUNDING PROGRAM	DESCRIPTION	ELIGIBILITY
TRANSIT SECURITY GRANT PROGRAM HTTPS://WWW.FEMA.GOV/GRANTS/PREPAREDNESS/TRANSIT-SECURITY	FEMA program that provides funding to eligible public transportation systems (which include intra-city bus, ferries and all forms of passenger rail) to protect critical transportation infrastructure and the traveling public from terrorism, and to increase transportation infrastructure resilience.	Lane Transit District
REGIONAL CATASTROPHIC PREPAREDNESS GRANTS HTTPS://WWW.FEMA.GOV/GRANTS/PREPAREDNESS/REGIONAL-CATASTROPHIC	FEMA program that supports the building of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation by providing resources to close known capability gaps in Housing and Logistics and Supply Chain Management, encouraging innovative regional solutions to issues related to catastrophic incidents, and building on existing regional efforts.	Local governments as defined by 2 C.F.R. 200.64 (includes council of governments)
HAZARD MITIGATION GRANT PROGRAM (HMGP) HTTPS://WWW.OREGON.GOV/OEM/EMRESOURCES/GRANTS/PAGES/HMA.ASPX	Post-disaster FEMA program that provides funding to state, local, tribal and territorial governments to rebuild in a way that reduces, or mitigates, future disaster losses in their communities. This grant funding is available after a Presidentially declared disaster. State funds managed by SHMO under the state Hazard Mitigation Assistance program.	SHMO may apply on behalf of sub-applicants
HAZARD MITIGATION POST FIRE GRANT HTTPS://WWW.FEMA.GOV/GRANTS/MITIGATION/POST-FIRE	A subset of FEMA's post-disaster HMGP that provides Post Fire assistance to help communities implement hazard mitigation measures after wildfire disasters. Available in communities affected by fires resulting in a Fire Management Assistance Grant declaration on or after Oct 5, 2018.	States, tribes and territories
COMMUNITY DEVELOPMENT BLOCK GRANT- DISASTER RESILIENCE (CDBG-DR) HTTPS://WWW.HUDEXCHANGE.INFO/PROGRAMS/CDBG-DR/	HUD program that provides flexible grants to help cities, counties, and states to recover from Presidentially declared disasters, especially in low-income areas. CDBG-DR assistance may fund a broad range of recovery activities, including disaster relief, long-term recovery, restoration of infrastructure, housing, and economic revitalization. HUD allocates funds based on unmet recovery needs and notifies eligible States, cities, and counties if they are eligible.	State agencies, nonprofit organizations, economic development agencies, citizens, businesses
COMMUNITY DEVELOPMENT BLOCK GRANT –MITIGATION (CDBG-MIT) HTTPS://WWW.HUDEXCHANGE.INFO/PROGRAMS/CDBG-MIT/	HUD program that provides assistance in areas by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks and reduce future losses. Mitigation activities are defined as activities that increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, ad suffering and hardship by lessening the impact of future disasters.	Jurisdictions and nonprofit organizations within "Most Impacted and Distressed" (MID) areas resulting from a qualifying major disaster

Case Study: Portland

In 2019, upon recommendation in its 2018 RTP, Portland Metro partnered with the Regional Disaster Planning Organization (RDPO) to update its ETRs for the five-county Portland-Vancouver Metro Region, which were designated in 1996 and last updated in 2006. Funding for the project came from FEMA's Urban Areas Security Initiative (UASI) grant, which funds projects that enhance regional preparedness and expand regional collaboration in major metropolitan areas.[67]

With help from a team of consultants and Portland State University's Transportation Research and Education Center (TREC), Metro and RDPO evaluated the existing regional ETRs primarily through a seismic lens (including landslide risk) with GIS analysis. The update consisted of a literature review conducted by TREC, which included a summary of recent work and identified best practices and considerations for updating regional ETRs. A multi-disciplinary work group including over 30 representatives from 17 agencies provided expertise in emergency management, transportation planning, public works, engineering, operations, ports, and public transit.

The goals of the first phase of the update (2019-2021) were to designate an agreed-upon and catalogued network of regional ETRs, build a comprehensive dataset for use in future planning and update efforts, and conduct evaluation and analysis that will aid future phases of work. Phase 2 will involve prioritizing, operationalizing, and formalizing identified regional ETRs over a period of one to five years.

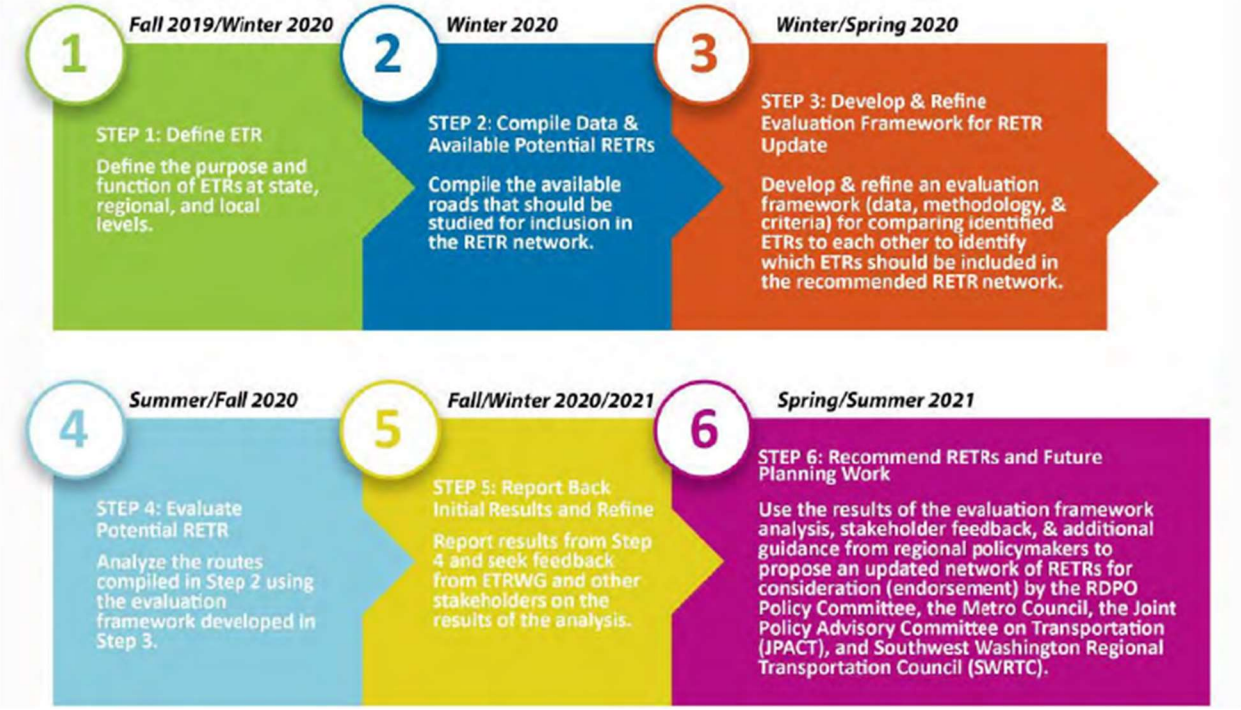
Phase 1 outcomes included:

- 195 designated routes (89 of which were new) connecting over 75% of State and regional critical infrastructure and essential facilities
- Enhanced visibility of regional ETRs through regional dialogue
- Regionally accepted network that provides adequate connectivity to critical infrastructure and essential facilities, as well as region's population centers and vulnerable communities, and connects to Statewide Lifeline Routes
- Comprehensive GIS database & online regional ETR viewer
- Regionally accepted set of recommendations for follow-on work

The project methodology (Figure 1) included defining key terms; compiling data on existing regional ETRs and detour routes, tunnels and culverts, essential facilities, critical infrastructure, ODOT bridge seismic vulnerability, geologic hazard data, current and projected population growth distribution, demographic data, designated over-dimensional freight routes, and utilities; developing and refining an evaluation framework for regional ETRs, including connectivity and access, route resilience, and equity (Figure 2); evaluating potential regional ETRs using GIS; conducting extensive stakeholder engagement; and recommending regional ETRs and future planning work.

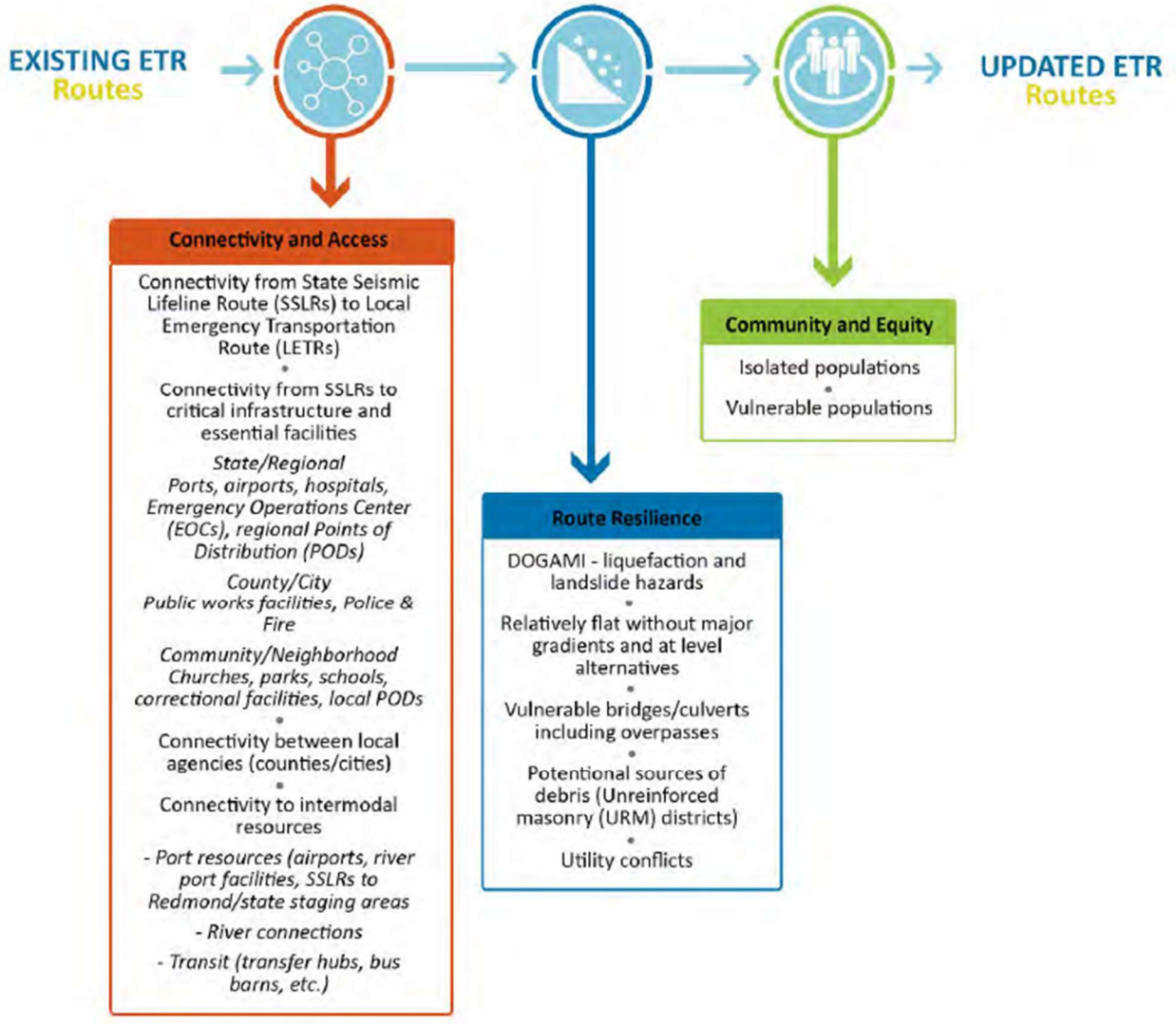
[67] Eligibility is determined through an analysis of relative risk of terrorism faced by the 100 most populous Metropolitan Statistical Areas in the United States. Per the 2021 UASI Program Guidance, the Portland Area is the only eligible urban area in Oregon.

Figure 1: Phase 1 Methodology and Timeline



Note: RETR = Regional Emergency Transportation Route

Figure 2: Evaluation Framework



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